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Proceedings of the 18th International Conference on Computers in Education : 2010

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Editors
Su Luan WONG
Siu Cheung KONG
Fu-Yun YU

Proceedings of the 18th International Conference on Computers in Education

Enhancing and Sustaining New Knowledge through the Use of Digital Technology in Education

ICCE 2010

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PREFACE

The 18th International Conference on Computers in Education (ICCE 2010) is being held from 29 November to 3 December 2010 in Putrajaya, Malaysia. This is the second time that Malaysia is given the honour to host this prestigious event in collaboration with the Asia-Pacific Society of Computers in Education (APSCE). It is one of the most highly anticipated conferences in the Asia-Pacific region which is well known for its high quality papers on Computers in Education. Indeed, the ICCE series will continue to play the paramount role of connecting researchers in the Asia-Pacific region and beyond with international research communities to disseminate and share new ideas on how to enhance and sustain new knowledge in the field of Computers in Education. This crucial role is reflected well in the conference theme of ICCE 2010: "Enhancing and Sustaining New Knowledge through the Use of Digital Technology in Education".

ICCE 2010 continues with the theme-based approach adopted by previous ICCE series as the theme based nature has been well received by past ICCE participants. A new category, the Work-in-Progress Poster (WIPP) session is also introduced in conjunction with the main event. The WIPP session aims to provide opportunities for poster presenters to showcase well-formulated and innovative ongoing work or late-breaking results. The WIPP session and other various activities such as the paper presentations, workshops, tutorials, interactive events, doctoral student consortium, height of graduate students, young researcher symposium are organised under the umbrella of the following six sub-conference:

C1: ICCE Conference on Artificial Intelligence in Education/Intelligent Tutoring System (AIED/ITS) and Adaptive Learning

C2: ICCE Conference on Computer-supported Collaborative Learning (CSCL) and Learning Sciences

C3: ICCE Conference on Advanced Learning Technologies, Open Contents, and Standards

C4: ICCE Conference on Classroom, Ubiquitous, and Mobile Technologies Enhanced Learning (CUMTEL)

C5: ICCE Conference on Game and Toy Enhanced Learning and Society (GTEL&S)

C6: ICCE Conference on Technology, Pedagogy and Education

The Programme Committee for ICEE 2010 comprised a strong team of 206 experts in the field of Computers in Education from 29 countries. There were also 14 experts who acted as additional reviewers. Overall, the conference received 219 paper submissions (173 full papers, 36 short papers and 10 poster papers) from 21countries (Table 1).

Table 1: Distribution of Paper Submissions for ICCE 2010

Country	Submission	Country	Submission
Australia	5	New Zealand	4
Austria	1	Pakistan	2
Canada	2	Philippines	5
Chile	2	Singapore	19
China	4	Spain	3
Finland	1	Sweden	1
Germany	4	Taiwan	55
Hong Kong	6	Thailand	5
Japan	63	United Kingdom	1
Korea	10	Vietnam	1
Malaysia	25		
TOTAL	219		

All papers were subjected to a rigorous review process by at least 3 reviewers. These papers were then meta-reviewed by the Executive Co-Chairs and Co-Chairs of the respective sub-conference. The conference finally accepted 38 full papers, 89 short papers and 64 poster papers as shown in Table 2. As can be seen in Tables 3-8, the acceptance rate of full papers for each sub-conference is below 25%. This is testimony to the quality of our conference.

Table 2: Overall results of paper review for ICCE2010

Result		Submission	Full paper	Short paper	Poster
			173	36	10
Accept	Full	38 (21.9%)	38		
	Short	89	75	14	
	Poster	64	42	17	5
Reject		28	18	5	5

Table 3: Results of paper review for C1

Result		Submission	Full paper	Short paper	Poster
			26	4	2
Accept	Full	5(19.2%)	5		
	Short	11	9	2	
	Poster	12	9	2	1
Reject		4 (12.5%)	3	0	1

Table 4: Results of paper review for C2

Result		Submission	Full paper	Short paper	Poster
			25	3	4
Accept	Full	6 (24%)	6		
	Short	12	11	1	
	Poster	5	3	1	1
Reject		9 (28.1%)	5	1	3

Table 5: Results of paper review for C3

Result		Submission	Full paper	Short paper	Poster
			23	6	3
Accept	Full	5 (21.7%)	5		
	Short	8	8	0	
	Poster	14	6	6	2
Reject		5 (15.6%)	4	0	1

Table 6: Results of paper review for C4

Result		Submission	Full paper	Short paper	Poster
			35	4	0
Accept	Full	8 (22.9%)	8		
	Short	18	16	2	
	Poster	13	11	2	0
Reject		0 (0%)	0	0	0

Table 7: Results of paper review for C5

Result		Submission	Full paper	Short paper	Poster
			17	4	0
Accept	Full	4 (23.5%)	4		
	Short	9	9	0	
	Poster	7	3	4	
Reject		1 (4.8%)	1		

Table 8: Results of paper review for C6

Result		Submission	Full paper	Short paper	Poster
			47	15	1
Accept	Full	10 (21.3%)	10		
	Short	31	22	9	
	Poster	13	10	2	1
Reject		9 (14.2%)	5	4	0

For the first time ever in the ICCE series, five established academic societies are taking part in ICCE 2010. The presence of the Association for Educational Communications and Technology (AECT), International Society of the Learning Sciences (ISLS), International Association of Mobile Learning (IAMLearn), IEEE Technical Committee of Learning Technology (IEEE TCLT) and International Artificial Intelligence in Education Society (AIED) certainly shows APSCE's commitment in forging stronger ties and collaboration with societies beyond the Asia Pacific region. This is indeed a concrete step towards the beginning of a long, strong and fruitful relationship with top notch societies. It is hoped that such longstanding relationships will in turn nurture a vibrant research community of younger as well as more experienced researchers to collaborate with one another.

I would like to thank everyone who was either involved directly or indirectly in making ICCE 2010 a reality. Thank you for your commitment and effort. Lastly, I certainly hope that you will enjoy the conference as you embark on an exciting journey to acquire rich academic and cultural knowledge.

Su Luan WONG
Chair of Program Coordination Committee
ICCE 2010

KEYNOTE SPEAKERS

1. Computer-supported Collaborative Learning (CSCL) and Learning Sciences

Keith R. SAWYER

Department of Education
Washington University in St. Louis, United States of America

Title of ICCE 2010 Keynote Speech:
Creativity, Innovation, and the New Sciences of Learning

In today's technologically complex and economically competitive world, creativity and innovation are critical to success. The key task for educators is to prepare learners to participate creatively in today's knowledge economy. The new interdisciplinary science of learning has come to a consensus about how to structure learning environments to result in the kinds of knowledge that support creative work. In my talk I will give an introduction to the new curriculum, educational software, and alternative learning environments that are being used to foster creative learning.

To educate for creativity, we first need to understand the nature of innovation today. I begin my talk by explaining how creativity and innovation happen in today's knowledge economy. The core message is that innovation today is always collaborative: deeply embedded in organizations and social networks. I then outline what kind of education is most likely to result in the kinds of knowledge that underlie creative collaborative work. Graduates need a deep conceptual understanding of complex concepts, and the ability to work with them creatively to generate new ideas, new theories, new products, and new knowledge; the ability to critically evaluate what they read, to be able to express themselves clearly both verbally and in writing, and to be able to understand scientific and mathematical thinking; to acquire integrated and usable knowledge, rather than the sets of compartmentalized and decontextualized facts that all too often result from traditional instructional methods.

2. Classroom, Ubiquitous, and Mobile Technologies Enhanced Learning (CUMTEL)

Hiroaki OGATA

Department of Information Science and Intelligent Systems
Faculty of Engineering,
University of Tokushima, Japan

Researcher, PRESTO (Sakigake)
Japan Science and Technology Agency (JST)

Title of ICCE 2010 Keynote Speech:
The Role of Technology in Enhancing Ubiquitous Learning Experiences

CSUL (Computer Supported Ubiquitous Learning) is defined as a technology-enhanced learning environment supported by ubiquitous computing such as mobile devices, RFID tags, and wireless sensor networks. CSUL takes place in variety of learning spaces, e.g., classroom, home and museum, and provides the right information using the contextual data like location, surrounding objects and temperature. One of the challenges of CSUL research is capturing what you have learned with the contextual data, and reminding you of them in the right place and the right time.

This talk shows a ubiquitous learning log system called SCROLL (System for Capturing and Reminding Of Learning Log). Ubiquitous Learning Log (ULL) is defined as a digital record of what you have learned in the daily life using ubiquitous technologies. It allows you to log your learning experiences with photos, audios, videos, location, QR-code, RFID tag, and sensor data, and to share and to reuse ULL with others. Using SCROLL, you can receive personalized quizzes and answers for your questions. Also, you can navigate and be aware of your past ULLs supported by augmented reality view.

For example, if you visit another country, you may learn some vocabulary or culture there. But you may forget what you learned after coming back your home. However, if you record your ULL using SCROLL and visit the same place again, you would be reminded of your past learning log and its context by SCROLL.

You can try the web-based version of SCROLL at http://ll.is.tokushima-u.ac.jp, also download two Android free Apps (Learning log for you and Learning log navigator) from Android Market.

3. Game and Toy Enhanced Learning and Society (GTEL&S)

Hans Christian ARNSETH

Institute for Educational Research,
University of Oslo, Norway

Title of ICCE 2010 Keynote Speech:

Learning to play or playing to learn

Revisiting issues of authentic learning design, transfer of knowing and functions of teacher scaffolding in game based learning

Due to developments in digital game design, game based learning have recently become an important field of research, policy and practice. In the discourse surrounding computer games and learning, significant learning potentials are attributed to computer games. Games can make learning more engaging, authentic and relevant for participation in the 21st century work place and society at large (Prensky, 2001). Furthermore, researchers claim that gaming practices can work as ideal learning environments where players are engaged, supported by tools and peers and collaborate and share knowledge in communities (Gee, 1999). Informed by a socio-cultural perspective on human practices, I examine and try to unpack some of the claims made about the benefits and characteristics of computer games in regard to learning by focusing specifically on some of the ideas that are invoked in both policy and research discourse. These ideas concern firstly how games can enable the design of authentic learning, and secondly, how skills can be transferred across situations and contexts. Concerning these points, it seems obvious that we as researchers need to examine critically the nature of the contexts we study and carefully scrutinize the historical developments of schooling as institutionalized practices of learning and knowing (Saljo, 2001).

In line with a socio-cultural and dialogic approach to understanding practices, computer games are perceived as complex mediational means (Wertsch, 1991). What players learn is constituted in practices through complex negotiations between people and artifacts within different ecologies. Learning is about solving problems or overcoming challenges that are situated in an environment where "learners" are active sense makers. From this perspective issues of contextualizing knowledge becomes crucial, but connections between settings are not straightforward (Dewey, 1938).

4. Technology, Pedagogy and Education

Hanafi ATAN

School of Distance Education,
Universiti Sains Malaysia, Malaysia

Title of ICCE 2010 Keynote Speech:
Activity Tools for Constructivist Pedagogies in the Web-Based Learning Environment

Constructivism is a student-centred pedagogic approach where knowledge is constructed actively by the students themselves. In this approach, the teacher is a facilitator providing the intervention necessary to create opportunities for the learners to discover new knowledge and collaboratively construct their own understanding of such knowledge. There are many approaches that are based on constructivism such as cognitive apprenticeship, inquiry-based learning, problem-based learning, cooperative learning, etc. This talk focuses on Problem-Based Leaning (PBL), and looks at how PBL can be integrated within the Moodle open source Learning Management System (LMS). It discusses how various activity tools, such as the forum board and Wiki within the LMS, can be utilised to deploy such an approach successfully. Incorporating the findings of a research study being conducted at the School of Distance Education (SDE), Universiti Sains Malaysia (USM), the analysis of the collaborations within the PBL approach, involving both its depth and dimensions, is presented. The focus of the analysis is on the thread levels while the Oliver & McCollughlin Model is deployed to measure the dimensions of the collaboration undertaken by the students. Cognitive, explanatory and social dimensions and their effects on students' learning, such as learning outcomes and learning satisfaction, are discussed.

The incorporation of the intelligent avatar (utilising virtual reality technology and artificial intelligence) within the *Moodle* LMS to facilitate the learning process is also presented. Again, based on the research undertaken at the SDE, USM, the effects of using such an avatar are presented. Various dimensions, for example, the avatar’s roles (as motivator or expert), appearances (highly realistic, moderately realistic, cartoon-like) and feedback (illustrated and non-illustrated) which present information on students’ learning outcomes, attitude and motivation are presented.

THEME-BASED INVITED SPEAKERS

1. Theme-Based Invited Speaker of C1

Akihiro KASHIHARA
Dept. of Information and Communication Engineering
University of Electro-Communications, Japan

Title of ICCE 2010 Invited Speech:
Model-based Scaffolding Technologies for Learning Web Resources

In recent years, there have been increasing resources valuable for learning on the Web, which bring about a lot of opportunities for learners to explore knowledge in a wider and deeper way. In general, the Web resources could be related with Web search engines to compose a hyperspace. Most of them also provide learners with their own hyperspace consisting of the Web pages and their hyperlinks where the learners can navigate the pages and construct knowledge. However, the hyperspace is not always well-structured for navigation and knowledge construction. It is quite hard for the learners to learn in the unstructured hyperspace only with common Web browsers. In addition, there are few learning theories and models suggesting how to learn in unstructured hyperspace. Any instruction suitable for the learners could not be accordingly provided.

In the last ten years, I have built a model of learning in unstructured hyperspace with my colleagues. In particular, we have focused on how to self-regulate navigation and knowledge construction process in the hyperspace. We have also proposed several cognitive tools as scaffolding technologies based on the model, which allow learners to reify their learning process including self-regulation. In addition, the scaffolding technologies include developing cognitive skills of learning in unstructured hyperspace by means of a learner-adaptable scaffolding/fading method.

In this talk, I would like to demonstrate the cognitive tools together with the underlying model. I will also present some case studies with these tools and the future direction.

2. Theme-Based Invited Speaker of C2

Manu KAPUR
Learning Sciences Lab, National Institute of Education, Singapore

Title of ICCE 2010 Invited Speech:
Productive Failure in Computer-supported Collaborative Problem Solving

Designing for productive failure involves designing conditions for learners to persist in solving complex problems without the provision of instructional structures initially. When designed well, this process affords learners opportunities to generate and explore a diversity of representations and methods for solving the problem although they are rarely able to solve the problem successfully. In spite of this seeming failure, persisting in the problem solving process is germane for learning provided an appropriate form of instructional structure subsequently follows. In my talk, I will describe how this can be achieved, and how designing for productive failure requires engaging students in a learning design that embodies four core, interdependent mechanisms: a) activation and differentiation of prior knowledge in relation to the targeted concepts, b) attention to critical conceptual features of the targeted concepts, c) explanation and elaboration of these features, and d) organization and assembly of the critical conceptual features into the targeted concepts. I will then instantiate these mechanisms embodied in the design principles by describing a series of laboratory and classroom-based experiments aimed at unpacking the productive failure effect. I will end my talk by deriving broader implications for theory and learning designs.

3. Theme-Based Invited Speaker of C3

Maomi UENO
Graduate School of Information Systems,
University of Electro-Communications Japan

Title of ICCE 2010 Invited Speech:
Advanced technologies for e-Testing

Recently, e-Testing has become widely adopted, and has gradually replaced CBT (computer based testing). The CBT is based on the combination of two technologies: statistics and psychology. In addition to utilizing statistics and psychology, e-Testing also utilizes computer science. E-Testing provides a new technology to automatically construct multiple test forms (consisting of different sets of items) which have equivalent difficulty. This lecture will describe methodologies used for the multiple test forms construction of traditional CBT systems, as well new methodologies used in e-Testing (which takes into account trade-off between accuracy of estimates and computational costs). Furthermore, this talk will describe aspects of e-Testing in relation to data mining, text mining, etc. Finally, we will describe a planned large scale deployment of advanced e-testing system (that utilizes the above mentioned techniques) by Japanese government in 2011 for administering Information-technology engineers examination (the largest national examination in Japan: 600,000 examinees/year).

4. Theme-Based Invited Speaker of C4

Lung Hsiang WONG
Research Scientist
Learning Sciences Lab, National Institute of Education, Singapore
Title of ICCE 2010 Invited Speech:
What Seams do We Remove? - The Ten Dimensions of Mobile-assisted Seamless Learning

Seamless learning refers to the seamless integration of the learning experiences across various dimensions including formal and informal learning contexts, individual and social learning, and physical world and cyberspace, among others. Inspired by the exposition by Chan, Roschelle, Hsi, Kinshuk, Sharples, Brown, et al. (e.g., 2006) on the seamless learning model supported by the setting of one or more mobile device per learner, I analysed 49 recent academic papers on mobile-assisted seamless learning (MSL) to further unpack the notion and the potential ways to put it in practice. With this, ten dimensions that characterise MSL are identified. Such a framework would allow us to identify research gaps in the stated area. A practitioner interested in developing or adopting a MSL design can use my analysis to situate the dimensional space where the constraints or parameters of her design problem lie, and look at relevant design and research-based evidence of other related MSL systems to refine her own design.

5. Theme-Based Invited Speaker of C5

Yam San CHEE
Learning Sciences & Technologies Academic Group and the Learning Sciences Lab
National Institute of Education, Singapore

Title of ICCE 2010 Invited Speech:
Being and Becoming: Performance Pedagogy for 21st Century Learning with Educational Games

Research activity in the field of game-based learning is burgeoning, and there is a diverse range of approaches being used to harness the power of games for learning. In this talk, I shall argue in favor of using computer and video games to support performance pedagogy. The 21st century demands learning outcomes that are enactive: students should be able to demonstrate capacities to speak and act, that is to perform, in ways that are authentic and have value in the real world. In short, they learn to be certain kinds of people, such as citizens in the context of citizenship education. Learning is thus a process of becoming. I shall illustrate these ideas with reference to the game products and learning curricula that we have developed based on the educational games "Legends of Alkhimia" for chemistry and "Statecraft X" for citizenship education.

6. Theme-Based Invited Speaker of C6

Chien-Sing LEE
Faculty of Information Technology
Multimedia University, Malaysia

Title of ICCE 2010 Invited Speech:
Instructional design and creativity: "I do" or "Till death do we meet?"

Instructional design has often been defined as the design of systematic instruction. It is often associated with the design of instruction based on standard techniques, mapped to standard methods translated from teaching and learning principles. Thus, instructional design often creates an impression of structured or rigid learning. Creativity on the other hand, is often identified from original and useful outcomes. Generation of original and useful outcomes is often associated with divergent thinking, and right-brain-oriented design, which are totally non-prescriptive and non-standard in nature. Hence, instructional design and creativity are often regarded as totally mutually exclusive; too dissimilar in nature and aims that any form of marriage between them is impossible.

This talk comprises of four sections. First, changes in instructional design are reviewed to identify what constitutes the essence of instructional design. Second, concepts related to creativity are reviewed to identify keys to creativity. Third, the discussion begins. Systems are compared and a model derived. Implications to technology, pedagogy and education conclude.

2009 APSCE Distinguished Researcher Award Winner

Dr. Fu-Yun YU, National Cheng Kung University, Taiwan

Dr. Fu-Yun Yu is a Professor and the Chairperson of the Institute of Education at National Cheng Kung University in Taiwan. Her research on the development of innovative technological instructional strategies has won her the respect of educational scholars around the world. Her major contribution to date has been her seminal work in the field of student question generation, which has been highly acclaimed in the educational community. Through intensive classroom-based research Dr. Yu has not only built an empirical base that shows how student question generation improves higher-order thinking skills and encourages active learning, but has also developed a customizable scaffolded online student question generation system capable of accommodating the needs of both instructors and students at all levels - the first such system ever developed. She has also published over 100 papers, focusing on ways of using emerging technology to increase learner's cognitive, affective and social growth that have lead to evidence-based suggestions and applications for practitioners and researchers.

Dr. Yu has received several awards, including research awards and funding from the National Science Council of Taiwan every year since 1998, the Best Paper Award from the Global Chinese Conference on Computers in Education (2002), the Wu Ta-You Commemorative Award from the National Science Council in Taiwan (2004), the Outstanding Teacher of the Year from National Cheng Kung University (2006), the First Level Research Grant Award from the National Science Council in Taiwan (2005-2007), the High-Ranking & High-Impact Top-tier Journal Publication Award from National Cheng Kung University (2008, 2009), as well as others. Her outstanding academic achievements and dynamic personality have garnered invitations to sit on the editorial boards of several established journals, and the committees of many internationally renowned conferences. She was invited to sit on the ICCE Program Committee 2005 – 2009, the CSCL 2005 Program Committee and Steering Committee, and the ICCE Best Paper Selection Committee 2007, 2009. She was also invited to chair the CSCL 2005 Student Community Program, the ICCE Doctoral Student Consortium 2007-2009, the APSCE Financial Aid Program 2007-2008, the APSCE Newsletter Subcommittee 2006-2007, and is currently an Associate Editor at the Journal, Research and Practice of Technology-Enhanced Learning.

2009 APSCE Distinguished Researcher Award Winner

Dr. Tsukasa Hirashima, Hiroshima University, Japan

Dr. Tsukasa Hirashima's contributions in Computers in Education, especially, in artificial intelligence in education include modeling of problem-solving process, error-visualization for error-awareness, information filtering, question/ problem generation, learning by problem posing and design method of learning games. His research activities are rich in originality, and have impacted the field of artificial intelligence in education. He has received four best paper awards from major international conferences about computer and education (World Conference on Educational Multimedia and Hypermedia (ED-MEDIA) 1995, International Conference on Computer in Education (ICCE) 2001, 2002, and Artificial Intelligence in Education (AIED) 2009). Within Japan, he has also received National Conference Award from Japanese Society of Artificial Intelligence (JSAI) in 1993, SIG Research Awards from JSAI (SIG on Advanced Learning Science and Technology) in 1996, 1998, 1999, 2003 and 2008, Outstanding Game Award of academic section from Japanese Game Amusement Society in 2003 and 2005, Best Paper Award from Japanese Society for Information and Systems in Education (JSISE) in 2008 and 2009, and Conference Award from JSISE in 2009.

Since 2005, he has taken important roles in the management of ICCE: workshop/tutorial co-chair in 2005, workshop co-chair in 2006, PC co-chair in 2007, invited talk in 2008, and sub-conference (AIED) PC co-chair in ICCE 2009. As a workshop co-chair in 2005 and 2006, he demonstrated his leadership in establishing the workshop track as an important and regular pre-conference event in ICCE. He also organized workshops on the theme of question/problem generation at ICCE 2006, ICCE 2007 and ICCE 2009. Now he is a member of APSCE Executive Committee, a co-chair of APSCE SIG on AIED/ITS and Adaptive Learning, and a chair of APSCE outreach & publicity subcommittee. In other conferences or associates, he also served as Poster co-chair in ITS 2006 and AIED 2009, and PC member of AIED 2005, ITS 2006, AIED 2007, ICALT 2007, ICALT 2008, ICALT 2009 and AIED 2009. In Japan, he is a vice-editor-in-chief of English journal and a member of executive board of JSISE. He is also a member of trustee and editorial board of JSAI, a member of editorial boards of related academic societies. In addition, he is a chairperson of Advanced Learning Science and Technology SIG in JSAI.

2009 APSCE Young Researcher Leader Award Winner

Dr. Hiroaki Ogata, University of Tokushima, Japan

Dr. Hiroaki Ogata is one of the top researchers from the Asia-Pacific region in the areas of computer supported collaborative learning (CSCL) and mobile and ubiquitous learning environments (MULE). He has very high visibility and reputation world-wide for his contributions to these fields. In his research fields, he proposed several new concepts of contextualized and ubiquitous language learning in the authentic world which have initiated a new research and development direction in the field of mobile learning. His outstanding research results have been recognized by the mobile learning community as he was invited to be the keynote speaker in several top-tier conferences of mobile learning such as IEEE International Conference on Wireless Mobile and Ubiquitous Technologies in Education (WMUTE) and IADIS Mobile Learning Conference.

The publication record of Dr. Ogata is outstanding with high quality research publications sustained over a longer period of time, not withstanding that he is still rather young. His publications include over 50 refereed journal articles, more than 150 international conference papers, 7 edited books, and 9 book chapters. Several Best Paper Awards (JSiSE 1998, WebNet 1999, IPSJ 2004, ICALT 2006, MULE 2007, CollabTech 2008, ICCE 2008 and ICIE 2009) underline the excellence of his work.

Dr. Ogata has been involved in a large number of externally funded research projects such as Grant-in-Aid for Scientific Research from the Ministry of Education (MEXT) and Japan Society for the promotion Science (JSPS), and also PRESTO from Japan Science and Technology Agency (JST). He has been a member of numerous international conference committees and international journal editorial boards, and has frequently been invited to serve as guest editor for special issues. Dr. Ogata organized IEEE WMTE 2005 in Tokushima and has also provided substantial services to the international research community through organizing a series of international workshops on MULE and by providing professional discussion forums for young researchers and PhD students.

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S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

An Interactive Environment for Learning by Problem-Changing

Sho YAMAMOTO, Hiromi WAKI, Tsukasa HIRASHIMA
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sho@isl.hiroshima-u.ac.jp

Abstract: To make a new problem from the original one and to compare their solutions are promising activities to promote a learner to be aware of the structure of these problems. Especially for knowledge-rich problems like word problems in arithmetic, mathematics or physics, this awareness is very important to master the use of solution methods. To realize such exercises in physics, we have developed a computer-based learning environment that allows a learner to make a new problem by changing the original one and that diagnoses the problem change. Preliminary evaluation of the learning environment has also been reported.

Keywords: Interactive Environment, Problem-Changing Exercise, Physics Learning

Introduction

An interactive learning environment for problem-changing exercise where a learner is required to solve and change the problems is described in this paper. In usual problem solving exercise, a learner works on to solve several problems by using solution methods that the learner has already acquired and has been mastering. In the exercise, a learner practices not only to execute the solution methods but also to recognize the semantic structure of problems in order to apply the solution methods [1]. Therefore, it is important for the learner to solve various kinds of problems with different semantic structures. Moreover, to realize effective learning during the problem solving exercise, it is important for the learners to be aware of the difference between problems [2, 3]. It is well-known that poor problem solvers are often unaware of the semantic structure of the problems from the viewpoint of problem-solving [5, 6, 7, 8]. Several researchers have already suggested that problem-changing by learners where a learner poses a new problem by changing the existing problem, is a promising method to promote them to be aware of the differences between problems [9, 10].

One of the most difficult issues to effectively realize such learning activity is the way to give feedback for the learner's problem changes. To give useful feedback, it is necessary to assess the problem change that is composed of an original problem, a new problem and their differences. If a learner has carried out this learning by him/herself, the learner is required not only to change and solve the problems but also to assess his/her problem change. It is often too difficult for the learners to complete these tasks. Although a teacher can able to assess the problem change and give feedback based on the assessment, taking care of several learners at a time is hard because the learners are usually allowed to change a problem in various ways. Mutual assessment by learners is a solution of this issue but to complete these tasks is not easy for the learners, especially for the beginners. We have investigated the function of automatic assessment of learner's problem-change to realize “problem-changing exercise” as a more common and useful learning method. We call the framework of the automatic assessment as “agent-assessment”, because the above-mentioned first assessment is often called as “self-assessment”, the second as “teacher-assessment” and the last as “peer-assessment”.

We have paid special attention for learning by problem-posing [11] and have already developed interactive learning environments for "solution-based problem-posing exercise with agent-assessment" in arithmetical word problems [12, 13]. On the other hand, we have investigated a model of exercise problems in physics and automatic problem generation based on the model [14]. In this study, we have proposed "learning by problem-changing" as an advanced style of "learning by problem-posing" and developed an interactive learning environment for the learning. In the next section, the framework of problem-changing exercise has been described by comparing problem-solving and solution-based problem-posing exercises. Then, implementation of a learning environment for the problem-changing exercise and the results of preliminary evaluation of the environment have also been explained.

1. Learning Environment for Problem-Changing Exercise

1.1 Framework of Problem-Changing Exercise

In this subsection, the framework of problem-changing exercise has been described by comparing problem-solving exercise and solution-based problem-posing exercise. In Figure 1, three types of exercise models are shown. In problem-solving exercise, a learner is required to solve several problems that can be solved by the same solution method. In this exercise, a learner has to find a structure that is necessary to apply a solution method in a problem. In solution-based problem-posing, a learner is required to pose problems that can be solved by the same solution method. This means that a learner has to compose the same structure in this exercise. Through these activities, it is expected that the learner can understand the way to use the solution method. Both exercises, however, include no direct activity to promote awareness for the differences among problems or solution methods.

In problem-changing exercise, a learner has been provided with a problem to solve it. The learner is required to make a new problem by changing the provided problem. Problem-1 in Figure 1(c) corresponds to the original one and Problem-2 or Problem-3 corresponds to the generated one. Because a learner makes the differences in problems by him/herself, the

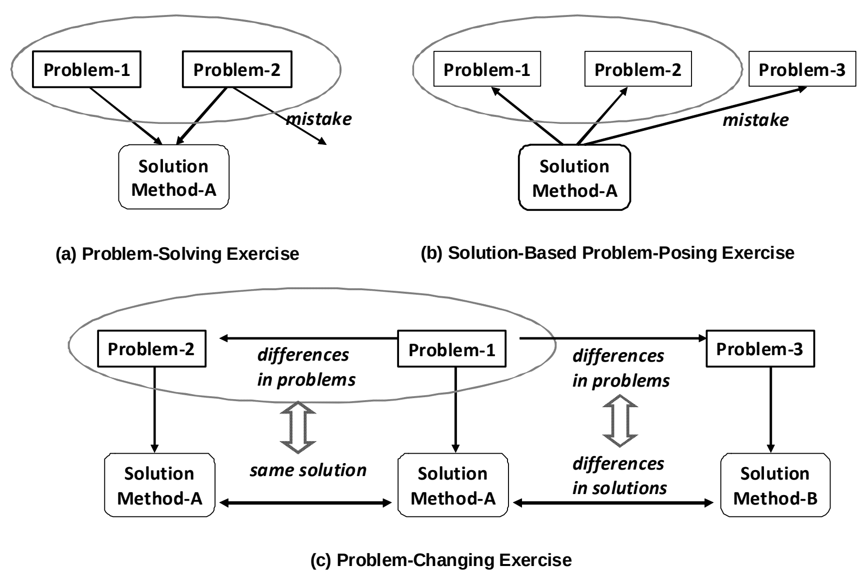

Figure 1. Three types of model exercises.

differences are well-known to the learner. The learner is then required to solve the generated problem. In this figure, Problem-2 is generated by changing Problem-1 but the same solution method can be applied. This means that the problem change does not have any effect to the solution method. For Problem-3, the different solution method has to be applied. This means that the problem change has some effects to the solution method. Through the comparison of problems as well as solutions, it is expected that a learner more clearly recognize the structures in the problems necessary to apply the solution methods.

1.2 Learning Environment

In this learning environment, a learner (1) solves a physics problem, (2) changes the problem, (3) solves the changed problem, and (4) compares the two problems and solution methods. The learning environment provides with an interface where a learner can solve and change the problems. The learning environment is to diagnose the problem-solving and problem-changing, and then give feedback based on the diagnosis. In this subsection, these steps are explained.

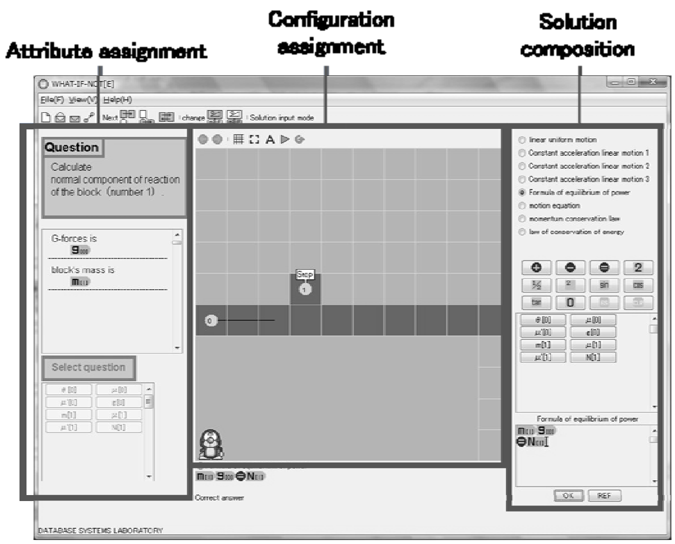

Figure 2. Interface of Learning Environment of Problem-Changing Exercise.

1.2.1 Interface of Problem-Solving and Problem-Changing

Figure 2 shows the interface of problem-solving and problem-changing in the learning environment. A problem is specified in the "attribute assignment" area and "configuration assignment" area. In the configuration area, the physical components and their relations are assigned. Both related attributes that are necessary to solve the problem and their statuses whether the attribute values are given or not, are assigned in the attribute assignment area. Solution of the problem is composed in "solution composition" area. In the area, a learner selects a formula from a list of formulas. Then the learner concretes the formula by using several attributes and calculation components provided in the solution composition area. When the learner completes the input and pushes the diagnosis button, the learning environment diagnoses the formula expression.

After a learner correctly solves a problem, the learner is required to change the problem for the next task. The problem change is carried out in the same interface. In the configuration area, the learner can change the components and relations between them. In the area, several physical components are prepared as icons and add the current configuration by drag&drop operation. Components in the current configuration can be deleted and changed the location. Then, from a list of attributes in the new physical situation, learner decided status of the attributes in the new problem, that is, given attribute and required attribute (the answer of the problem). The learner is then required to solve the new problem generated by the problem change in the same way with the original problem. The diagnosis and feedback for the problem-solving and problem-changing are explained in 1.2.2.

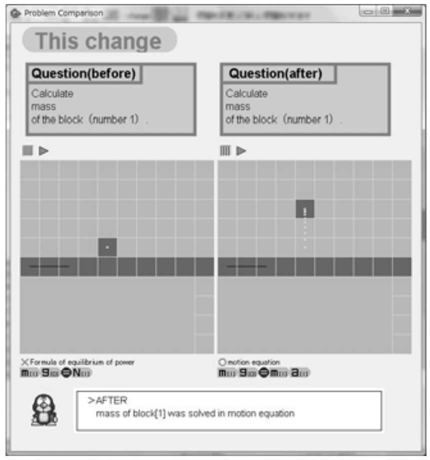

Figure 3. Interface for Problem Comparison

1.2.2 Problem Comparison

After solving the new problem, learner examines the difference between the problems and the solutions in the problem comparison interface as shown in Figure 3. In the interface, sentence of the original problem and the changed one is shown at the upper part of the interface. The situations of the problems are shown in the middle. In the lower part, learning environment presents the solution methods that are applied to solve the problems.

1.3 Diagnosis and Feedback

1.3.1 Internal Description of Problems

Internal description of problems is composed of (1) situation description, (2) attribute status, and (3) solution method. Situation description is composed of attributes exist in the physical situation in which the problem is included with the numerical relations among them. Attribute status specifies whether the attribute value is given, required or unknown in the problem. A problem is defined by specifying given value attributes and required value as one. Solution method is the procedure to derive the required value from given values by using the numerical relations among the attributes included in the situation. Therefore, solution method can be derived automatically by the situation description as well as attribute status. The framework to describe problems in physics have been proposed by the authors and used for problem sequencing or problem generation [15, 16, 17].

In this framework of the problem description, the problem change is categorized into two types, (1) attribute status change in the same situation, and (2) situation change. If there is a change in the same situation, it is easy to deal with because all attributes and numerical relations have been prepared in the problem description. As for the situation change, it is necessary to restrict. The situations that can be deal within this learning environment are prepared as "microworld graph" beforehand [18]. A node of microworld graph is a situation and a link, which can be the possible change of the situation (the authoring of the graph has also been investigated continuously [19]). The microworld graph used in the learning environment consists of six components, that is, block, plane (smooth/unsmooth), slope (smooth/unsmooth), string, pulley, and external force. Then the number of the components and connection methods are also restricted. If the learner tries to compose unprepared configuration, it is not accepted by the environment.

1.3.2 Errors in the Environment and Feedback

In problem-solving phase, a learner often makes a mistake to compose a solution. Because the environment can solve the problem, the error can be detected by comparing a correct solution. As for an error in the problem-solving, it is indicted directly and the correct one is explained.

In problem-changing phase, (1) unacceptable configuration, (2) errors in attribute status are detected. Unacceptable configuration is not an error, but if a learner tries to make an unprepared configuration, the environment informs the learner that it is unacceptable. Errors in attribute status are the case that a learner makes an unsolvable problem. When a physical situation is accepted by the environment, an error is interpreted as a lack of some given attributes. Hence, the environment points out that the problem can not be solved, and suggests the learner to add a few given attributes. Even if the problem is solved, there are sometimes unnecessary given attributes in the attribute status. The learning environment points out the existence of unnecessary given attributes, and suggests the learner to find and delete them.

2. Experimental Use

Since there is no similar technology-enhanced learning environment that supports problem-changing exercise, the main purpose of this experimental use is to confirm whether the exercise can be carried out in the environment or not. We also examined the learning effect of the exercise by measuring between pre-test and post-test comparing the experimental group with the control group. Through the analysis of the results, we have concluded that the learning environment is promising.

2.1 Procedure of Experimental Use

The experimental group took the pre-test for five minutes one day before the experimental use. The subjects were explained about the way to change and solve problems in the environment. The subjects are then asked to carry out problem-changing exercise for twenty minutes. Just after the use, subjects took the post-test. As for the control group, the subjects were required only to solve physics problems with the learning environment where only the problem-solving step was available. We prepared two different tests and half of the subjects in each group took one test in the pre-test and the other in the post-test, then the other half of the subjects took the tests in reverse order. Questionnaire was carried out just after the post-test. The subjects were undergraduate students in the engineering division. Available data are twenty-one in the experimental group and fifteen in the control group.

2.1.1 Analysis of Log Data and Questionnaire in the Experimental Group

In the problem-changing exercise for twenty minutes, a subject was requested to diagnose his/her problem changes 5.8 times in average. This means that a subject makes one new problem in every 3.4 minutes. More than half of the problem changes (58%) included errors, but almost half of the errors (46%) found in the solution description. Because we have already confirmed that the subjects have enough ability to solve the same level of physics problems and the frequency of errors decreased gradually in the exercise, we guess that the main reason of errors in the solution description was the difficulty and lack of experience of the operations in the learning environment.

The results of the questionnaire are shown in Table 1. Two third of the subjects agreed that this exercise was interesting. More than two third of the subjects agreed that the problem-changing exercise with the learning environment was more effective to comprehend the relation between problems than usual problem-solving exercise, though more than half of the subjects disagreed this learning environment was easy to use. These results suggest that the problem-changing exercise realized with the learning environment is promising although it is necessary to improve the learning environment from the viewpoint of usability.

Table 1. Results of Questionnaires.

	Strongly Agree	Agree	Disagree	Strongly Disagree
The software is easy to use.	1	8	11	1
The exercise with the software is more effective to comprehend the relations between problems than usual problem-solving exercise.	1	14	5	1
The exercise with the software is interesting.	4	10	6	1

2.2 Results of Pre-test and Post-test

2.2.1 Explanation of the tests

There is no standard way to evaluate the learning effects of the problem change. As a measurement in this research, a subject was provided with six problems and requested to describe the relations between them on paper. Figure 4 is an example of the provided problems. Each problem was labeled by an alphabet. In Figure 4, "A" in the left upper part is the label. Figure 5 shows an example of the description of the relations. The subjects were instructed to describe the relations in two ways, that is, one way is to connect two problems by a link and to give explanation about the link, and the other way is to enclose several problems and to give the explanation about the group. Each link and group is counted as one relation. If the explanation refers to solution method and if it is correct, the relation is counted as a solution relation. "Both problems are solved by equation of motion" is an example of the solution relation. Both "a string is contained in both problems" and "the number of objects is different" are counted as total relations but not counted as a solution relation. Here, we assumed that if this exercise promoted the subjects to be aware of the structure of the problems from the viewpoint of solution, the number of the solution relations was expected to increase.

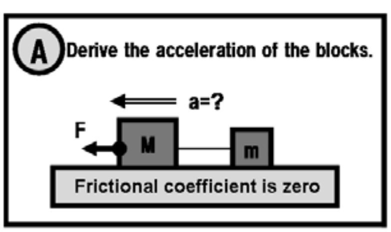

Figure 4. A Problem in the Test.

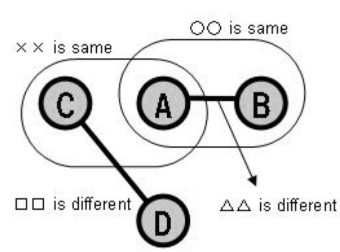

Figure 5. A Sample of the Description.

2.2.2 Analysis of the Results

The results of the experiment are shown in Table 2, Figures 6 and 7. As for the number of solution relations, although there was no significant difference between the experimental group and the control group in the pre-test (two sided p-values from Mann-Whitney test with correction for ties, p=0.41), there was a significant difference in the post test (p=0.048). Besides, there was a significant difference in the numbers of the solution relations between the pre-test and the post-test in the experimental group (p=0.003), and marginal significant difference was found in the control group (p=0.06). These results suggest that although both exercises improved the subjects' awareness for problem structure from the viewpoint of problem-solving, the problem-changing exercise was more effective than the problem-solving.

As for the total number of relations, there were no significant differences between the experimental group and the control group both in the pre-test (p=0.18) and post-test (p=0.16). Besides, there was no significant difference in the numbers of the total relations between the pre-test and the post-test in the experimental group (p=0.12) though there was a significant difference in the control group (p=0.004). These results suggest that the subjects in the experimental group focused more on solution relations than the subjects in the control group. While this experimental use is a preliminary one with the limitations on the number of subjects and the learning time, we found enough results to judge the problem-changing exercise is promising.

Table 2. Results of the Experiment.

	Solution relations		Total relations	
	Pre-test	Post-test	Pre-test	Post-test
control group (n=15)*	0.3(0.46)	0.6(0.40)	2.2(1.61)	5.2(2.80)
experimental group (n=21)*	0.2(0.51)	1.5(1.66)	3.3(2.10)	4.10(1.87)
p-value	0.41	0.048	0.18	0.16

*Average scores

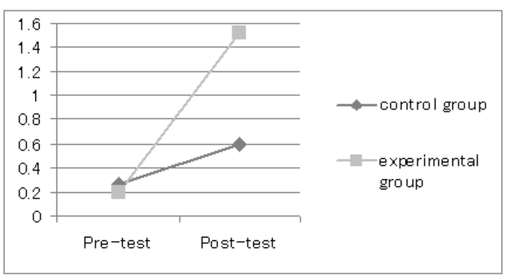

Figure 6. Numbers of Solution Relations.

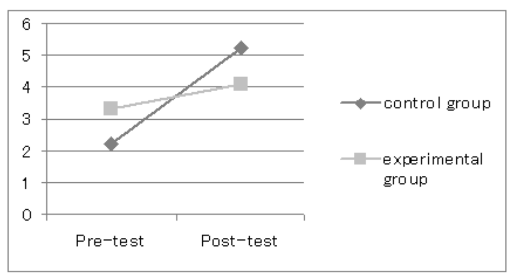

Figure 7. Numbers of Total Relations.

3. Conclusions

In this study, we have designed and developed an interactive learning environment for learning by problem-changing with a target to learn physics. Although several investigations have already suggested that problem-changing is as effective as a learning activity, it is not easy for teachers or learners to realize the learning in usual classroom situation. The main difficulty is related to the way in assessing the problem change. However, the learning environment we have developed includes the function to assess the problem change automatically. We call this kind of assessment as "agent-assessment". Through a preliminary evaluation of the learning environment, the problem-changing exercise in the learning environment promoted the subjects to be aware of the relations between problems from the viewpoint of solution methods. Because the current environment is a kind of prototype one that deals with only a small number of problems, the experiment was also preliminary one. Our future works, therefore, to focus on sophistication and expansion of the environment and to carry out larger size experiment including more subjects and increase in learning time.

Acknowledgements

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References

[1] VanLehn, K. (1989). Problem solving and cognitive skill acquisition. In M. Posner (Ed.), Foundations of cognitive science, Mahwah, NJ: Erlbaum.
[2] Scheiter, K., Gerjets, P. (2002). The impact of problem order: Sequencing problems as a strategy for improving one's performance. Proceedings of the 24th Annual Conference of the Cognitive Science Society, 798-803.
[3] Scheiter, K., Gerjets, P. (2003). Sequence Effects in Solving Knowledge-Rich Problems: The Ambiguous Role of Surface Similarities. Proceedings of the 25th Annual Conference of the Cognitive Science Society, 1035-1040.
[4] Mayer, R.E. (1981). Frequency norms and structural analysis of algebra story problems into families, categories, and templates. Instructional Science, 10, 133-175.
[5] Chi, M.T.H., Feltovich, P.J., Glaer, R. (1981). Categorization and representation of physics problems by experts and novices. Cognitive Science, 5, 121-52.
[6] Larkin, J.H. (1983). The role of problem representation in physics. In D. Gentner & A.L.Stevens (Eds.), Mental Models (pp.75-98), Lawrence Erlbaum Associates Inc.
[7] de Jong, T. Ferguson-Hessler, Monica G. (1986). Cognitive structure of good and poor novice problem solvers in physics. Journal of Educaional Psychology, 78(4), 279-286.
[8] Nathan, M.J., Kintsch, W., Young, E. (1992). A theory of algebra-word-problem comprehension and its implications for the design of learning environments. Cognition and Instruction, 9, 329-389.
[9] Polya, G. (1957). How to solve it: A new aspect of mathematical method, Princeton University Press.
[10] Brown, S.I., Walter, M.I. (1993). Problem posing: Reflections and applications. Lawrence Erlbaum Associates.
[11] Silver, E.A., CAI, J. (1996). An analysis of arithmetic problem posing by middle school students. Journal for Research in Mathematics Education, 27(5), 521-539.
[12] Hirashima, T., Yokoyama, T., Okamoto, M., Takeuchi, A. (2007). Learning by problem-posing as sentence-integration and experimental use. AIED 2007, 254-261.
[13] Hirashima, T., Yokoyama, T., Okamoto, M., Takeuchi, A. (2008). Long-term use of learning environment for problem-posing in arithmetical word problems. Proc. of ICCE2008, 817-824.
[14] Hirashima, T., Ueno, T., Yamamoto, S. (2009). Problem generation as structure simplification following problem-solving process. ICCE 2009 Workshop Proceedings of the 17th International Conference on Computers in Education.
[15] Hirashima, T., Kashihara, A., Toyoda, J. (1996). Toward a learning environment allowing learner-directed problem practice - helping to problem-solving by using problem simplification. Proc. of The Third International Conference on Intelligent Tutoring Systems, 466-474.
[16] Funaoi, H., Akiyama, M., Hirashima, T. (2006). Automatic creation of mis-choices and comments for multiple choice question based on problem solving model. ICCE 2006 Workshop Proc. of Problem-Authoring-Generation and -Posing in a Computer-Based Learning Environment, 49-54.
[17] Hirashima, T. (2009). Increasingly problem simplification as scaffolding in exercises. Proc. of the Workshop on Question Generation, 58-65.
[18] Horiguchi, T., Hirashima, T. (2005). Graph of microworld: A framework for assisting progressive knowledge acquisition in simulation-based learning environments. Proc. of AIED 2005 IOS Press, 670-677.
[19] Horiguchi, T., Hirashima, T. (2009). Intelligent authoring of 'Graph of Microworlds' for adaptive learning with microworlds based on compositional modeling. AIED2009, 207-214.
[20] Mizumoto, A., Takeuchi, O. (2008). Basics and considerations for reporting effect sizes in research papers. English Education, 31, 57-66.

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Form-Wise Error Detection in a FonF-Based Language Education System

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Abstract: A language education system oriented for focus-on-form instruction should recognize which linguistic forms are focused in a particular lesson, and it should also evaluate how properly the focused forms are used in learners' utterances. This paper discusses how forms should be described in the system, how the form description helps the system recognize focused forms, and how the system evaluates learners' use of the focused forms. Preliminary evaluation of the system shows that the system correctly detects focused forms and that it successfully evaluates the use of the detected focused forms. Neither incorrect detection nor evaluation failure has been attested in its preliminary evaluation.

Keywords: Focus on form, foreign language education, dialog system

Introduction

In second language education, a pedagogical approach called focus on form (FonF) has attracted much attention because it could solve a potential problem of another pervasively adopted approach called communicative approach (CA) [2]. While FonF aims at improving learners' ability to produce grammatically correct sentences, the CA puts a higher priority on conveying a speaker's intention than on making grammatically correct utterances. The CA therefore has a risk that learners would acquire incorrect grammatical rules for their target languages. If FonF is effectively incorporated into a CA-based education system, it should help overcome the problem.

In our previous studies, we developed a CA-based Japanese education system [10], and we have been trying to incorporate FonF into the system [9]. The system engages in role play with a learner under a given situation in which the learner must accomplish a given task. The system accepts ungrammatical input by referring to its situation knowledge. The situation knowledge is a set of semantic representations denoting what learners should convey in order to accomplish a given task. The system detects errors in learners' input by referring to the situation knowledge.

FonF instruction is performed focusing on particular linguistic forms (FonF forms). For example, FonF forms involve grammatical constructions like "verb-*te kudasai*" (denoting honorific request), "-*ga* (nominative case particle) + potential verb" (denoting ability or possibility), etc. A FonF-based language education system therefore should recognize which forms are focused in a particular lesson. In addition, the system should evaluate learners' use of the focused forms. Error detection in our previous system, however, is not form-wise; that is, the system detects every error irrespective of whether it is involved in a focused form. Since the error detection is performed by referring to the situation knowledge, storing information on focused forms in the situation knowledge would enable the system to recognize which forms are focused and to evaluate how properly the focused forms are used.

Section 1 describes the outline of the previous system and its extension for form-wise error detection. Section 2 deals with how to store information on focused forms in the situation knowledge. Section 3 explains how to evaluate learners' use of focused forms by referring to the situation knowledge. Section 4 provides the result of preliminary evaluation of the system. The final section provides a summary of this study.

1. Backgrounds and Goals

1.1 Outline of the Previous System

We are developing a Japanese education system by extending a Japanese dialog system developed by the Japanese Dialogue Tools (JDT) project [4,11]. The JDT system produces semantic representations from input sentences and accumulates the representations as context information. The system performs problem solving by referring to the context information and its problem-solving knowledge.

The JDT system is designed for Japanese native speakers, and our previous education system includes some additional modules. The outline of the previous education system is shown in Fig. 1, where the added modules are given in the gray shaded area.

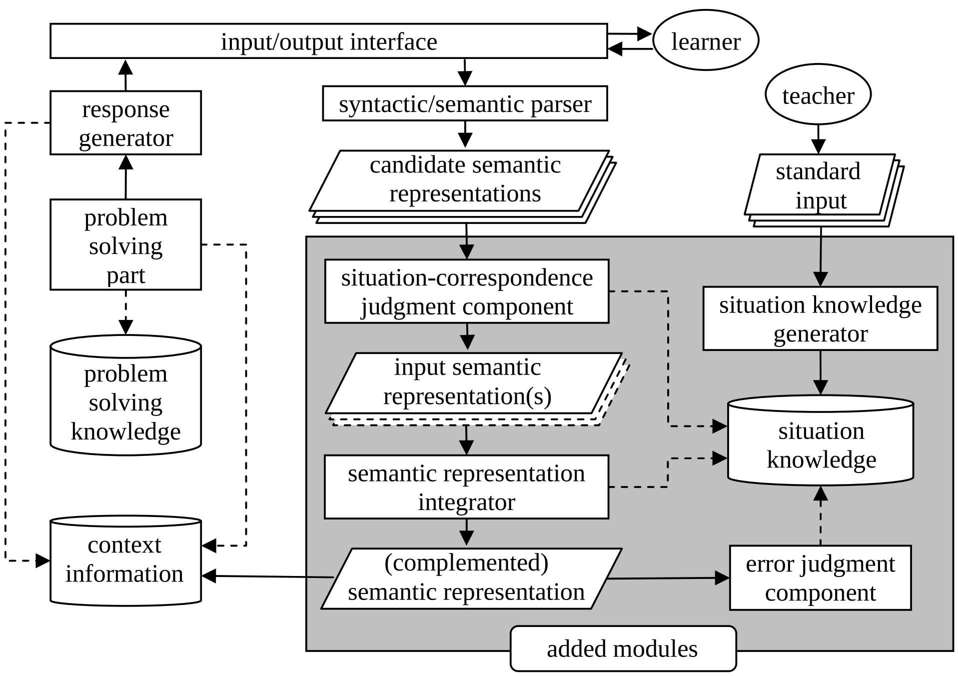

Fig. 1: Outline of the Previous System

A learner's input sentence goes through the input/output interface and is processed by the syntactic/semantic parser, which generates candidate semantic representations for the input. In the JDT semantic representation, the meanings of content words (verbs, nouns, etc.) are represented by concept frames containing attribute-value pairs, and the meanings of function words (case particles, auxiliary verbs, etc.) are represented as attributes or markers attached to frames. Dependency relations between content words are represented by pointers which link attribute values to the concept frames denoting the values. Fig. 2 shows an example semantic representation for *Hoteru-o sagashi-te* (*Find [me] a hotel*), where markers are given in square brackets. (Unlike English, Japanese allows phonetically null subjects/objects. We put them into square brackets in English translation.) For the sake of simple illustration, we omit irrelevant details throughout this paper.

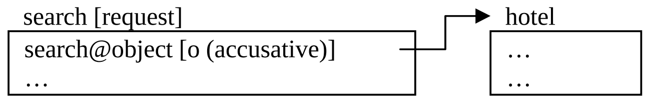

Fig. 2: Semantic Representation for Hoteru-o sagashi-te (Find [me] a hotel)

Accordingly, the system can compare the meanings of different sentences by comparing attribute-value pairs in their semantic representations. If an input involves "finding a hotel", its semantic representation has the attribute-value pair of "search@object" and "hotel" irrespective of its sentence style. As a result, the system absorbs the difference in sentence styles and accepts a wide variety of input sentences [4,11]

The candidate semantic representations go to the situation-correspondence judgment component, which compares each candidate with the situation knowledge and decides which one is the most plausible representation corresponding to the learner's intention.
The situation knowledge is generated by the situation knowledge generator. A teacher feeds the generator with the standard input, which is a set of sentences necessary for accomplishing a task in a given role-play situation. The generator produces the semantic representation of each standard input sentence. The generator then integrates the concept frames denoting the same concept into one frame. Fig. 3 shows the situation knowledge associated with two standard input sentences: *Tokyo-no hoteru-ni tomari-tai* (*[I] want to stay at a hotel in Tokyo*) and *Yasui hoteru-o sagashi-te* (*Find [me] a cheap hotel*). In Fig. 3, the meaning of *yasui* (*cheap*) is represented by the rate-possession frame, and the value of the rate-possession@object attribute, "- (minus)" , is transferred to the value of the same attribute in the hotel frame based on the fact that they are the same attribute.

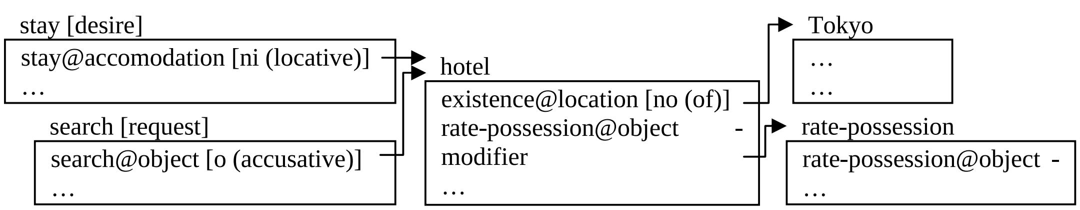

Fig: 3. Sample Situation Knowledge

The situation-correspondence judgment component correctly matches learners' input like *Yasui hoteru-ni tomari-tai* (*[I] want to stay at a cheap hotel*) and *Tokyo-no hoteru-o sagashi-te* (*Find [me] a hotel in Tokyo*) with the situation knowledge as well as those in the standard input.

When a learner's input is grammatical, the frames in the semantic representation constitute a single tree, and the representation matches with a part of the situation knowledge. When an input is ungrammatical, the situation-correspondence judgment component divides the input into sub-trees so that each of the sub-trees matches with a part of the situation knowledge. In other words, the situation-correspondence judgment component determines which part of the situation knowledge is uttered by the learner.

The semantic representation integrator receives the input semantic representation(s) from the situation-correspondence judgment component. If the input is grammatical, the semantic representation integrator receives a single tree, and the tree trivially passes through the integrator. If the input is ungrammatical, the integrator receives more than one sub-tree. Then the integrator integrates those sub-trees into a single tree by referring to the situation knowledge. The integrator complements the sub-trees with appropriate concept frames, and integrates them into one tree which matches with a part of the situation knowledge. In other words, the integrator reproduces the learner's intention from ungrammatical input.

The output from the semantic representation integrator is accumulated in the context information and is referred to by the problem solving part and the response generator in order for the system to reply to the learner's input. At the same time, the output of the integrator goes to the error judgment component, which determines whether the input involves any errors. The error judgment component is designed by taking account of actual error patterns made by Japanese learners [3,9].

1.2 Extension for Form-Wise Error Detection

Our previous system is capable of accepting (un)grammatical input and detecting errors in learners' input, but FonF instruction needs more than those capacities. In FonF instruction, learners receive instruction when they incorrectly use focused forms. On the contrary, no instruction is necessary when nonfocused forms are erroneously used. This is because too much instruction would discourage learners from using their target languages.

Accordingly, a FonF-based education system should be able to recognize which forms are focused in a particular lesson and to evaluate whether a learner correctly uses the focused forms. In order to realize form recognition, we construct a form dictionary, which stores information on every FonF form. In addition, we construct a form detector, which searches the situation knowledge for FonF forms by referring to the form dictionary. A teacher selects forms to be focused from the detected FonF forms and the situation knowledge stores the information on which part of the knowledge corresponds to the focused forms. The form dictionary is also used in form evaluation. We extend the situation-correspondence judgment component and the error judgment component so that the former should search the candidate semantic representations for the focused forms and the latter should evaluate whether the detected FonF forms are correctly used in the (complemented) semantic representation.

2. Form Recognition

2.1 FonF Forms and Form Dictionary

We looked through Japanese textbooks for beginners and their teacher's manuals [5,6,7,8] and found that 225 forms were involved there. We selected 159 FonF forms from the 225 forms. In selecting the FonF forms, we adopted the following criteria by referring to a FonF literature [12]: (1) multiple forms corresponding to a single form in another language, (2) forms rarely used in ordinary conversation, (3) forms bearing less importance for conveying intention, and (4) forms inducing typical errors. Some linguistic forms have multiple pragmatic functions. In counting the number of forms, we treated a form with multiple functions as separate forms each of which has a single function.

In CA-based second language education, instruction is designed based on pragmatic functions like order, request, etc. Accordingly, FonF forms should be described from two different viewpoints: (1) a surface pattern of each form (form pattern) and (2) its pragmatic function (form function). The form dictionary stores the form pattern and form function of every FonF form.

Form patterns are described by a combination of 6 elements: (a) parts of speech (noun, verb, etc.), (b) surface forms of morphemes (-*ga* (nominative case particle), -*kara* (*from*), etc.), (c) a particular inflection involved in a form (attributive form, continuative form, etc.), (d) inflection types (*i*-adjective, *na*-adjective, etc.), (e) conceptual classes (place, human, etc.), and (f) word types (potential verb, honorific verb, etc.). The system can recognize any combination of these elements. The elements (a)-(d) are recognized by referring to the surface form information attached to semantic representations. The element

(e) is recognized by referring to the concept hierarchy of the system. Although the word type recognition is necessary for a FonF-based education system, it is not required in an ordinary dialog system and the JDT system does not have any word type hierarchy. Therefore we have newly constructed a word type hierarchy. The system recognizes the element (f) by referring to this hierarchy. Accordingly, we can represent every form pattern in the form of the JDT semantic representation, and the form dictionary stores form patterns represented as semantic representations.

Each FonF form has its form function in addition to its form pattern. Form functions can be divided into two classes according to whether (i) a form as a whole has a single function or rather (ii) a form function is a union of functions which come from the elements constituting the form. For example, the form *-te itadake-mase-n-ka* is made up of (inflected) forms of *-te itadaku*, *-masu*, *-n* and *-ka*, whose functions are honorific receiving of an action, politeness, negation and interrogation, respectively. On the other hand, the form as a whole has the function of polite request. Notice that the form as a whole does not have the negation function and the interrogation function, and that the request function is not denoted by any of the form-constituting elements. (The same holds true for the English sentence *Why don't you ...?* It is used as a suggestion instead of a question asking the reason.) The form dictionary explicitly stores form functions of type (i) in addition to form patterns. Form-constituting elements in a form pattern have their own functions and these functions are represented in form patterns. Form functions of type (ii) are synthesized from these functions represented in form patterns.

We fed the system with input sentences containing the selected 159 FonF forms, and found that the system generated 151 correct semantic representations. Among the 8 failures, 3 cases were due to incorrect morphological analysis and 5 cases were due to the JDT framework; the JDT framework has not established the way to represent these 5 natural language expressions. (All the 5 cases involve parallel arrangement of phrases.) Since the reasons for the 8 failures are irrelevant to what is being proposed in this paper, let us put the 8 cases aside. In what follows, the discussion will be concerned only with the 151 FonF forms whose semantic representations are correctly generated by the system.

2.2 Form Detector

The error judgment component in our previous system compares the (complemented) semantic representation with the situation knowledge, and detects the difference between them. Therefore, if we extend the situation knowledge so that it should contain information on focused FonF forms, then the system can recognize which forms are focused in a particular lesson. Although the JDT semantic representation holds information on surface forms, the situation knowledge in our previous system deletes the information. This is because semantic equivalence is enough for CA-based instruction. Since FonF instruction needs information on surface forms, we have extended the situation knowledge and the knowledge now holds surface form information.

The situation knowledge is generated by using the standard input from a teacher. The standard input is a set of sentences necessary for accomplishing a task in a given role play situation. The form detector searches the situation knowledge for FonF forms by referring to the form dictionary. The teacher then selects FonF forms to be focused in his/her lesson and the situation knowledge stores information on which part of the knowledge corresponds to the focused forms.

Since the JDT semantic representation has a tree structure, each form pattern in the form dictionary also has a tree structure headed by a concept frame. Accordingly, the detector performs detection of each form pattern in the following manner. (1) The detector picks up the head of a form pattern and detects corresponding frames in the situation knowledge. (2) The detector compares the head with each of the detected frames with respect to conceptual classes of the frames, markers attached to the frames, attributes in the frames, and pointers connecting the corresponding attributes and their values. (3) The detector recursively compares the corresponding value frames. In comparing a form pattern with the situation knowledge, the detector also checks whether their surface forms match with each other. Finally, if the form pattern matches with a part of the situation knowledge, the detector judges that the form is used in the corresponding part of the situation knowledge. Fig. 4 describes how the form *-te kudasai* (denoting honorific request) matches with the semantic representation of *Hoteru-o yoyaku-shi-te-kudasai* (*Would you reserve a hotel?*).

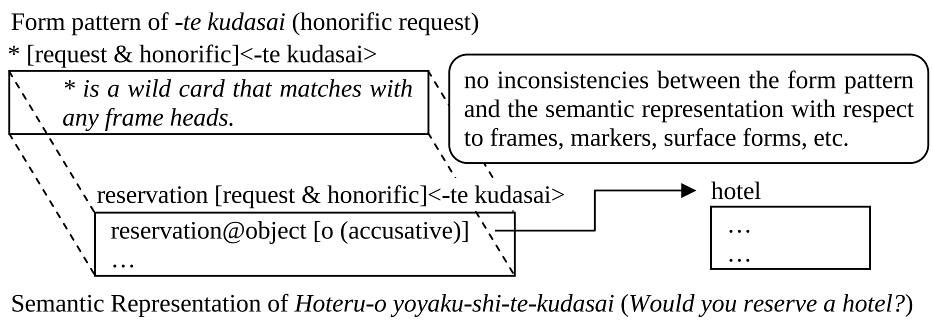

Fig. 4: Example Form Detection

3. Form Evaluation

In our previous system, the situation-correspondence judgment component compares the candidate semantic representations with the situation knowledge and judges which part of the situation knowledge each candidate corresponds to. In comparing the candidate representations with the situation knowledge, the component does not compare their surface forms. This is because semantic equivalence is enough for CA-based instruction. We have therefore extended the situation-correspondence judgment component so that it should perform surface level comparison in addition to the original semantic level comparison. The extension enables the component to detect whether each of the focused forms or part of it is uttered in learners' input.

The situation-correspondence judgment component detects which part of the input corresponds to which part of the focused forms and the semantic representation integrator differentiates uttered part of the focused forms from unuttered part of the focused forms. Accordingly, the error judgment component performs form-wise error detection based on the results of the situation-correspondence judgment and the semantic representation integration. The error judgment component looks through the (complemented) semantic representation and detects errors involved in the focused forms by referring to the situation knowledge and the form dictionary.

The error detection is performed based on the following two viewpoints: (1) whether the input involves a structure which is equivalent to the structure of the form pattern of a focused form, and (2) whether the surface form of the input matches with the surface form of the focused from. Consequently, the result of the error detection is classified into four types: (i) the input matches with a focused form with respect to its structure and the surface form, (ii) the input matches with a focused form with respect to its structure but not to the surface form, (iii) the input does not match with a focused from with respect to its structure nor to the surface form, but the input involves every concept in the form pattern of the focused form, and (iv) the input falls into none of (i)-(iii).

The classifications (i)-(iii) roughly corresponds to the distinction among TL, IL, and NTL encoding, where TL is completely targetlike encoding, IL is interlanguage encoding, and NTL is nontargetlike encoding [1]. In other words, TL or (i) indicates that the learner correctly understand the target form. IL or (ii) shows that the learner understands the function of the target form but encodes it in a nontargetlike way. NTL or (iii) shows that the learner's understanding of the target form is insufficient with respect to both the form pattern and the form function. The system judges the case (iv) as an utterance irrelevant to the target form. In addition, there are cases in which a focused form is used when it should not be used. The error judgment component also detects this type of error and judges it as OVERUSE.

4. Preliminary Evaluation

In order to evaluate the system, we picked up 41 FonF forms. Recall that form patterns are represented as semantic representations (section 2.1) and that the semantic representation is composed of (a) frames, (b) elements constituting frames, and (c) pointers (section 1.1). We therefore analyzed each FonF form from the viewpoint of which of (a)-(c) constitutes the form. The result is that 1 form is composed of (a) alone, 113 forms are made up of (a) and (b), 24 forms are constituted of (a) and (c), and 13 forms are made up of all the three types of elements. Accordingly, we selected 27 (a)-(b) forms, 12 (a)-(c) forms, and 2 (a)-(b)-(c) forms as the test set.

The evaluation of form recognition took the following steps. We first made 41 pieces of the situation knowledge containing the 41 forms. We then examined whether the form detector correctly detected the 41 forms from the situation knowledge. The result is shown in Table 1. The form detector successfully detected all the 41 forms and no erroneous detection was attested.

Table 1: Preliminary Evaluation of Form Detector

Forms to Detect	Detected Forms	Erroneous Detection
41	41	41

Since the test set includes every possible combination of (a)-(c) in FonF forms, the result shows that the system, in principle, has the ability to correctly detect every FonF form.
We examined the accuracy of the system's form evaluation in the following manner. (1) We made the situation knowledge containing the 41 forms. (2) We set the detected 41 forms as focused forms. (3) We made 4 types of input (TL, NTL, OVERUSE and irrelevant input) for each piece of the situation knowledge. As for IL, we made the input for 32 pieces of the situation knowledge but could not make IL input for the other 9 pieces of the situation knowledge. For example, forms like -*sugi masu* (denoting excess) and -*te shimai-mashi-ta* (denoting regret) do not have any synonymous expressions with the same structure of the semantic representation. Accordingly, any input with the same semantic structure as these expressions necessarily becomes a TL example. If we change the structure, it is not an IL example by definition. As a result, we fed the system with the 41 TL examples, 32 IL examples, 41 NTL examples, 41 OVERUSE examples, and 41 irrelevant examples. The result is shown in Table 2. The result confirmed that the error judgment component correctly detected all the 5 types of examples. No erroneous detection was attested.

Table 2: Preliminary Evaluation of Form-Wise Error Detection

Form Type	TL	IL	NTL	OVERUSE	Irrelevant
Number of Input	41	32	41	41	41
Success	41	32	41	41	41
Failure	0	0	0	0	0

5. Concluding Remarks

In this study, we have constructed the form dictionary and the form detector in order to enable our FonF-based education system to recognize which forms are focused in a particular lesson. The form detector searches the situation knowledge for FonF forms by referring to the form dictionary. The situation knowledge stores information on which forms are focused. We have also extended the situation- correspondence judgment component and the error judgment component in the previous system. The extended components determine which of the focused forms are uttered in learners' input, and evaluate the learners' use of the focused forms. The preliminary evaluation of the system has confirmed that the system successfully detects FonF forms in the situation knowledge, and that the system correctly performs form-wise error detection. Neither erroneous form detection nor erroneous form evaluation has been attested. Important topics of future research are (a) full evaluation of form detection and form-wise error detection and (b) evaluation of the system's usability from the viewpoints of both learners and teachers.

Acknowledgements

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References

[1] Doughty, C.,& Varela, E. (1998). Communicative focus on form. in C. Doughty, & J. Williams (Eds.) (1988). 114-138.

[2] Doughty, C., & Williams, J. (Eds.) (1998). *Focus on Form in Classroom Second Language Acquisition*. Cambridge: Cambridge University Press.

[3] Ichikawa, Y. (1997). *Nihongo Goyo Reibun Shojiten [A Dictionary of Japanese Language Learners' Errors]*. Tokyo: Bonjinsha.

[4] Ikegaya, Y., Noguchi, Y., Kogure, S., Konishi, T., Kondo, M., Asoh, H., Takagi, A., & Itoh, Y. (2005). Integration of dependency analysis with semantic analysis referring to the context. *Proceedings of PACLIC 19*, 107-118.

[5] Kaigai Gijutsusha Kenshu Kyokai (Ed.) (1990) *Shin Nihongo no Kiso I*. Tokyo: 3A Corporation.

[6] Kaigai Gijutsusha Kenshu Kyokai (Ed.) (1992) *Shin Nihongo no Kiso I Kyoshiyo Shidosho*. Tokyo: 3A Corporation.

[7] Kaigai Gijutsusha Kenshu Kyokai (Ed.) (1993) *Shin Nihongo no Kiso II*. Tokyo: 3A Corporation.

[8] Kaigai Gijutsusha Kenshu Kyokai (Ed.) (1994) *Shin Nihongo no Kiso II Kyoshiyo Shidosho*. Tokyo: 3A Corporation.

[9] Kondo, M., Kure, U., Daicho, Y., Kogure, S., Konishi, T., Y Itoh, Y. (2009). Error judgment in a language education system oriented for focus on form. *Proceedings of ICCE 2009*, 43-50.

[10] Shiratori, T., Minai, N., Itoh, T., Konishi, T., Kondo, M., & Itoh, Y. (2004). Error detection and response-manner selection in a Japanese education system for nonnative speakers. *Proceedings of ICCE 2004*, 1383-1389.

[11] Takagi, A., Asoh, H., Itoh, Y., Kondo, M., & Kobayashi, I. (2006). Semantic representation for understanding meaning based on correspondence between meanings. *Journal of Advanced Computational Intelligence and Intelligent Informatics*, *10*, 876-912.

[12] Williams, J. & Evans, J. (1998) What kind of focus on which forms? in C. Doughty, & J. Williams (Eds.) (1988).139-155.

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Interactive Question-Posing Environment for Beginners' English Learning

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Abstract. Several investigations have already suggested that question-posing is a promising learning as well as a problem-solving activity. In order to realize this learning method, however, how to give feedback for the posed questions becomes a big issue. In this paper, we describe an interactive learning environment that promotes learning by question-posing in English learning for beginners. The learning environment supports learners to pose question and answer sentences. The most important characteristics of the learning environment are automatic assessment of the posed questions and feedback based on the assessment. We call this assessment as agent-assessment. To realize these functions, we have used automatic question generation techniques from English sentences proposed in our previous researches. Preliminary evaluations and related works are also described in this paper.

Keywords: Question-Posing, English Learning, Agent-Assessment

1. Introduction

An interactive learning environment for question-posing of English learning has been already designed and developed. In the learning environment, a learner reads an English short text first. The learner is, then, required to pose question sentences and answer the questions themselves. The learning environment has ability to assess both the questions and the answers, as well as to give feedback to learners based on the assessment. We also carried out an experimental use of the learning environment.

Several investigations have already suggested that question-posing is one of the promising learning as well as problem-solving activities [1, 2, 3]. In learning by question-posing, assessment and feedback for the questions & answers posed by learners are important issues. Although to make learners assess the questions & answers by themselves is worthwhile as a kind of learning activity, accuracy of the assessment cannot be secured especially for beginners. If the questions or answers included with errors, it is necessary to detect them and also to support to correct them. Mutual assessment between peer learners includes the same difficulty. Teachers are involved to assess questions & answers and to give adequate feedback; however, to take care of question-posing by several learners simultaneously is a heavy task because the learners are usually allowed to pose various kinds of questions. Due to the above-mentioned reason, we have investigated the function of automatic assessment of questions & answers posed by learners in technology-enhanced learning. We consider the framework of the automatic assessment as “agent-assessment”, because the first one of the above-mentioned assessments is often called as “self-assessment”. The second one is “peer-assessment” and the last one is “teacher-assessment”. Here, agent-assessment is not having any conflict with the other types of assessments because it can be used as basic information for self-assessment, peer-assessment and teacher-assessment.

We have already developed several interactive learning environments for learning by question/problem-posing such as target arithmetical word problems [4, 5, 6] and mechanics problems [7]. In these studies, master the use of a solution method is the aim of the learning and the learners are required to pose problems that can be solved by the specified solution method. In English learning, question-posing is a well-known effective learning strategy with wider learning goals. Chan [8] indicated four different effects due to learning by question-posing as follows; (1) the students' awareness can be improved and their thinking can be controlled, (2) long time retention of knowledge and skills can be improved, (3) ability to apply and transfer the knowledge, and (4) attitude and motivation can be improved. As a concrete method of question-posing, Schumaker [9] proposed a procedure where a learner is promoted to find a clue word first in a text and then to pose question & answer sentences including the clue. Based on the proposal, we have designed and developed a learning environment for clue word based question-posing targeting learning English.

In this paper, question-posing in learning environment is described. Authoring method to realize agent-assessment is also explained. Besides, results of experimental use are reported in this paper.

2. Learning by Question-Posing

In learning by question-posing environment, a learner is first required to read several sentences. Then the learning environment requests the learner to select a clue word from a list of keywords that are extracted from the sentences, and promotes the learner to pose a question related to the clue word. To pose a question, the learner is provided with a set of words and required to make question as well as answer sentences by combining the words. The posed questions and answers are then assessed by the learning environment. If an error is detected, feedback concerning the detected error is given to the learner. In this section, the framework of learning by question-posing is described in detail. The way to realize the agent-assessment is also explained in the next section.

2.1 Flow of Question-Posing

By using the following sentences as an example, the flow of question-posing is explained.

Australia has many kinds of interesting animals. Koalas are very popular. They sleep during the days. Look at the mother koala in the picture. She has a baby on her back.

After reading and comprehending the sentences, a learner is required to select a clue word that should be included in the question and/or answer the learner will pose. In Figure 1, the learner is selecting the noun '*Australia*' from the list of clue words at the right side of the interface.

In the second step, the system generates pairs of questions and its answers from the sentences. For instance, when a learner has already selected the word *'Australia'* as the clue word, the system generates several questions and answers including *'Australia'* from the sentences. Following two pairs are examples that are generated by the system.

What has many kinds of interesting animals? ------Australia does.

How about koalas? ------koalas are very popular.

Currently, the target questions are restricted in interrogative pronouns, that is '*who*', '*what*', '*when*', '*where*' *and* '*how*'. In order to promote the question-posing, the environment provides the learner with a list of interrogative pronoun and requests to select one of them. In this example, selectable interrogative pronouns are '*what*' and '*how*'. If the learner selects other interrogative pronouns, that is, '*who*', '*when*', *or* '*where*', the system indicates that it is impossible to pose questions and answers with the interrogative pronoun for the current sentences. Here, it is assumed that the learner has selected '*what*'.

In the third step, the system provides the learner with a set of words that is enough to pose a question correctly, and the learner is requested to compose a question sentence with the words shown in Figure 2.

Figure 1. Selection of a clue word.

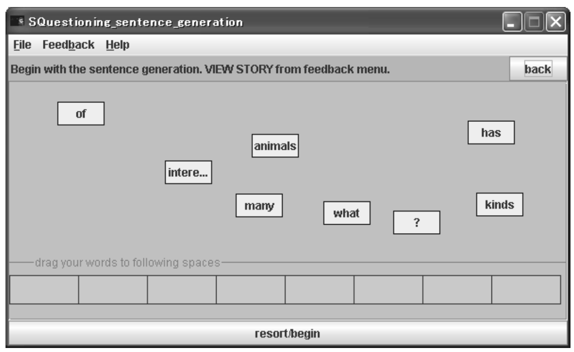

Figure 2. Words as components of a sentence.

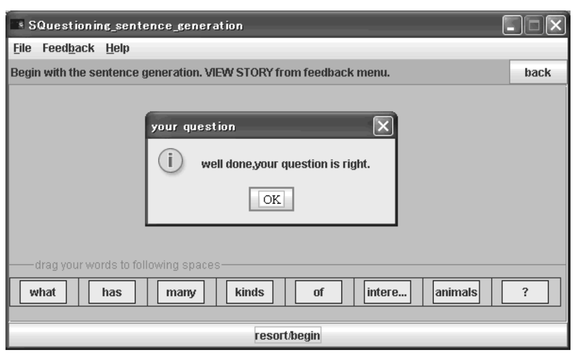

Figure 3. A question posed by arranging the words.

In the fourth step, the learner arranges the words to generate a question sentence. In the assessment, the generated sentence is compared with the prepared correct question. In Figure 3, the learner generates the correct question as: '*what has many kinds of interesting animals?'* The feedback to wrong sentence is explained in the next subsection.

When the learner posed a question correctly, the learner is required to make an answer of the question by arranging provided words in the same way. This is one type of question posing in this learning environment.

2.2 Feedback

In the system, four kinds of feedbacks are provided for an error in question-posing as follows.

(1) If a learner selects a wrong interrogative pronoun, the system indicates the learner that it is impossible to pose a question with the interrogative pronoun.

(2) If there is a mistake in the order of the words, the system indicates the wrong words and requests to rearrange them as shown in Figure 4.

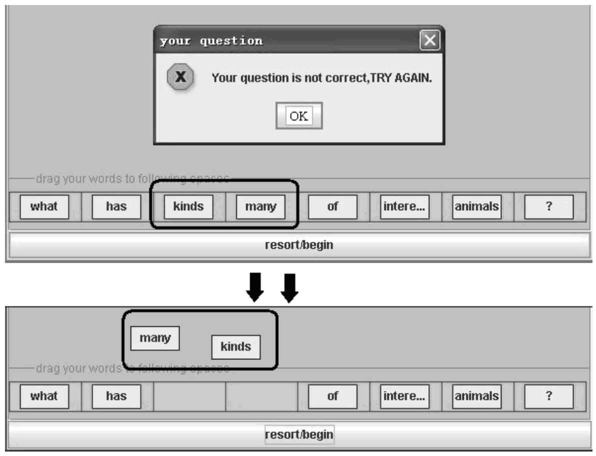

Figure 4. Rearrangement of the words.

(3) If a learner cannot make any questions or answers, the system provides related sentences to the selected clue word and promotes the learner to read them again.

(4) If a learner cannot make any questions even if the related sentences were provided, the system itself poses questions and answers as examples.

Although the current feedback is useful for a learner to be aware of his/her errors, it is not explained the reason why the questions and answers are wrong. Sophistication of the feedback is our important future work.

3. Authoring Module

In order to realize this learning by question-posing, it is necessary to prepare a lot of questions and answers for each text. This preparation is usually hard task. In our framework, authoring module has been developed to prepare the questions and answers. We have investigated an automated question generation function for an intelligent English learning system [10, 11]. The function uses syntactic and semantic information of an original text generated by natural language processing techniques, and dictionaries of synonyms and antonyms. To extract the syntactic and semantic information, DCG (Definite Clause Grammar) is used [12]. We have experimentally confirmed that 80% of questions appeared in four English textbooks for novice learners in Japan can be generated by the functions. Then, almost 90% of questions generated by the function are syntactically and semantically adequate. In our authoring module, this automatic question and answer generation function is adopted.

Since some of the generated questions and answers are inadequate ones, it is necessary for authors to select adequate questions and answers from the list of questions and answers that automatically generated. Here, the task to generate questions and answers is simplified to the task to select them from the list of sentences. It is also possible to modify the selected ones or to add several questions and answers. As for clue words, authors can select adequate ones from the list of nouns derived from the original sentences.

In Figure 5, sentences of the questions and answers generated by our system are shown in the area of ‘expert sentence’s panel’ on upper-right hand. While, author clicks one of the generated sentences, the clicked sentence would appear on the ‘modifying sentence’s panel’ below the figure. The author can modify the sentences by changing, rearranging or deleting the words and can also save and delete the sentences.

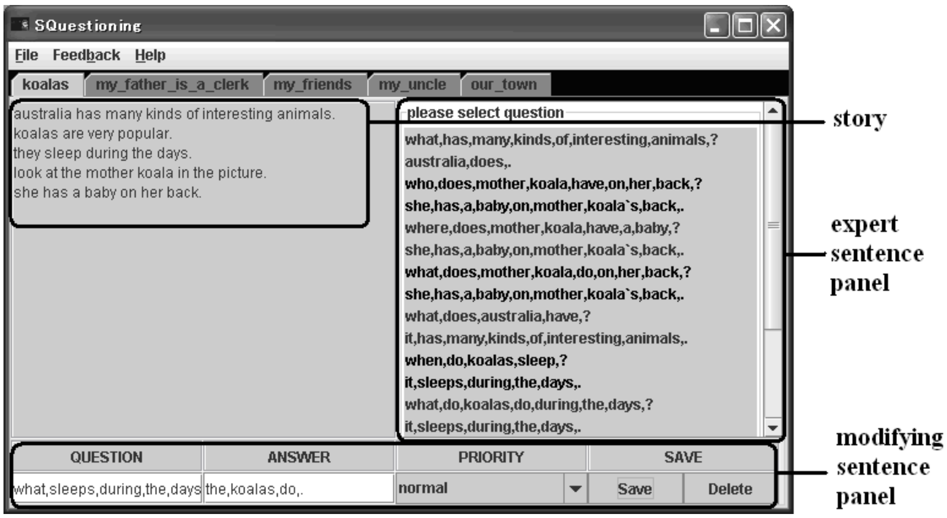

Figure 5. Sentences Modification Function.

4. Preliminary Evaluations

We have evaluated the learning environment from the viewpoint of “learning” and “authoring”. Since the subjects in this evaluation were not real users, the number of subjects was small and the experiment time also was short, these evaluations are preliminary ones. We have however judged that these experiments were strong enough to examine the possibility of this research.

4.1 Evaluation of Learning Module

The subjects were 15 master course students in the graduate school of engineering. They have at least 8 years experience of regular English lessons. In this experiment, they were engaged in question-posing with both the learning environment and pencil&paper. The subjects were then asked to compare the question-posing in the learning environment with the question-posing on pencil&paper. In addition, three English teachers were asked to evaluate the questions and answers that were generated in both the conditions. This was a preliminary evaluation of the learning environment to examine promising activity.

4.1.1 Comparison of Question-Posing between Pencil&paper and Learning Environment

We prepared four texts as learning materials and requested the subjects to pose questions with pencil&paper for two out of four texts and with learning environment for other two texts. The subjects are divided into two groups and it is counterbalanced with the assignment of the texts. Each text was composed of 64 words in average. All texts were picked up from the beginner English texts.

In the first step of the experiment, we explained the meaning of the question-posing and then distributed two texts with a paper and asked them to write three pairs of question and answer sentences for each text on a paper. We call this type of question-posing as “pencil&paper”. In the next step, after explaining the operation of the system, the subjects were requested to generate three pairs of question and answer sentences by using the learning environment. Here, 30 pairs of questions and answers are prepared for each text in average. After the use of the system, the subjects answered the questionnaire. The results are shown in Table 1. All subjects agreed that question-posing with the system was useful for learners. In comparison, almost half of the subjects judged the learning environment system as better than pencil&paper in English learning. No one judged the system was worse than pencil&paper. These results suggested that learning by question-posing with the system is a promising learning method for English.

Table 1. Results of Questionnaires for the Learning Environment

QUESTIONS	ANSWERS			
	Strongly Agree	Agree	Disagree	Strongly Disagree
Do you think the clue words supported by the system are useful to generate questions and answers with?	11	4	0	0
Do you think the feedback which indicates errors form the system is useful to generate questions and answers?	10	3	2	0
Do you think question-posing with the system is useful for learners to learn English?	9	6	0	0
	Self-questioning	teacher	both	neither
Which is the more effective English learning method, to answer the questions what given by teacher or to answer the questions what generated by yourself (question-posing)?	5	0	10	0
	System	Pencil&paper	both	neither
Which is easier to make questions and answers, the system or the pencil&paper?	14	0	0	1
Which is effective to learn English, the system or pencil&paper?	7	0	7	1

4.1.2 Evaluation of Quality of Questions and Answers

Since questions that can be posed in the system are limited, it is necessary to examine the quality of questions in comparison with questions of pencil&paper, that is, unlimited situation. We asked three English experts (TOEIC more than 800 points) to analyze 180 pairs of questions and answers generated in both pencil&paper and system conditions. Two of them are English teachers and one of them has the experience as an English teacher. They were requested to categorize the 180 pairs of sentences into three levels as low (1 point), middle (2 points) and high (3 points). Since the pairs are mixed together, they didn't know the generation conditions of the pairs. If a pair is judged as low level, the pair is obtained one point. The scores are shown in Table 2. The average points of them are almost same. This result suggested that quality of questions posed in the system was not low even in the restriction of questions-posing way.

Table 2. Scores of Questions and Answers

evaluator	average point	
	pencil&paper	system
person A	1.41	1.62
person B	1.22	1.25
person C	1.96	1.82
average	1.53	1.56

4.2 The Experiment Use of the Authoring Module

In our preliminary experiment of authoring module, we required three subjects to use the system. The subjects' average TOEIC score was around 700. Their task was to prepare useful and adequate learning materials for the question-posing module. In order to prepare the materials, they need to use the sentence modification and clue words selection functions of the authoring module. After using the system, they would answer the questionnaire. The information about the using time, the number of the texts, number of questions generated by the system, and number of questions modified by the subjects are shown in Table 3. Here, the modified questions meant the questions which are generated by system are not correct. The questionnaires' result is shown in Table 4. As a result, all subjects agreed that the authoring module is useful to prepare the materials.

Table 3. Results of Authoring Experiment.

	Time	Text	Generated questions	Modified Questions
subject A	11 minutes	2	15	7
subject B	12 minutes	2	13	6
subject C	10 minutes	2	13	6

Table 4. Results of Questionnaires for the Authoring Module

QUESTIONS	ANSWERS			
	Strongly Agree	Agree	Disagree	Strongly Disagree
Were you able to prepare correct sentences with the authoring tool?	3	0	0	0
Were you able to find adequate clue words with the authoring tool?	2	1	0	0
Do you think the questions that you made are useful for learning?	3	0	0	0
Do you think it is easy to prepare the correct sentences and clue words if you use the authoring tool?	1	2	0	0

5. Related Researches

In English technology enhanced learning, there are several related researches for question-posing. In question bank [13], a learner can pose questions on the website to get answers from other learners. This is a kind of realization of learning by question-posing with peer-assessment. Mostow and Chen have developed a learning environment of self-questioning with agent-assessment [14]. Almost, this is similar to our research approach. Their main research target, however, was to generate questions and their answers from a given text from the viewpoint of natural language techniques. In their research, the way to pose a question is very simple, that is, a learner is required to select a word one by one with menu operations. Then the authoring module to compensate the incompleteness of automatic question generation function has not been discussed. Moreover, although they have evaluated the system on a corpus, it has not been used in a learning context. Therefore, we could say that their research is near to our previous researches about automatic question generation [10, 11]. Based on these considerations, main contributions of our research are in the advanced idea and method to make use of the techniques of automatic question generation in the context of learning by question-posing.

6. Conclusion

In this paper, an interactive learning environment of learning by question-posing has been introduced and preliminary experimental evaluations are reported. Question-posing is well known as a useful learning activity in understanding of the questions themselves, their answers and solution methods for the questions. To conduct this learning activity, however, is often difficult for learners. To realize the learning activity to be more common one, we have designed and developed an interactive learning environment that promotes learning by question-posing in English learning for beginners. In the learning environment, learners are supported to pose question sentences and answer sentences. The most important characteristics of the support are automatic assessment of the posed questions and feedback based on the assessment. To realize these functions, we have used automatic question generation techniques from English sentence proposed in our previous researches. In this paper, question-posing in this learning environment and authoring module to realize agent-assessment with the automatic question generation techniques have been described. Preliminary experiments and related works are also elucidated in this paper.

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References

[1] Brown, S.I., Walter, M.I. (1993). Problem Posing: Reflections and Applications, Lawrence Erlbaum Associates.
[2] Silver, E.A., Cai, J. (1996). An Analysis of Arithmetic Problem Posing by Middle School Students, Journal for Research in Mathematics Education, Vol.27, No.5, pp.521-539.
[3] English, L.D. (1998). Children’s Problem Posing within Formal and Informal Contexts, Journal for Research in Mathematics Education, Vol.29, No.1, pp.83-106.
[4] Hirashima, T., Nakano, A., Takeuchi, A. (2000). A Diagnosis Function of Arithmetical Word Problems for Learning by Problem Posing, Proc. of PRICAI2000, pp.745-755.
[5] Nakano, A., Hirashima, T., Takeuchi, A. (2002). An Evaluation of Intelligent Learning Environment for Problem Posing, Proc. of ITS2002, pp.861-872.
[6] Hirashima, T., Yokoyama, T., Okamoto, M., Takeuchi. A. (2007). "Learning by Problem-Posing as Sentence-Integration and Experimental Use", Proc. of AIED2007, pp254-261.
[7] Yamamoto, S., Waki, H., Hirashima, T. (2009). An Approach to Promote Learning by Problem-Based Problem-Posing, TELearn 2009.
[8] Chan, L. (1991). Promoting Strategy Generalization through Self-Instructional Training in Students with Reading Disabilities, Journal of Learning Disabilities, Vol. 24, No. 7, pp. 427-433.
[9] Schumaker, J. B., Deshler, D. D., Nolan, S. M., & Alley, G. R. (1994). The self-questioning strategy. Lawrence, KS: The University of Kansas.
[10] Kunichika, H., Katayama, T., Hirashima, T., Takeuchi, A. (2001). Automated Question Generation Methods for Intelligent English Learning Systems and its Evaluation, Proc. of ICCE 2001, pp.1117-1124.
[11] Kunichika, H., Urushima, M., Hirashima, T., Takeuchi, A. (2002). A Computational Method of Complexity of Questions on Contents of English Sentences and its Evaluation. ICCE 2002: pp.97-101.
[12] Kunichika, H., Takeuchi, A., Otsuki, S. (1995). An Authoring System for Hypermedia Language Learning Environments, and its Evaluation, Proc. of ICCE95, pp.73-80.
[13] Draaijer, S., Jaap B. (2005). Questionbank: computer supported self-questioning, Proceedings of the 9th CAA Conference, Loughborough: Loughborough University.
[14] Mostow, J., Chen, W. (2009). Generation Instruction Automatically for the Reading Strategy of Self-questioning, Proceedings of the 14th International Conference on Artificial Intelligence in Education (AIED2009): pp.465-472.

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Ontological Modeling for Reflective Instructional Design: A Case Study on Modeling a Lesson Plan

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Abstract: This paper discusses computer-based support for self-reflection of teachers in a lesson design task. One of the keys to success in the design task is an alternating cycle of externalization of ideas and reflection resulting from those externalized ideas. However, it is difficult for teachers to externalize their ideas to generate effective reflection. This study aims at enhancing reflection by ontological modeling of the design rationale of a lesson plan. The result of a trial in which a teacher externalized the design rationale of her plan and investigated reflection generated in the trial is reported here.

Keywords: Ontology, Instructional design, lesson plan, self-reflection

Introduction

Teachers explicitly or implicitly make plans of their lessons before they deliver them, in a format called "a lesson plan." In this paper, in order to distinguish the content of a plan and its representation, we call the former a "lesson plan design" and the latter a "lesson plan script." Although a lesson plan design is not always fully described in a lesson plan script because of readability, length restrictions, and so on, the script plays an important role in clarifying the designs of the teacher who made it, as well as in sharing the design with other teachers in a peer-review meeting, which is called "lesson study" [8]. In particular, it is said that the discussions in lesson studies encourage improvements in teaching ability [1].

One of the difficulties in making a lesson plan is that a teacher typically designs and refines a plan in his/her mind through describing it in a certain format. In other words, this process is done with an alternating cycle of externalization of ideas and reflection resulting from those externalized ideas. A task like this is called an "ill-defined design task" [7][9]. Achieving such a task requires support not only for representing the product (a lesson plan script in the case of this study) but also for reflecting decision-making in the design process [4]. Reflection can be classified into two types: "reflection-in-action" and "reflection-on-action" [6]. The former is reflection that is carried out during a task and improves the task dynamically, whereas the latter is reflection that is carried out after a task and helps to evaluate the task and the product. It is considered that both types of reflection are helpful in designing and refining a lesson plan.

This study aims at building computer systems to support designing lesson plans in terms of reflection carried out during the process. In this paper, we report the results of a trial in which a junior-high school teacher modeled the design rationale of a lesson plan using the results obtained in the OMNIBUS project [2] with the help of the authors. We discuss the results in terms of the two types of reflection mentioned above.

This paper is organized as follows. The next section presents an overview of the OMNIBUS project conducted by the authors and the results expected to support lesson plan design in terms of reflection in the process. Section 2 reports the results of a trial carried out with a junior-high school teacher, and Section 3 discusses the results in terms of reflection in and after the design process. Finally, the last section concludes this paper and presents our future plans for this study.

1. OMNIBUS project

The OMNIBUS project is a research project aimed at building a learning/instructional-theory-related ontology named OMNIBUS and a theory-aware authoring system named SMARTIES. This section gives an overview of OMNIBUS and SMARTIES in terms of their expected roles in making lesson plans. The starting point of this project is to organize a variety of learning/instructional theories independently of the learning paradigms. The results are reported in [2]. Currently we aim to deploy OMNIBUS and SMARTIES in practical settings in order to investigate the capability of OMNIBUS to accumulate not only theoretical but also practical knowledge and to enhance SMARTIES for instructional design, including lesson planning. The main topic discussed in this paper is the latter.
The cores of OMNIBUS are the concept of an *I_L event* and its decomposition structure. An I_L event is a basic unit of learning and instruction from the standpoint of engineering approximation. Fig. 1 shows its basic construction. Note that, in OMNIBUS, leaning is defined as state changes of a learner. An I_L event is composed of the state change of a learner and the actions of the learner and an instructor, which are called learning and instructional actions. In the latter, the word “instructional” is used in a broad sense as to mean any actions facilitating learning in agreement with the definition of the word by Reigeluth and Carr-Chellman [5].

In OMNIBUS, a learning/instructional scenario is modeled as a tree structure of I_L events that is called an *I_L event decomposition tree*. Fig. 2 illustrates an example[1]. The flow of a scenario is represented as the sequence of leaf nodes taken from left to right. The root node represents the goal of the whole scenario. The bottom layer, called *learning/instructional scenario*, represents the sequence of actual learning and instructional actions with learning objects provided for the learners. The hierarchical structure of I_L events is called a *scenario model* and represents the design rationale of the learning/instructional scenario.
The key of this tree structure is the hierarchical relation between upper (macro) and lower (micro) I_L events, called a *WAY*. This is a relational concept that defines achievement and decomposition relation between I_L events. A WAY can be interpreted in bottom-up and top-down manners. In the case of bottom-up interpretation, it should be read as “performing the micro I_L events achieves the macro I_L event.” On the other hand, interpreted in a top-down manner, in order to achieve the macro I_L event, those micro I_L events are available as a method. With this modeling framework, we conducted a trial to reproduce an actual

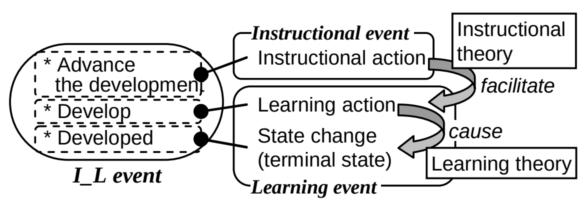

Fig. 1 I_L event.

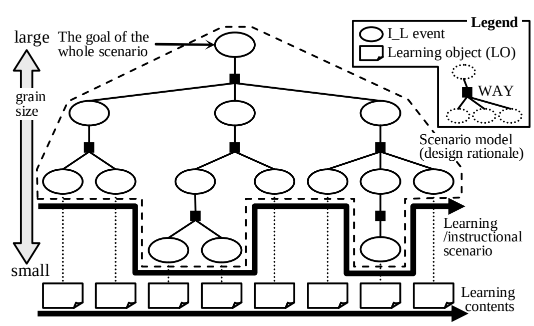

Fig. 2 I_L event decomposition tree.

[1] This is not an *is-a* structure but a kind of part-whole structure of a goal and sub-goals.

lesson plan made by a teacher in the form of an I_L event decomposition tree.

SMARTIES is an authoring system that is aware of learning/instructional theories and compliant with the standard technology of IMS Learning Design. For further details of the functionalities of SMARTIES, see [2]. Although one of the characteristics of SMARTIES is the theory-awareness, in the trial reported in this paper, SMARTIES was used just as an environment for a teacher to externalize and model her lesson plan, as well as its design rationale, without theoretical support. As the basic functionality, SMARTIES allows users to make an I_L event decomposition tree in either a bottom-up or top-down manner. Therefore, SMARTIES can be used to externalize the design rationale of a lesson plan in the form of an I_L event decomposition tree. In addition, although this was not used in the trial, if I_L events are described in terms of the concepts defined by OMNIBUS, SMARTIES can provide applicable theory-based learning/instructional strategies modeled as an I_L event decomposition and can help authors analyze the I_L event decomposition tree.

2. A Trial of OMNIBUS and SMARTIES for Designing a Lesson Plan

2.1 Setting of the trial

A trial for modeling a lesson plan based on OMNIBUS and SMARTIES was carried out as design practice of a lesson plan in a course for teachers of technology in the graduate school of a university. Its purposes include examining:

- the capability of the OMNIBUS ontology for describing the content of a lesson plan made by actual teachers, and
- the effectiveness of SMARTIES for facilitating reflection-in/on-action in designing a lesson plan through building an I_L event decomposition tree.

The trial subject was a student in the graduate school of Okayama University, originally a Japanese junior-high school teacher of technology and home economics. She had 11 years teaching experience and had participated in lesson studies several times a year. Therefore she was familiar with making lesson plans.

Table 1 shows the course of the trial. Before this trial, the subject made a lesson plan script on sheets of paper. This lesson plan was made newly for the lecture in question and was refined through discussion with the second author, who was the teacher of the course. In this trial, the first and second authors asked the subject questions about her script and, together with her, modeled it as an I_L event decomposition tree in SMARTIES. The purposes of the questions asked in this trial were:

(1) to represent each step in the script as state changes of learners, and
(2) to clarify the design rationale of each step in the script.

Following these purposes, the questions are basically “what state do you want to make your students achieve?” and “what is the design rationale for an activity of learners or instruction by the teacher?” Such questions by the authors were used as a trigger to get implicit information that had not been described in the script but had been considered in the design process by the subject. The authors modeled what was elicited from her as an I_L event decomposition tree.

Note that, in the trial, the first author, not the subject, operated SMARTIES. This is because the purpose of this trial was not to evaluate the usability of SMARTIES but to examine the description capability of OMNIBUS. SMARTIES is still just a prototype system designed to verify the feasibility of ontology-aware functions,

Table 1 The course of the trial.

Pre-trial	Making a lesson plan script through discussion with the instructor (the second author) without SMARTIES
1	Explanation of SMARTIES (30 min.)
2	Modeling a lesson plan with SMARTIES (5 hours in total)
Post-trial	Modification of the lesson plan script by the subject alone without SMARTIES

and it usually takes time for teachers to become familiar with using it by themselves. Finally, after the trial, the subject refined the paper-based lesson plan script based on the I_L event decomposition tree made in this trial. The refined lesson plan script was given to the authors together with the reasons for the refinements.

2.2 An overview of the I_L event decomposition tree made in the trial

The lesson plan script used in this trial was for a lecture on Technology and Home Economics for junior-high school students, aiming at developing their ability to select materials and processing methods appropriate to making required products.

Figure 3 shows an overall view of the I_L event decomposition tree made in this trial. Each node represents an I_L event, and each link between upper and lower nodes represents a WAY. This model was composed of 77 I_L events. As explained in Section 1.1, the bottom layer of the model represents the actual interaction between the teacher and the students, and the upper layers in the structure represent the design rationale of the interaction. The rightmost node is for wrapping up the lesson. Although only this node could not be further decomposed due to time limitations, the others were decomposed several times. The number of decompositions depended on the granularity of the design rationale that the subject explained in the trial.

The original lesson plan script was composed of 11 steps of instruction. Among them, we were not able to sufficiently model the last two steps, which involve the wrapping-up part of the lesson. Therefore, nine steps in the script were modeled in this trial. As is seen in Fig. 4, those nine steps were decomposed into 23 I_L events. The remaining 54 I_L events (higher than the leaf level) in the tree represent the design rationale of the sequence.

Although in SMARTIES users can use their own terms to describe the content of I_L events, the model made in this trial was described only in terms of the concepts defined in OMNIBUS. Note that this does not mean that all the terms appearing in the original script had already been defined in OMNIBUS as is. Although some terms were the same as some concepts in OMNIBUS, others were replaced with similar concepts in consultation with the trial subject, without losing the intended meaning. For example, "confirm" in the script was replaced with "recognize", defined in OMNIBUS. "Exchange information" was replaced with a combination of "ask" and "inform." Strictly speaking, the replacement is not always correct. However, at least in this trial, such replacement was done in mutual agreement with the subject and was acceptable to her. Of course, the ac-

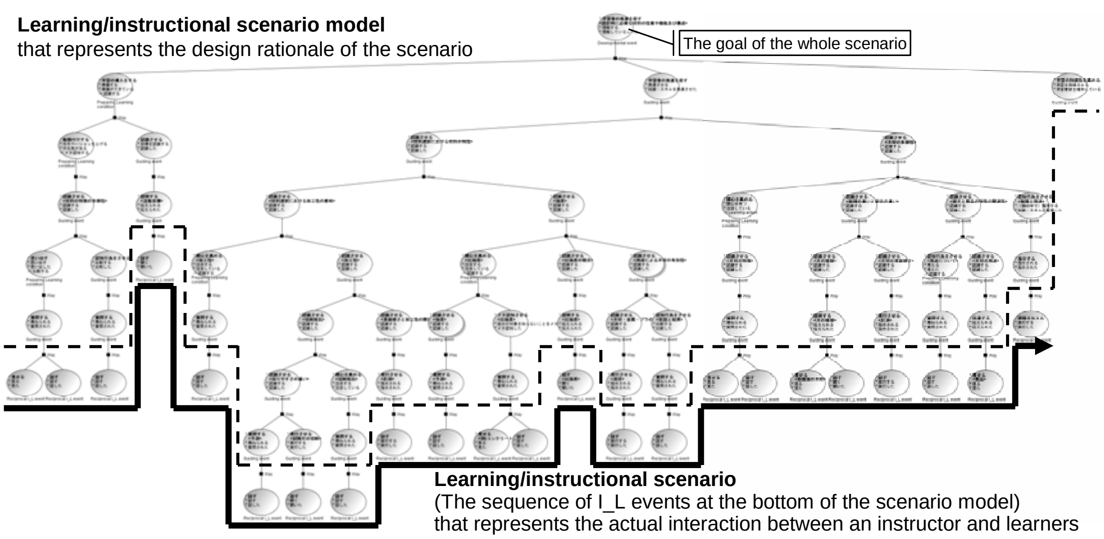

Fig. 3 Overall view of the I_L event decomposition tree made in this trial.

ceptable range will differ from one subject to another, and replacement of terms by concepts defined in OMNIBUS should be done carefully depending on the subject.

3. Discussion of the trial results

3.1 Reflection-in-Action

This subsection presents how the design rationale of the lesson plan was explained by the subject and modeled during the trial. The subject had already finished making her lesson plan script before the trial. In the trial, she recalled and explained its design rationale. This process done in the trial can be considered as equivalent to a partial process of *Reflection-in-action*. Reflection-in-action is what a person does to refine the product during its design process by reflecting on decision-making during the process. In terms of a timing for reflection, what the subject did in the trial was not reflection-in-action because it did not involve reflecting on it in the middle of the process of designing the original plan, but instead involved recalling and reflecting on it after the design process was completed. However, from the scope of reflection, the reflection done in this trial focused not on the whole product but on each decision-making step, and hence this can be interpreted as equivalent to the scope of reflection-in-action. Consequently, although what the subject did in the trial is not real reflection-in-action, not the same as in the timing, we can consider reflection-in-action in designing the lesson plan with the trial result from the scope.

Figure 4(A) shows a portion of the original script that the subject made before the trial. Although the script was composed of seven columns, only three columns are extracted here because these are important in making an I_L event decomposition tree. The leftmost column in the table represents the types of major processes, and Fig. 4(A) is a part of a “preparation” phase, one of the phases in this plan, which are named by the subject: “preparation”, “understanding/construction” and “conclusion.” Each row has sub-processes from the viewpoints of both learners and teachers. The second and third cells from the left represent sub-processes of learners and teachers, respectively. Each of them has two levels of actions. Items with simple numbers represent the first-level sub-processes, and items with bracketed numbers represent the second-level sub-processes, which are the most concrete actions in the script.

In this trial, the authors first focused on the actions in the second-level sub-processes and began making a part of the I_L event decomposition tree shown in Fig. 4(B) from the script. For example, from “*asking* the students a question to focus attention on material workability” shown in Fig. 4(a-1), we first made an I_L event having “ask” as the instructional action, shown in Fig. 4(b-1). Finally, however, two I_L events were made in the model in relation to this part in the script. The other one was added through dialogue between the subject and the authors. After we made one of the I_L events, the subject remembered two kinds of intentions of asking questions. One is to cause the learners to remember what they learned before this lesson, and the other is to let them compare what they recalled. Therefore, we made another I_L event, and these two intentions were separately described as two different macro I_L events (Fig 4(b-2)). Upon obtaining more information from the subject, these two I_L events were for making the learners recognize the variety of materials (Fig 4(b-3)) and for getting them motivated (Fig 4(b-4)).

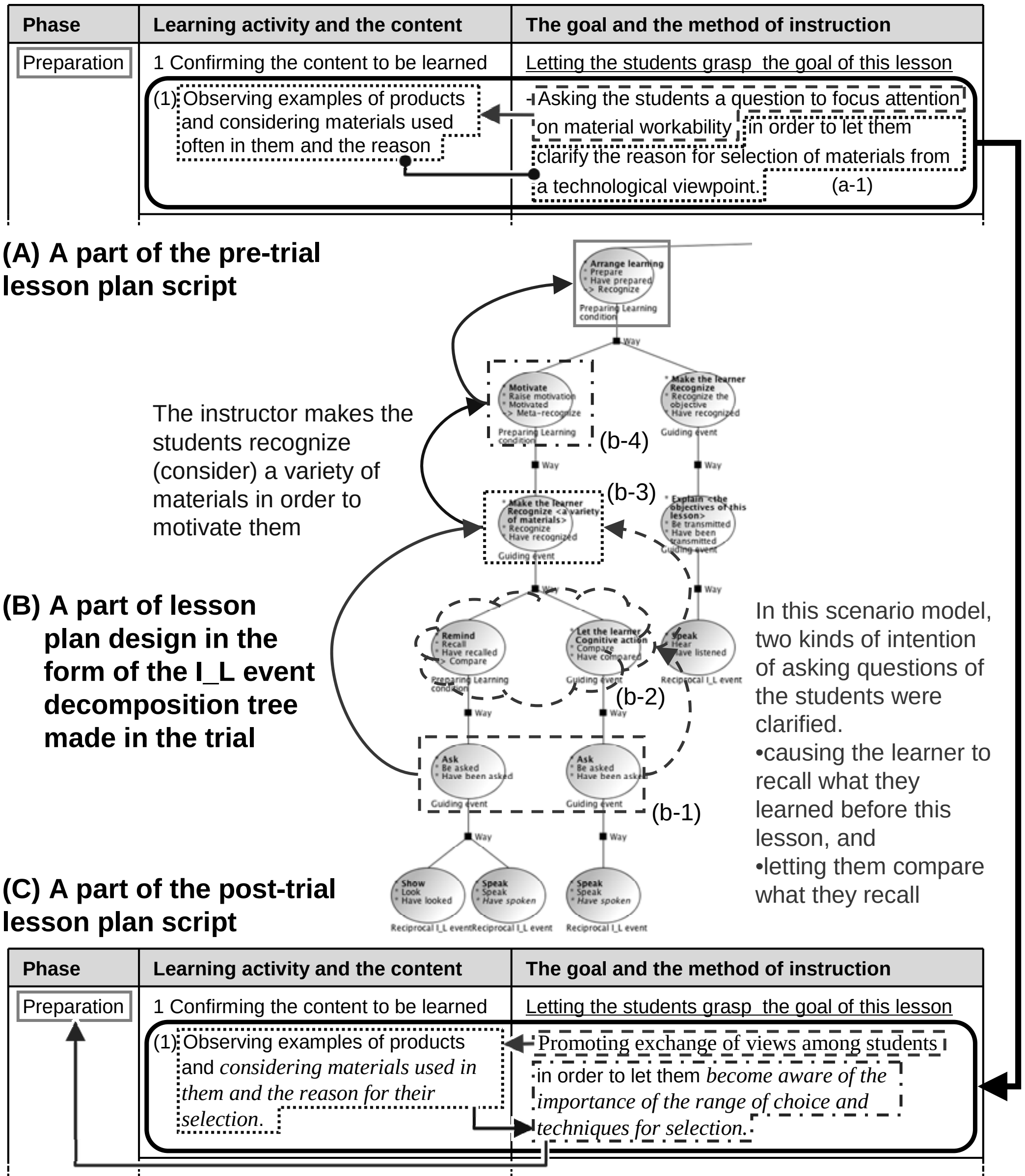

Fig. 4 The lesson plan and the I_L event decomposition tree made in the trial.

Through even more dialogue between the subject and the authors, the part of the I_L event decomposition tree shown in Fig. 4(B) was finally made from the script shown in Fig. 4(A). Only the part of it shown in Fig. 4(b-1) and (b-3) is described explicitly in the script; the other parts are not described in the script, although the subject thought about them. Such an implicit design rationale in the lesson plan design was extracted through modeling and dialogue about the script with SMARTIES.

3.2 Reflection-on-Action

This subsection discusses the effect of the scenario model made in the trial on the changes of the script before and after the trial. The changes can be considered as a result of reflection-on-action. As stated above, the model is the representation of the design rationale of the original script. That is to say, it offers the subject an overview of the design rationale that is in her mind. The subject surveyed it and modified the script after the trial. This is exactly reflection-on-action achieved with the help of SMARTIES.

Fig. 4(C) shows a part of the script that the subject modified from the part shown in Fig. 4(A) after the trial. The changes in the script from the pre-trial to the post-trial versions are italicized in Fig. 4(C). The major difference is that the meaning of this part in the lesson was clarified compared with the pre-trial script. In a broad sense, the goal of this part is the same as “getting learners motivated” in both scripts. However, the subject explained that the goal in the pre-trial script was for only part of the lesson, whereas the goal in the post-trial script was for the whole lesson. To put it more concretely, the former is for the motivation to use a machine tool in this lesson, and the latter is for the motivation to become aware of the importance of what they learn in this lesson.

The subject described the reasons for the changes as “thanks to the model made in SMARTIES” and “thanks to dialogue with the authors.” This means that the use of SMARTIES and communication with the authors in the trial both had an influence on reflection after the trial, and it cannot be identified which one mainly affected reflection with the current data.

3.3 Correspondence between the scenario model and the lesson plan scripts before and after the trial

This subsection presents quantitative analyses of the influence of modeling the lesson plan on refinement of its script. Table 2 shows the correspondence relation between the scenario model made in the trial and the scripts before and after the trial. The scenario model was composed of 77 I_L events, as mentioned in Section 2.2.

Only 31 of them (40 % of the total) correspond to the pre-trial script. There are three possible interpretations for this low correspondence: (1) the subject did not describe them although she had thought about them, (2) she changed her thoughts through the trial, and (3) she newly thought about them in the trial. In the questionnaire after the trial, she explained that the reasons for this were mainly because she had not described everthing that she had explicitly thought about and what she had designed tacitly based on years of experience. Consequently, it can be considered that the reason is mainly (1), and that SMARTIES helped her to remember the design rationale. However, we cannot confirm this because we did not record the dialogue and cannot conduct a protocol analysis of it.

On the other hand, 52 of the I_L events in the scenario model (68 % of the total) correspond to the post-trial script. This percentage is larger than that in the pre-trial script. This is thought to be because what the subject did not describe in the pre-trial script was clarified during the trial and then described in the post-trial script in order to refine it. If all the things in a lesson plan design could be described in the script, the percentage of the correspondence might not be so high. However, a script is usually in the form of a summary because of readability, and it is difficult to describe all of the design in the script, as mentioned above. In this trial, according to the subject’s custom, the script was limited to two pages of A4-size paper. In that respect, it can be considered that the increase of the correspondence rate shows the effect of OMNIBUS and SMARTIES on reflection in designing the lesson plan. Verification of this effect needs analysis of not only the percentage of the correspondence but also the quality of the script. This will be the topic of future work in this study.

Table 2 Correspondence between the model and the pre/post-trial scripts.

	Total number of I_L events in the model	Number of I_L events corresponding to the script	Correspondence rate
Pre-trial	77	31	40 %
Post-trial		52	68 %

4. Conclusion

This paper discusses the effectiveness of OMNIBUS and SMARTIES in designing lesson plans in terms of reflection. From the results of the trial, we consider that OMNIBUS and SMARTIES have a certain effect on reflection in designing lesson plans. The trial demonstrated that modeling a lesson plan as an I_L event decomposition tree aided reflection-in-action in which teachers can retrospectively review the decision-making, and that taking an overall look at the model helps reflection-on-action in which they can check the validity and consistency of the lesson plan design. Of course, this paper presents the results of only one trial. In order to verify the effectiveness of our proposal, even more trials and data are required.

In addition to the problem of the validity, the difficulty of use of OMNIBUS has significant scope for continued improvement. It is very difficult for teachers to use SMARTIES in its current state. One of the main reasons is the difficulty in expressing their ideas in terms of the controlled concepts and vocabulary defined in OMNIBUS. Although it is very difficult to organize the universal vocabulary, there is a fair possibility of success in building a shared vocabulary in a community of teachers. Actually, there is an example of ontology aligned with vocabulary in a teacher community [3]. In addition SMARTIES should have a new function for bridging the gap between detailed concepts defined in OMNIBUS and teachers' mind.

There is plenty of room for further research into practical deployment of OMNIBUS and SMARTIES. From this viewpoint, we might go on to an even more detailed examination of reflection in designing lesson plans and the functionality of authoring systems to support such reflection.

Acknowledgements

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References

[1] Fernandez, C.: Learning from Japanese approaches to professional development, *Journal of teacher Education*, 53(5), pp. 393-405, 2002.

[2] Hayashi, Y., Bourdeau, J., and Mizoguchi, R.: Using Ontological Engineering to Organize Learning/Instructional Theories and Build a Theory-Aware Authoring System, *International Journal of Artificial Intelligence in Education*, 19(2), pp. 211-252, 2009.

[3] Kasai, K., Yamaguchi, H., Nagano, K., and Mizoguchi, R.: A Semantic Web system for supporting teachers using ontology alignment, *Int. J. Metadata, Semantics and Ontologies*, 2(1), pp. 35-44, 2007.

[4] Nakakoji, K. and Fischer, G.: Intertwining Knowledge Delivery, Construction, and Elicitation: A Process Model for Human-Computer Collaboration in Design, *Knowledge-Based Systems Journal* 8(2-3), Butterworth-Heinemann Ltd, Oxford, England, pp. 94-104, 1995.

[5] Reigeluth, C.M. and Carr-Chellman, A.A.: Understanding Instructional Theory, *Instructional-design theories and models: Building a Common Knowledge Base, Routledge*, New York, NY, pp. 3-26, 2009.

[6] Schon, D.A., *The Reflective Practitioner: How Professionals Think in Action*, Basic Books, NY, 1983.

[7] Simon, H.A., *The Sciences of the Artificial* (Third ed.), The MIT Press, Cambridge, MA, 1996.

[8] Stigler, J.W. and Hiebert, J., *Teaching gap*, The Free Press, NY, 1999.

[9] Winograd, T., Flores, F., *Understanding Computers and Cognition: A New Foundation for Design*, Abelx Publishing Corporation, Norwood, NJ, 1986.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Evaluating the Effectiveness of Adaptive Tutorial Dialogues in EER-Tutor

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Abstract: Researchers have long been interested in tutorial dialogues as they are considered to be one of the critical factors contributing to the effectiveness of human one-on-one tutoring. We discuss an evaluation study that investigates the effectiveness of adaptive tutorial dialogues in database design. EER-Tutor, a database design tutor was enhanced to facilitate adaptive tutorial dialogues. The control group participants received non-adaptive dialogues regardless of their knowledge level and explanation skills. The experimental group participants received adaptive dialogues that were customised based on their student models. The performance on pre- and post-tests indicated that the experimental group participants learned significantly more than their peers. The subjective responses indicated no difference in their impression towards the quality of the dialogues and the understandability of the questions. However there was clear evidence that the control group did not like having to go through the entire dialogue before resuming problem-solving.

Keywords: tutorial dialogues, constraint-based tutors, adaptive dialogues

Introduction

One-on-one human tutoring is wildly considered to be the most effective form of instruction [2]. Students' learning gains have been increased by two standard deviations when tutored by human tutors compared to traditional classroom instruction. This has inspired researchers to explore how the effectiveness of human tutoring strategies can be incorporated into intelligent tutoring systems. One of the critical factors contributing to the effectiveness of human tutoring is the conversational aspect of the instruction. Dialogues provide opportunities for students to reflect on their existing knowledge and to construct new knowledge. Some of the dialogue-based tutoring systems that have been developed are Why2-Atlas [3], Auto Tutor [3], CIRCSIM-Tutor [4], Geometry Explanation Tutor [1] and KERMIT-SE [9]. Why2-Atlas and AutoTutor use dialogues as the main activity to help students learn the domain knowledge. The other systems provide problem-solving environments as the main activity and use tutorial dialogues as a way of remediating errors in the student solutions. For example, CIRCSIM-Tutor is a natural language (NL) tutor that helps students learn cardiovascular physiology related to regulation of blood pressure. The Geometry Explanation Tutor requires students to justify the problem-solving steps in their own words. KERMIT-SE, a database design tutor, engages students in dialogues when their solutions are erroneous. All these instructional tasks except database design are well-defined: problem solving is well-structured, and therefore explanations expected from learners can be clearly defined. In contrast, database design is an ill-defined task: the final result is defined only in abstract terms, and there is no algorithm to find it.

Our long-term goal is to develop a general model for supporting dialogues across domains. Since we previously implemented dialogues for EER-Tutor [5], the initial work on this project started with the same system. Based on the findings of two Wizard-of-Oz studies [7, 8], we developed a model to support dialogues. Our model consists of three parts: an error hierarchy, tutorial dialogues and rules for adapting them. The error hierarchy categorizes all the error types in a domain. At the lowest level an error type is associated with one or more violated constraints, which form leaves of the hierarchy. The error types are then grouped into higher-level categories. Remediation is facilitated through tutorial dialogues, one of which is developed for each error type. When there are multiple errors in a student solution, the hierarchy is traversed to select the error most suitable for discussion and the corresponding dialogue is then initiated. Finally, the adaptation rules are used to individualize the dialogues to suit the student's knowledge and reasoning skills by controlling their timing and the exact content. In response to the generated dialogue learners are able to provide answers by selecting the correct option from a list provided by the tutor. For a detailed discussion of the model see [7].

The next section presents the details of the evaluation study. Section 2 presents the results followed by conclusions.

1. The Study

We conducted a study with the EER-Tutor in March 2010 at the University of Canterbury, which involved volunteers from an introductory database course. The objective of the study was to investigate whether adaptive dialogues are more effective in improving learning than non-adaptive dialogues. The participants were randomly assigned to two groups (experimental and control). The experimental group received adaptive support based on our model. The control group was given non-adaptive support in which two different students with different knowledge levels received the same dialogue. Differences between the two groups were: (i) Dialogue selection (ii) Dialogue prompts and (iii) Additional support.

Dialogue selection: The dialogue selection for the control group was based on a depth-first traversal of the error hierarchy. The first violated constraint that was found in the traversal was selected for discussion. As the errors in the hierarchy were ordered from simpler to more complicated errors, the depth-first search results in the simplest error to initiate a dialogue. For instance, Figure 1 presents the dialogue that a control group participant receives for the submitted solution. It contains multiple errors: (i) ROOM should be represented as a weak entity instead of a regular entity (ii) Attributes are missing from the entities HOTEL, EMPLOYEE and ROOM (iii) Cardinality between HOTEL and WORKS_FOR is incorrect etc. The error selected for discussion was that ROOM was modelled as a regular entity. Now consider an experimental group participant with an identical student model to the previous student submitting the same solution. Figure 2 represents the dialogue to be received. This dialogue focuses on the incorrect cardinality between EMPLOYEE and HOTEL. This is because cardinality was identified as the most difficult concept based on his/her student model. (i.e. the error this student will most likely to make in the next attempt).

Dialogue prompts: The control group saw the entire dialogue regardless of the number of times they have seen the dialogue previously or their responses to the dialogue prompts. As a result, the same solution submitted by two different students with different knowledge levels in the control group received identical dialogues. For instance, the prompt received by the control group participant discusses the domain concept related to the error selected for discussion (EERTutor1 in Figure 3(a)). We call this type of prompt a problem-independent prompt as it focuses on the relevant domain concept [7]. The entire dialogue is given in Figure 3(a). In contrast, the prompt received by the experimental group participant discusses the selected error in the context of the current problem (EERTutor3 in Figure 3(b)). This type of prompt is called problem-dependent prompt [7]. This error was chosen for discussion because his/her student model identifies that cardinality is the most difficult concept at this moment. He/She receives a problem-dependent prompt (instead of a problem-independent prompt) because this is the first time this mistake is made during the current session. If he makes this type of error repeatedly, he will be given the problem-independent prompt (EER-Tutor1 in Figure 3(b)).

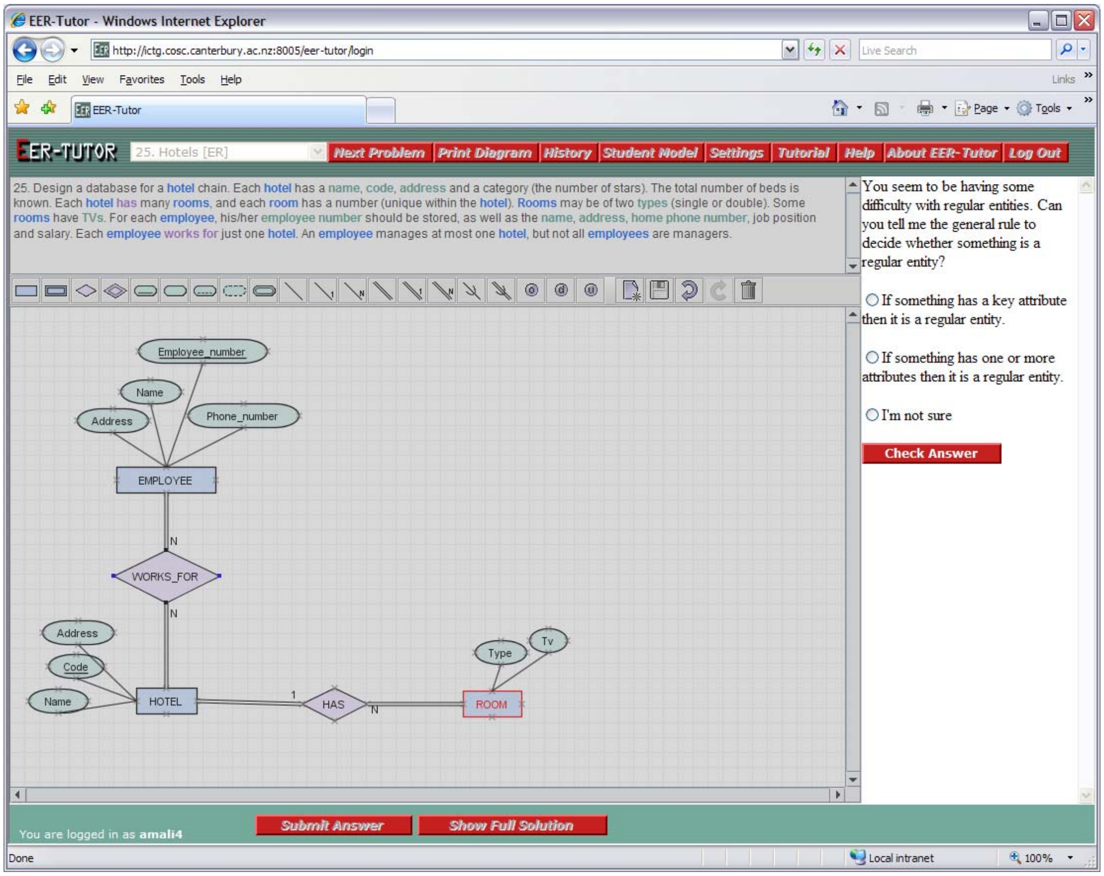

Fig. 1. The dialogue received by a control group participant

Additional support: When an experimental group participant abandons a problem (i.e. changes a problem without submitting at least once) or has been inactive for a period of time, they were asked whether they needed help. If they requested help then their solution was evaluated and an error was selected for discussion based on their student model. The control group did not receive this support.

The study consisted of four stages: (i) pre-test (ii) interactions with EER-Tutor (iii) post-test (iv) questionnaire.

Pre- and post-tests: Pre-tests were used to determine the participants' knowledge before interacting with the system and also to determine whether the knowledge between the experimental and control was significantly different. Both pre- and post-tests had 6 questions each. The questions in the pre- and post-tests were of similar difficulty. We wanted to evaluate whether students' problem-solving abilities as well as explanation skills improved after interacting with the system. One question asked the participants to provide the database schema for the given requirements. This is a typical question that can be found in examinations, text books etc. Three other questions were aimed to understand the effect the system had on students' explanation skills. The remaining two questions asked about declarative knowledge.

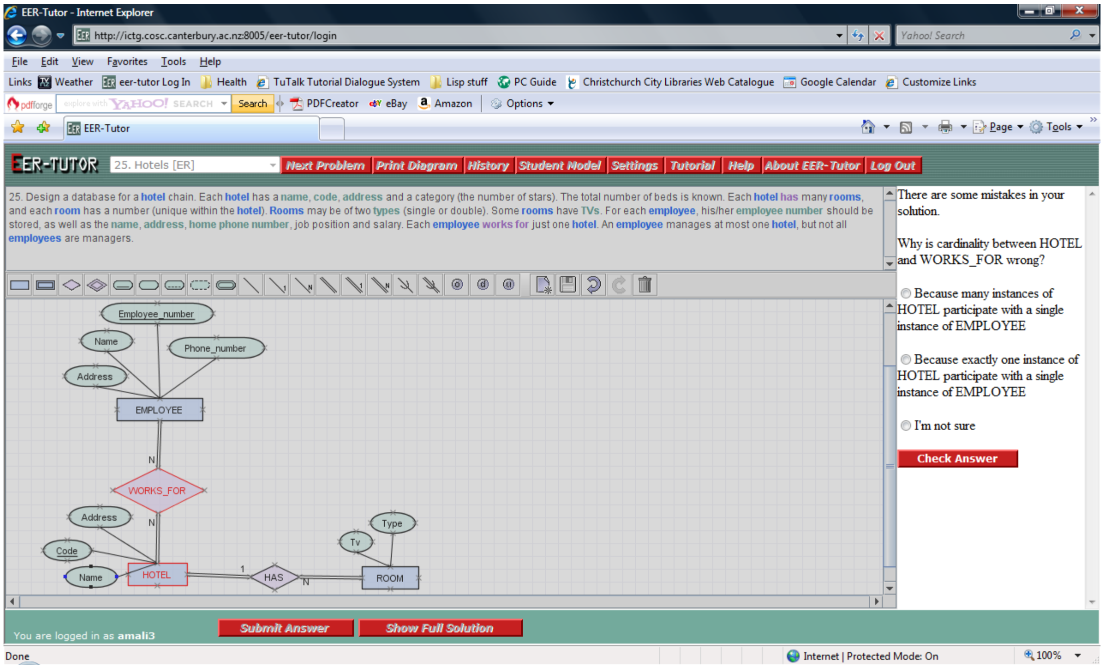

Fig 2. The dialogue received by an experimental group participant

Questionnaire: There were eight questions aimed at understating participants' view of different aspects of dialogues. Five questions had Likert scales (ranging from 1 to 5) discussing the quality, the length and the prompts in the dialogues. Participants were also given an opportunity to explain how the dialogues helped them in their learning. Some questions focused on suggestions to improve the dialogues and EER-Tutor in general.

Procedure: The participants used EER-Tutor for the first time in their regular lab sessions during the third week of the course, by which time they had been introduced to ER modeling.

They were randomly divided into the control and experimental groups. The duration of the study was limited to a single 2-hour session. At the beginning of the session students were given about 10 minutes to complete the pre-test. Then they started solving ER modelling problems using EER-Tutor. Towards the end of the session, they were given 10 minutes to complete the post-test and 5 minutes to answer the questionnaire.

2. Results and Discussion

Out of 104 students enrolled in the course, 77 participated in the study. Some students did not complete the post-test. Table 1 reports some statistics about the 65 participants who completed both pre-and post-tests. There were 31 participants in the experimental group and 34 in the control group. There was no significant difference on the pre-test performances of the two groups. The post-test performance of the experimental group was significantly better compared to their peers who received non-adaptive dialogues Both the learning gain[1]

[1] Learning gain = post-test score – pre-test score

and the normalised learning gain[2] of the group who received adaptive dialogues was also significantly higher than the gains of the control group.

EERTutor1: You seem to be having some difficulty with regular entities. Can you tell me the general rule to decide whether something is a regular entity? ***Student1***: *I don't know* **EERTutor2:** Let's try a simple thing. What is used to uniquely identify instances of a regular entity ***Student2***: key a*ttribute* **EERTutor3 :** Great ! Now tell me why modelling *ROOM* as a regular entity is incorrect? ***Student3***: *I'm not sure* **EERTutor4**: Let's see. Check carefully whether you can find a key attribute for *ROOM*. {When Continue button is pressed} Now please select the key attribute for *ROOM* ***Student4***: *No key attribute for ROOM* **EERTutor5**: Great! Now tell me the best way to model *ROOM*? ***Student5***: *I need more help* **EERTutor6:** Ok. As *ROOM* does not have a key attribute it cannot be a regular entity. So it should be a weak entity. **EERTutor7**: Great ! try to answer this question so that you'll remember what you learnt. …………….. uniquely identifies instances of a …………… ***Student6***: key *attribute, regular entity* **EERTutor8**: Excellent, go ahead and do the changes. Submit the solution when you're done.	**EERTutor1**: Looks like you have trouble with cardinality. Let's focus on cardinality now. What do you represent by cardinality on the E1 side between entities E1 and E2 in a binary relationship? ***Student1***: *I don't know* **EERTutor2:** Here's a simple question to try. How do we model connections between entities? ***Student2***: *Using relationships* **EERTutor3 :** Great ! Why is the cardinality between *HOTEL and WORKS_FOR* is wrong? ***Student3***: *I'm not sure* **EERTutor4**: Let's see. Try to figure out how many instances of *HOTEL* participates with a single instance of *EMPLOYEE*? {When Continue button is pressed}Now tell me how many instances of *HOTEL* participates with a single instance of *EMPLOYEE*? ***Student4***: Exactly one **EERTutor5:** Great! Guess you know how to make change now. Before that, try to answer this question. What is the correct question to ask when deciding the cardinality on the E1 side between entities E1 and E2 in a binary relationship? ***Student5***: How many instances of E1 participates with a single instance of E2? **EERTutor6**: Excellent job, go ahead and do the changes. Submit the solution when you're done.

Fig. 3 A hypothetical dialogue for EER-Tutor received by a (a) control group participant (b) experimental group participant

As the study was limited to a single lab session, the two groups spent a similar time interacting with the system. There were also no significant differences between the number of attempted and solved problems. The total number of dialogues, the total number of single-level dialogues (some dialogues are limited to a single feedback message as they discuss simple errors) and the total number of multi-level dialogues were also similar for the two groups.

The control group answered a significantly higher number of questions than their peers. This was expected, as the control group had to go through the entire dialogue before resuming problem-solving. However, percentage number of correct answers was similar for both groups. There were no significant differences on the total number of questions answered incorrectly or the questions with a *More Help* request (i.e one of the options available was *I don't know* or *I need more help* which resulted in presenting the relevant information to the

[2] Normalised learning gain =learning gain/(1-pre-test score)

student). Also there was no significant difference on the percentage of questions that requested more help. However, it is interesting to note that the experimental group has provided a significantly higher percentage of incorrect answers. Further analysis is required to understand the cause for this.

Table 1. Some statistics from the study (sd given in parentheses)

	Control (34)	Experimental (31)	p
Pre-test (%)	54.5 (18.1)	51.3 (16.1)	ns
Post-test mean (%)	61.2 (14.9)	69.9 (11.5)	0.005
Gain	6.8(15.6)	18.6 (16.8)	0.002
Normalised gain	0.002 (0.7)	0.3 (0.4)	0.01
No. of constraints learnt	1.2 (1.5)	2.3 (2.3)	0.02
Interaction time (min)	62.8 (22.1)	62.9 (24.1)	ns
Attempted Problems	8.6(4.8)	10.6(4.8)	ns
Solved problems	9.0(4.8)	7.9 (4.7)	ns
Total Dialogues received	12.1 (7.3)	14.0 (8.3)	ns
Single-level dialogues seen	2.1(3.0)	1.9 (2.7)	ns
Multi-level dialogues seen	10 (6.8)	12.1(7.2)	ns
Total number of questions answered	34.4 (25)	23.6 (14.6)	0.01
Total number of questions answered correctly	23.3 (17.9)	14 (10.4)	0.006
% number of questions answered correctly	61.4(23.1)	59(16.9)	ns
Total number of questions answered incorrectly	9.1 (8.3)	7.3 (4.3)	ns
% number of questions answered incorrectly	23.7(12.9)	31.8(15)	0.01
Total number of questions with a *More Help* request	2.1 (3.5)	2.4 (3.5)	ns
% number of questions answered with a *More Help* request	6.1(6.9)	9.22(11.4)	ns

Effect size[3] is a standard way to compare the results of one pedagogical experiment to another. It indicates how much more the experimental group has learnt compared to the control group? The effect size (Cohen's d) for learning gains of the two groups is 0.69 (the effect size based on the normalized gain is 0.51). This is comparable to the study with SQL-Tutor conducted in a similar setting in a single 2-hour session [6]. An effect size of 0.66 was reported for that study for the students who used SQL-Tutor compared with those who did not use the tutor. The effect size obtained here is therefore remarkable because the only difference between the two groups was the adaptivity of the dialogues.

2.1 Learning Curves

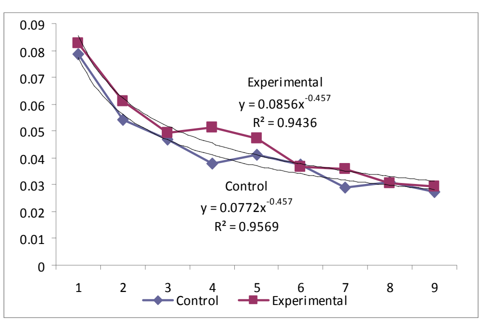

Fig 4: Probability of violating a constraint

In order to investigate how the students in both groups learnt the database design concepts in terms of constraints we analyzed how frequently constraints were violated. Figure 4 illustrates the learning curves for both groups. The probabilities of violating a constraint on the first and subsequent attempts were averaged over all students. The X-axis represents the attempt number (first, second and so on) when a student violated a constraint. The Y-axis shows the probability of violating these constraints. The probability of making a mistake is initially higher for the experimental group than the control group even

[3] Effect size = (Experimental Mean – Control Mean) /Standard Deviation of both groups

though not significant. Figure 4 indicates that both groups learnt the constraints in a similar manner. Both learning curves have a good fit to the power curve, indicating that the transferability of learning is high for both groups

We also investigated the number of constraints learnt by both groups. For each constraint in a student model, the first 5 attempts and the last 5 attempts during which a constraint was relevant was considered. If the probability of violating a constraint was reduced by 0.7 during the last 5 attempts, then that constraint was considered to be learnt. This analysis revealed that the experimental group learnt a significantly higher number of constraints than the control group (2.3 vs 1.2 p= 0.02).

2.2 Subjective Responses

Table 2 presents the subjective responses about various aspects of the dialogues. The starting and the ending points of the Likert scale had descriptive labels and the middle points had only numeric labels. For instance, when asking about overall quality of the dialogues, the starting and the ending labels were Poor (1) and Excellent (5) The points 2, 3 and 4 were indicated on the scale. The impression about the quality of the dialogues and the ease of understanding the questions were similar between the groups. However there was clear evidence that the control group did not like having to go through the entire dialogue.

Table 2. Subjective responses about tutorial dialogues (standard deviation reported in parentheses)

Question	Likert scale	Control	Experimental	p
Overall quality of the dialogues	Poor to Excellent (1 to 5)	3.5 (1.0)	3.7(0.8)	ns
Length of the dialogues	Too long to Too short (1 to 5)	2.6 (0.9)	3.2(0.5)	0.002
Ease of understanding the questions	Very Hard to very easy (1 to 5)	3.1(1.0)	3.4(0.8)	ns

3. Conclusions

We discuss an evaluation study that investigates the effectiveness of adaptive tutorial dialogues in EER-Tutor. The control group participants received non-adaptive dialogues regardless of their knowledge level and explanation skills. The experimental group participants received adaptive dialogues that were customised based on their student model. The study was conducted in their regular lab sessions and was limited to a single 2-hour session. At the end of the session the performance of the experimental group participants increased significantly more than their peers with an effect size of 0.69. The experimental group also learnt a significantly higher number of constraints than the control group. These results strongly suggest that the adaptive dialogues had a positive effect on learning database design. These results are significant because (i) the difference between the two groups was minimal (i.e. the only difference was the adaptivity of the dialogues) and (ii) the duration of the study was limited to a single 2- hour session. The subjective responses indicated no difference in their impression towards the quality of the dialogues and/or the understandability of the questions. However there was clear evidence that the control group did not like having to go through the entire dialogue before resuming problem-solving.

The participants were given the opportunity to interact with the system after this study. These interactions will be analysed to see how motivated they were to use EER-Tutor in their own time. Also we plan to use performance on their assignment which requires them to design a complex data model as a delayed post-test to investigate their improvement in their knowledge in database design.

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References

[1] Aleven, V., Ogan, A. Popescu, O. Torrey, C., & Koedinger, K. R. (2004). Evaluating the effectiveness of a Tutorial Dialogue System for Self-Explanation, Lester, J. C., Vicario, R.M., Papaguacu, F. (eds.) *Proceedings of ITS2004*, (pp 443-454). Alagoas, Brazil: Springer-Verlag.

[2] Bloom, B. (1984) The 2-sigma problem: The search of group instruction as effective as one-to-one tutoring, *Educational Researcher* 13, 3-16.

[3] Grasser, A.C., VanLehn, K., Rose, C.P., Jordan P. W., & Harter, D. (2001) Intelligent Tutoring Systems with Conversational Dialogue *AI magazine*, 22(4), 39-51.

[4] Millis, B., Evens, M., & Freedman, R. (2004). Implementing Directed Lines of Reasoning in an Intelligent Tutoring System using the Atlas Planning Environment, *Proceedings of the International Conference on Information Technology*: *ITCC 2004*, (pp. 729-733). Nevada-USA: IEEE Computer Society.

[5] Mitrovic, A., Martin, B. & Suraweera, P. (2007). Intelligent Tutors for all: Constraint-based modeling methodology, systems and authoring, *IEEE Intelligent Systems*, 22(4), 38-45.

[6] Mitrovic, A., Martin, B., & Mayo, M. (2002) Using Evaluation to Shape ITS Design: Results and Experiences with SQL-Tutor. *User Modeling and User-Adapted Interaction*, 12 (2-3), 243-279.

[7] Weerasinghe, A., & Mitrovic, A. (2008). A Preliminary Study of a General Model for Supporting Tutorial Dialogues. *Proceedings of the International Conference in Computers in Education*, (pp. 125-132). Taipei, Taiwan: Asia-Pacific Society for Computers in Education.

[8] Weerasinghe, A., & Mitrovic, A. (2006). Individualizing Self-Explanation Support for Ill-Defined Tasks in Constraint-based tutors, Aleven V. Ashley, K., Lynch, C. and Pinkwart, N. (eds.), Workshop on Intelligent Tutoring Systems for ill-defined domains at ITS2006, (pp. 55-64). Jhongli, Taiwan.

[9] Weerasinghe, A., & Mitrovic, A. (2006). Facilitating Deep Learning through Self-Explanation in an Open-ended Domain, *Knowledge-based and Intelligent Tutoring Systems* 10(1), 3-19.

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A New Perspective for Metacognition-Driven Learning

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Abstract. While the importance of metacognition is widely acknowledged in education, some researchers indicate that the domain of metacognition is one that lacks coherence. In order to overcome this issue, it is necessary that each researcher explains what he addresses as metacognition by using his own or other people's framework of metacognition. We propose a new framework for metacognition which explains what types of metacognitive activity occurs and what types of metacognition-driven learning they cause. With this framework, it becomes possible not only to identify what types of metacognitive activity or what types of metacognition-driven learning a computer system supports but also to propose new functions that support the various types of metacognitive activity and metacognition-driven learning.

Keywords: Metacognition, framework, metacognition-driven learning, an abstraction operation, an instantiation operation, a modification operation

Introduction

Metacognition is defined broadly as "cognition about cognition," and it consists of metacognitive knowledge, which is knowledge about human cognitive activities, and metacognitive activities that control cognitive-activity processes [4, 8].
Metacognition training is becoming an important issue in computer-based learning environments [2, 3, 5, 7, 10] so that metacognition is widely acknowledged as an important element for successful learning [10, 14].

However one issue that has been raised about the current situation is the difficulty of mutual understanding and sharing of achievements in metacognition research among researchers [17]. A conceivable solution to overcoming this current situation is that each researcher explains his own research by his or other's framework of metacognition. Explanation of research achievements based on a framework of metacognition enables sharing and mutual understanding of research achievements [1].

A number of models and conceptual frameworks for metacognition and self-regulated learning have already been proposed [12, 15]. We also constructed a framework [11]. Unfortunately, however, our previous framework was not successful in explaining how metacognition-driven learning happens and what types of metacognitive activity cause such learning. With the framework extended to cover metacognition-driven learning presented in this paper, it becomes possible to analyze existing metacognition training systems and identify which system supports which type of metacognition-driven learning; in addition, it enables us to propose new functions for facilitating metacognition-driven learning the systems do not support yet.

In this article, we first describe metacognition-driven learning and what types of metacognitive activity cause the learning. Then, we describe an extended framework for metacognition. Finally, based on the extended framework, we analyze Betty's Brain [2, 3] and Error Based Simulation (EBS) system [10], and we propose new functions to be added to respective systems in order to support a metacognitive activity to cause metacognition-driven learning.

1. Metacognitive Activities and Metacognition-Driven Learning

1.1 Metacognition-Driven Learning and three new types of Metacognitive Activities

Collins and Brown claim that the simplified expressions of problem solving processes enable the learner to recognize features of the learner's own problem solving processes, and they enable students to characterize problem solving strategies in terms of abstractions such as backward reasoning [5, p7]. Abstractions can be constructed in a form that is critical to developing good metacognitive strategies [5, p17]. They also claim that students can reflect any differences between their problem solving results and the correct result, trying to understand what led to those differences [6, p.463]. Deriving abstractions about one’s own problem solving process is a type of metacognitive activity because the operation makes one to reflect one’s own problem solving process. We call such operation an *abstraction operation,* that is, one can lift a specific instance up to a class-level expression that it belongs to. We believe that a leaner can understand what causes the problem solving outcome, only by deriving abstractions. We believe such understanding is the key to *Metacognition-driven learning.*

Let us explain an abstraction operation and metacognition-driven learning by taking the EBS as an example [10]. EBS exhibits strange behavior when a learner draws erroneous force vectors on the blocks. If a learner draws force vectors of gravity and normal reaction forces on blocks without considering their lengths (quantity of the force) EBS exhibits that the block is buried in the ground or the block flies away in the sky. Most learners having used EBS say “When I drew the force of gravity and the normal reaction force on blocks at first time, the block flew away in the sky.” It means that the learners recognize an association between the force vectors drawn on blocks and strange behavior of the blocks at an instance level. Only one learner says “I did not consider the lengths of the force vectors.” In our interpretation, he could derive abstraction about his problem solving process. There might be a learner who can derive higher-level abstraction than the learner above such as “I carelessly solve a problem.” Learners who can derive abstractions like those might be able to discover or understand their good metacognitive strategies that can derive their metacognitive activities such as “let us consider the lengths of the force vectors” or “let us carefully solve a problem.” The discovery of metacognitive strategies is partly a kind of the *metacognition-driven learning*.

The learners who did metacognition-driven learning may use their metacognitive strategies to achieve their goals. To use them, they bring the class-level constraints down to the instance level to regulate actual cognitive activities. We call the operation an *instantiation operation*. In addition, modification of metacognitive strategies such as making a combination of metacognitive strategies is called a *modification operation*. In summary, the metacognitive activities for metacognition-driven learning that we suppose include an abstraction operation, an instantiation operation, and a modification operation in addition to observation, evaluation, selection, and execution of one's own cognitive activities.

1.2 Extended Metacognitive-Activity Framework

Our previous metacognitive-activity framework is constructed based on the presumption that cognitive activities and metacognitive activities are the same but involve different target objects. We assume five basic types of cognitive activity for problem solving, i.e., observation, evaluation, selection, virtual application, and rehearsal, and considered that the environment, such as a given problem, cognitive activities of others, and products of one's own working memory (WM) serve as objects. However, only observation, evaluation, selection and performance are shown in Figure 1(a). As virtual application is included in selection, and rehearsal is concurrent execution with all cognitive activities, the two are omitted in Figure 1(a). We extended this previous framework as shown in Figure 1(b). First, we added an abstraction operation, a modification operation, and an instantiation operation to the previous metacognitive activities (arrows in Figure 1). Then, we added metacognition-driven learning driven by the added metacognitive activities. Metacognition-driven learning achieves either of class addition, class deletion (unlearning), and class modification (rectangles in Figure 1).

2. Analysis of Training Systems Based on the Extended Framework

We analyzed Betty's Brain system [2, 3] and EBS[10].

2.1 The Self-Regulated Learning: Betty's Brain

Betty's Brain aims at acquisition of complex scientific knowledge and learning self-regulation skills by teaching a computer agent named Betty. The trigger for observing use of self-regulated learning strategies is Betty's response or Davis's advice. With Betty's

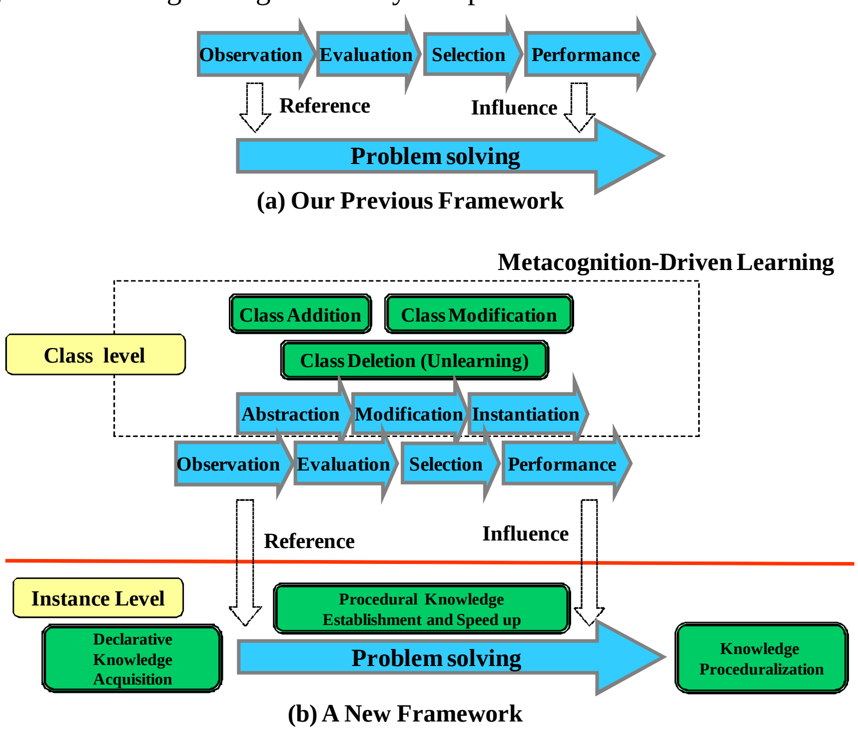

Figure 1. An Extended Framework for Metacognition

response, the learner reflects whether the learner has been effectively using the strategies on Betty. This reflection is an observation on the result of strategy application at the instance level and corresponds to the observation in Figure 1. Davis's advice is an explanation of how, when, and why to use each learning strategy. Davis's advice promotes to drive an instantiation operation of the strategies, but does not lead to an abstraction operation of strategy application or metacognition-driven learning.

The extended framework allows us to notice how a new function promotes an abstraction operation: a new function initially helps a leaner reflect his learning. Next, it helps him derive abstractions about his learning process. For example, suppose that, with Betty's explanation, the learner noticed an error in the cause–effect relationship in the concept map. We propose that, at that time, the learner be asked "Explain the reason why Betty misunderstood the cause–effect relationship," so that the learner is prompted to reflect on the process of Betty's incorrect learning of the cause–effect relationship (the process of the learner's own learning process). If the learner can successfully derive abstractions about the learner's learning process as "Multiple concepts were acquired but the relationship among the concepts was not considered," metacognition-driven learning such as "when multiple concepts are acquired, consider the relationship among the concepts" can be expected so that an abstraction operation, which has not yet been supported in the Betty's Brain, can be implemented.

2.2 EBS

Our second system is the above mentioned EBS. Upon seeing an unusual behavior of blocks that EBS exhibits, a learner realizes that he has made a serious error and carefully observes the situation presented to him. By observation, a learner strongly associates the force vector drawn (forces exerted) at the block with strange behavior of the block. The interview with students after learning with EBS demonstrated this point [10]. Although EBS does not directly support an abstraction operation, we believe that the association between the forces exerted at the block and strange behavior of the block unlearns learner's erroneous knowledge at the class level (class deletion (unlearning) in Figure 1). Evaluation experiments of EBS successfully proved this point: compared with the ordinary class, students in the EBS class were more successful in unlearning erroneous knowledge [10].

EBS does not directly support an abstraction operation, an instantiation operation, or a modification operation except unlearning. We can propose a function to be added for EBS to directly support an abstraction operation. When a learner corrects his drawn forces on the block by trial and error, the EBS system would demonstrate two kinds of his drawn forces on the screen: one does not comply with Newton theory and the other complies with it, and asks him the different forces between the two. This new function allows the learner to recognize the difference of his erroneous drawn forces and correct them. After that, the new function asks the learner "Please explain what let you draw your erroneous forces." If the prompt allows the learner to successfully abstract his cognitive activities such as "although there are forces that act on an block, I did not consider the resultant force," there is a possibility that the learner would be able to discover a strategy such as "if there are forces that act on an block, I have to consider the resultant force" and understand it as metacognitive strategy. If the learner was able to discover a strategy and understand it as a metacognitive strategy, he would be able to regulate his cognitive activities using the strategy.

As described above, the analysis of EBS based on the extended framework clarifies the types of unsupported metacognitive activities and serves to create new functions for supporting the types of metacognitive activity.

3. Conclusion

We proposed the metacognition-driven learning and the three new types of metacognitive activities. With these, we extended the previous metacognitive activity framework to a new framework. Finally, we demonstrated by examples that, based on the proposed extended metacognitive activity framework, it is possible to analyze existing metacognition training systems and explain the features and limits of the individual methods and systems using the same vocabulary, and also to add new functions and propose improvements to the systems.

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References

[1] Azevedo, R.: Theoretical, conceptual, methodological, and instructional issues in research on metacognition and self-regulated learning: A discussion, Metacognition Learning, Vol.4 No.1, pp.87--95 (2009)

[2] Biswas, G., Schwartz, D. L., Leelawong, K., Vye, N., & TAG-V.: Learning by Teaching: A New Paradigm for Educational Software. Applied Artificial Intelligence. 19(3), pp. 363--392 (2005)

[3] Biswas, G., Roscoe, R., Jeong, H., Brian Sulcer, B.: Promoting Self-Regulated Learning Skills in Agent-based Learning Environments . In: Procs. of 17th International Conference on Computers in Education[CDROM], pp.67—74. (2009)

[4] Brown, A.: Metacognition, Executive Control, Self-regulation, and Other more Mysterious Mechanisms". In: Weinert, F. E. & Kluwe, R. H. (eds.), Metacognition, Motivation, and Understanding, NJ: LEA, pp.65--116, (1987)

[5] Collins, A., & Brown, J.S.: The computer as a tool for learning through reflection. In H. Mandl and Lesgold (Eds.), Learning issues for intelligent tutoring systems. pp. 1--18 New York: Springer-Verlag (1988)

[6] Collins, A., Brown, J.S., & Newman, S.E.: Cognitive Apprenticeship: Teaching the Crafts of Reading, Writing, and Mathematics. In L.B. Resnick (Ed.), Knowing, Learning, and Instruction: Essays in Honor of Robert Glaser, pp. 453--494 Hillsdale, NJ: Lawrence Erlbaum Associates (1989)

[7] Conati, C. VanLehn, K.: Toward Computer-Based Support of Meta-Cognitive Skills: a Computational Framework to Coach Self-Explanation. International Journal of Artificial Intelligence in Education, 11, pp.398—415 (2000)

[8] Flavell,J.H.: Speculations about the nature and development of metacognition, In Weinert, F. E. and Kluwe, R. H. (eds.), Metacognition, Motivation, and Understanding, LEA, (1987).

[9] Hacker, D. J., Dunlosky, J., Graesser, A. C.: Metacognition in Educational Theory and Practice. NJ:LEA (1998)

[10] Hirashima,T., Imai,I.，Horiguchi,T., and Toumoto,T.: Error-based simulation to promote awareness of errors in elementary mechanics and its evaluation, Proc. of the 14th Artificial Intelligence in Education (AIED2009), pp.409 -- 416, (2009)

[11] Kayashima,M., Inaba,A. and Mizogichi,R.: What do you mean by to help learning of metacognition?, Proc. of the 12th Artificial Intelligence in Education (AIED2005), pp. 346--353, (2005)

[12] Pintrich, P. R. : The role of motivation in self-regulated learnig, In M. Boekaerts, P. R. Pintrich, and M. Zeidner (Eds.), Handbook of Self-Regulation, New York: Academic Press, pp.451--502, (2000)

[13] Veenman, M. V. J., Van Hout-Wolters, Bernadette H. A. M. and Afflerbach, P.: Metacognition and learning: conceptual and methodological considerations, Metacognition Learning, Vol.1, No.1, pp.3--14, (2006)

[14] Wang, M. C., Haertel, G. D., and Walberg, H.J.: What Influences Learning?: A Content Analysis of Review Literature, J. of Educational Research, Vol.84, No.1, pp.30-43, (1990)

[15] Winne, P. H. :Self-regulated learning viewed from models of information processing. In. Zimmerman, B.J., Schunk, D.H. (Eds.), Self-Regulated Learning and Academic Achievement: Theoretical Perspectives, LEA, pp. 153--189, (2001)

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Automatically Grading the *Use of Language* in Learner Summaries

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Abstract: A summary is a short clear description that gives the main facts or ideas about something. Summaries are widely used in traditional teaching as an educational diagnostic strategy to infer comprehension, or how much information from text is retained in memory. From its early beginning Computer Supported Learning Systems research has faced open-ended learners' response evaluation. Global summary grading includes partial discourse assessment on relevant issues such as coherence, cohesion, comprehension, adequacy and use of language. This paper describes the procedure followed searching for the best available approach to model the *use of language* grading of learner summaries written in Basque language.

Keywords: Automatic summary grading, use of language

Introduction

In educational contexts, a summary contains the main ideas which learners recall from text. Thus, summaries are widely used in traditional teaching as an educational diagnostic strategy to infer comprehension, or how much information from reading text is retained in memory [1-3]. Broadly speaking, there are two ways to approach learning diagnosis: close-ended and open-ended. The close-ended evaluation (multiple choice test, ordering exercises, etc.) has the advantage of being countable, assures the possibility of objective assessment and makes possible accurate computation. Therefore, it has been most widely used in Computer Supported Learning Systems (CSLSs) for learning evaluation. But, the close-ended mode also involves a greater probability of scoring by chance and restricts the freedom and richness of learner responses. Open-ended evaluation assesses free text. This assessment mode, although less accurate, has also been present in Artificial Intelligence and education since the very early works in Socratic dialog systems [4-8]. By using free text learners have the freedom to write anything and can construct their own answer. Therefore, it is more likely to obtain a better approximation to real learners' knowledge in open-ended modes. However, automatic evaluation in open-ended modes is complex and has to face uncertainty. Still, new developments in Natural Language Processing (NLP) allowed a rebirth with a variety of open-ended approaches in various applications: dialogue systems [9-12], feedback in narratives [13], etc. The work presented in this paper has been carried out in the context of an automatic summary grading environment, LEA [14]. Relevant variables identified when producing a summarisation environment are: text related (text type, text present/absent, theme and text length), discourse related (adequacy, coherence, cohesion, use of language and comprehension), learner related (learner level and learner's prior knowledge) and aid tools (dictionaries, spell and grammar check, etc.). The above variables have been identified after a deep analysis of both summary grading and human summary grading performance to model their criteria [15].

In the context of this work, global summary grading decisions are gained by means of a Bayesian Network model based on discourse measures on cohesion, coherence, comprehension, adequacy and *use of language* as independent measures [15].

Comprehension and coherence are modelled based on Latent Semantic Analysis [16] and cohesion, adequacy and *use of language* are computed based on surface measures gathered from tagged text and statistical analysis. The present study describes the procedure followed searching for the best available approach to model *use of language* grading of learner summaries written in Basque language. The paper is organized as follows. Section 1 describes the premises in *use of language* and error detection. Section 2 analyses how automatic measures predict *use of language* by means of a multiple linear regression model. Section 3 presents a validation experiment which takes a corpus based approach to analyse how sensitive the model is discriminating *use of language* in different maturity summaries. Finally, Section 4 presents conclusions and future work.

1. Grading use of language

Grades in *use of language* have been computed based on error diagnosis and error relevance measurement. Cassany [17] states the relevance of the amount of orthographic, syntactic and lexical errors for *use of language* grading purposes. In addition, he proposes a grading scheme based on the amount of errors diagnosed in *use of language*. Cassany weights the presence of those errors considering the next 0 to 5 grading scheme: 0 errors 5 points, 1-3 errors 4 points, 4-6 errors 3 points, 7-10 errors 2 points, 11-15 errors 1 point, more than 16 errors 0 points. This grading scheme will be taken into account in automatic Basque error measures. Lexical error diagnosis has been measured using an orthography check tool for Basque [18] and an error diagnosis tagger available through text parsing [19]: X1 *Basque spell-checker*, X2 *Basque spell-checker + lexicon,* X3 *Basque spell-checker + lexicon + rubric*, X4 *Basque spell-checker+lexicon checker proportion*, X5 *Error tagger*, X6 *ErrorTagg+rubric*, X7, *ErrorTagg proportion*. In addition, *use of language* has also been graded using measures on structure and shallow punctuation error diagnosis: X8 average sentence per paragraph, X9 number of paragraphs, X10 number of sentences, X11 average words per sentence, X12 average comma per sentence, X13 metrics on how single comma measures deviate from the central word mean tendency per sentence, X14 excessive use of commas and X15 amount of commas.

2. Use of language grading model

2.1 Procedure

17 human experts were asked to grade *use of language* on a 1 to 10 scale on 17 summaries written in Basque. The summaries had previously been gathered from university students, second language learners (L2) and primary and secondary school pupils (17x17 grades). The goal was to obtain a wide range of different scenarios involving *use of language* in summarisation. Each grader evaluated every summary gaining an agreement of $r = 0.75$ and $p < 0.05$. The task for expert graders consisted on reading the text based on which the summaries were written, read each summary and produce global grades on *use of language*. Automatically computed *use of language* measures were compared to graders' mean scores.

2.2 Results

A multiple linear regression analysis was run to observe which of the previously described measures could best predict human *use of language* grading. The best predictive model was obtained with error tagging *(X5)* and excessive use of commas *(X14)* as predictors, significantly disambiguating more than half of the total grading variance ($R^2 = 0.51$, $F(2, 13) = 6.964$, $p = 0.008796$), a large effect size $f^2 = 0.71$ [21] and post hoc power $1-\beta=0.8013$.

Error tagging (ETG_i) showed a β_1=- 0.44 t=-3.33 and p = 0.0054 and excessive use of commas *(UC_i)* showed a β_2=-0.45 t=-1.92 and p = 0.077. Therefore, the *use of language* grades, $Grade_i$, is obtained based on the equation:

$$Grade_i = \beta_0 + \beta_1 ETG_i + \beta_2 UC_i + \varepsilon_i$$

2.3 Discussion

Among the available methods two of the variables were most salient predicting more than half of the total variances involved in grading *use of language*. However, the method shows still ambiguity which has not been resolved by $Grade_i$. Authors believe that including error diagnosis methods such as subject-verb agreement diagnosis, grammar check, a more in depth orthography check and anaphora resolution could help to obtain better prediction measures. It might also allow further corpus based grammar error detection possibilities (*e. g.* [20]). Nonetheless, in comparison to humans, $Grade_i$ has been capable to gain what is considered a large effect size in Behavioural Sciences [21].

3. Learner Summary Corpus

From the psychological point of view, a key issue in summary assessment is the difference between a poor and a good summary. Many researchers in this area make a clear distinction between immature and mature summarisers. But, how do we identify a mature or an immature summary? Garner [2] distinguishes between low-efficient and high-efficient summarisers. She argues that high-efficient summarisers recognise true information that does not appear in the source text in a higher proportion than low efficient summarisers. Therefore, immature summarisers' difficulties are mainly related to comprehension and remembering. Students have great difficulties differentiating super-ordinate from subordinate information [22]. Language proficiency is a relevant point that can make the difference between a mature and an immature summary. For instance, second language (L2) summarisers are faced with comprehension failure and lack of grammar and lexicon knowledge that summarisers do not have in their first language. Although the final result is similar to a monolingual immature summariser's the reasons behind have shown to be different [23-24]. Overall deficits were that relevant information was less well selected; a less efficient language processing and the poorer role of language on summarisation and recall. Based on these premises, authors expected that the $Grade_i$ measure should be able to significantly discriminate between first language (L1) summarisers and L2 learners. Then, L2 learners should obtain significantly lower *use of language* error grade than L1 learners. On the other hand, considering differences found in overall summarisation assessment between mature and immature summarisers, differences might also appear in *use of language* grading.

3.1 Procedure

A corpus was developed distinguishing summarisation expertise and language proficiency. The corpus (*Learner summary corpus*) was compound by a total of 37 summaries −14 L2 learner summaries (7029 words), 11 primary and secondary education learner summaries (934 words) and 12 university student summaries (4762 words). Finally, all the summaries were automatically processed to gain $Grade_i$.

3.2 Results

A one way analysis of variance was run with the aim to observe if $Grade_i$ measures were capable to discriminate summariser writing maturity levels. The $Grade_i$ method identified significant *use of language* differences between the three different summariser maturity groups; $F(2, 34) = 20.509$ and $p < 0.001$, post hoc power $1\text{-}\beta=0.99$. In order to observe the specific maturity level differences, a Tukey's Honestly Significant Difference (HSD) post hoc mean comparison analysis was applied. Significant differences in *use of language* grades were found between L2 and L1 summaries. L2 learners showed significantly ($p <$ 0.001) lower measures than primary and secondary, Hedge's $g = 2.44$, and university learners, Hedge's $g = 1.79$. No significant differences were found between L1 summaries; however, a medium effect size [21] Hedge's $g = 0.65$ was found.

3.3 Discussion

$Grade_i$ was capable to discriminate summary maturity differences in *use of language*. There was a clear differentiation between L1 and L2 learners, which is consistent with [23-24]. Nonetheless, differences between mature (university students) and immature summarisers (primary and secondary education) were not found to be significant in this data. Still, the obtained medium effect size shows that there are differences in lexical error and orthography between mature and immature summarisers.

4. Conclusions

From its early beginnings automatic evaluation of summaries written by students is an open issue in the area of Computer Supported Learning Systems. Nowadays, and due mainly to advances produced in the area of NLP techniques and cognitive modelling, it is possible to face this difficult task. LEA is an automatic summary evaluation grading environment developed with the aim of automatically grading students' summaries. Among other relevant variables LEA considers summary related discourse measuring variables such as adequacy, coherence, cohesion, and comprehension. The concrete goal of the study presented along this paper has been the treatment of *use of language,* with a twofold goal: to find the best currently available method for *use of language* grading of learner summaries written in Basque on one hand, and to test the efficiency of the method on the other. First, a *use of language* grading model has been obtained; regression modelling showed that *lexical error tagging* and *excessive use of commas* measures best predict human grading. The model disambiguated more than half of the total ambiguity resolved by human graders and gains a large effect size. In addition, an experiment has been carried out to test the accuracy of the method. In future work, authors expect to increase the proportion of disambiguation including further grammar error diagnosis as part of the model.

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References

[1] Bartlett, F. C. 1932. Remembering; a study in experimental and social psychology. Cambridge University Press.

[2] Garner, R. 1982. Efficient text summarization. Costs and benefits. *Journal of Educational Research*, 75(5):275–279.

[3] Kintsch, W., Patel, V., & Ericsson, K. 1999. The role of long-term working memory in text comprehension. *Psychologia*, 42, 186–198.

[4] Clancey, W. J. 1982. Tutoring rules for guiding a case method dialogue. In D. Sleeman & J. S. Brown (Eds.), *Intelligent tutoring systems*, 201–226.

[5] Ford, L. 1988. The appraisal of an icai system. In *Artificial intelligence and human learning*, London: Chapman and Hall, Ltd., 109–123.

[6] Woolf, B. P. 1988. Representing complex knowledge in an intelligent machine tutor. In J. Self (Ed.), *Artificial intelligence and human learning*, London: Chapman and Hall, Ltd., 3–28.

[7] Winkels, R., & Breuker, J. 1989. Discourse planning in intelligent help systems. In C. Frasson & G. Gauthier (Eds.), *Intelligent tutoring systems: At the crossroad of artificial intelligence and education*, Norwood, New Jersey: Abblex Publishing Corporation, 124–139.

[8] Díaz de Ilarraza, A. 1990. Gestión de diálogos en lenguaje natural para un sistema de enseñanza inteligente. *Unpublished doctoral dissertation*, University of the Basque Country. In Spanish.

[9] Khuwaja, R. A., Evens, M. W., A., M. J., & A., R. A. 1994. Architecture of CIRCSIM-tutor. In Proceedings of the 7th annual ieee computer-based medical systems symposium.

[10] Schulze, K. G., Shelby, R. N., Treacy, D., Wintersgill, M. C., VanLehn, K., & Gertner, A. 2000. Andes: A coached learning environment for classical newtonian physics. *The Journal of Electronic Publishing,* 1 (6).

[11] Graesser, A., Person, B., & Harter, D. 2001. Teaching tactics and dialog in autotutor. *International Journal of Artificial Intelligence in Education*, 12, 257–279.

[12] Zinn, C., Moore, J. D., & Core, M. G. 2002. A 3-tier planning architecture for managing tutorial dialogue. In S. A. Cerri, G. Gouardéres, & F. Paraguau (Eds.), Proceedings of the 6th international conference on Intelligent Tutoring Systems Biarritz, France and San Sebastian, Spain: Springer-Verlag, 574-584.

[13] Robertson, J., & Wiemer-Hastings, P. 2002, June. Feedback on children's stories via multiple interface agents. In S. A. Cerri, G. Gouardéres, & F. Paraguau (Eds.), Proceedings of the 6th international conference on Intelligent Tutoring Systems Biarritz, France and San Sebastian, Spain: Springer-Verlag, pp. 923–932.

[14] Zipitria, I., A. Arruarte, and J. A. Elorriaga. 2008a. LEA: Summarization web environment based on human instructors' behaviour. In *Proceedings of 8th International Conference of Advanced Learning Technologies*, pages 564–568.

[15] Zipitria, I., P. Larrañaga, R. Armañanzas, A. Arruarte, and J. A. Elorriaga. 2008b. What is behind a summary-evaluation decision? *Behavior Research Methods*, 40(2):597–612,May.

[16] Zipitria, I., A. Arruarte, and J. A. Elorriaga. 2006. Observing lemmatization effect in LSA coherence and comprehension grading of learner summaries. In Ashley, K. and M. Ikeda, editors, *Proceedings of Intelligent Tutoring Systems*, Lecture Notes in Computer Science, Jhonghli, Taiwan. Springer,

[17] Cassany, Daniel. 1993. *Did´actica de la correcci´on de lo escrito*, volume 108 of *Serie lengua*. Editorial Gra´o, de IRIF SL, Spain. In Spanish.

[18] Aduriz, I., I. Alegria, X. Artola, N. Ezeiza, K. Sarasola, and M. Urkia. 1997. A spelling corrector for Basque based on morphology. *Literary and Linguistic Computing*, 12(1):31–38.

[19] Aduriz, I., M. Aranzabe, J. Arriola, A. Diaz de Ilarraza, K. Gojenola, M. Oronoz, and L. Uria. 2004. A cascaded syntactic analyser for basque. In *Proceedings of Computational Linguistics and Intelligent Text Processing*, pages 124–135.

[20] Leacock, C. and M. Chodrow. 2003. Automated grammatical error detection. In Shermis, Mark D. and Jill C. Burstein, editors, *Automated essay scoring: a cross-disciplinary perspective*, pages 186–197. Lawrence Erlbaum Associates.

[21] Cohen, J. 1988. *Statistical Power Analysis for the Behavioral Sciences*. Lawrence Erlbaum Associates.

[22] Taylor, B. M. 1982. Text structured and children's comprehension and memory for expository material. *Journal of Educational Psychology*, 74:323–340.

[23] Long, J. and E. Harding-Esch, 1978. Language Interpretation and Communication, pages 273–287. Plenum Press.

[24] Kozminsky, E. and N. Graetz. 1986. First vs second language comprehension: some evidence from text summarizing. *Journal of Research in Reading*, 9(1):3–21.

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Building an Ontology-Based System Which Supports the Instructional Design Process

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Abstract: In this study, we have developed a system called FIMA (Flexible Instructional Design Support Multi-Agent System) which supports teachers dynamically in designing instruction by facilitating their thinking in ways characteristic of expert teachers' thought processes: 1) multiple viewpoints thinking, 2) contextualized thinking and 3) the problem framing and reframing strategy. We especially focus on instructional design that integrates the use of information and communication technology (ICT). In this paper, we show examples of concrete supports which the FIMA prototype system we have built provides.

Keywords: Ontology, Instructional Design, Multi-Agent, ICT Use in Instruction

Introduction

The educational gaps caused by differences in teachers' professional abilities are a perennial problem, especially for complex tasks like instructional design. Among several approaches to this problem, providing teachers with an efficient and usable support system is promising, since most teachers want to participate in the process of designing high quality instruction. In order to investigate strategies to support less-skilled teachers in designing instruction, it is best to analyze skilled teacher's thinking processes in approaching this task. Sato et al. investigated differences in thinking processes between expert and novice teachers when they analyzed existing instructional plans [1]. This investigation came to the conclusion that the thinking of expert teachers is characterized by the following three features: 1) multiple viewpoints thinking, 2) contextualized thinking, and 3) the problem framing and reframing strategy. Because it is also important for teachers to analyze instruction objectively when they themselves design instruction, this study aims to support teachers in designing high quality instruction by directly facilitating these three types of thinking.

By "multiple viewpoints thinking", Sato means that expert teachers conceptualize instructional propositions and learning propositions in a mutually dependent way. To facilitate teachers' multiple viewpoints thinking, it is important to make them conscious of the relations between various concepts concerning both instruction and learning when they design instruction as well as effective to provide support information together with related concepts according to the teacher's needs. By "contextualized thinking", he means that expert teachers think of a lesson part not independently but in the context of other lesson parts which occur before and after it during an instruction. To facilitate such contextualized thinking, it is important to make the teacher conscious of the flow of instructional and learning activities for the achievement of educational goals; indeed, many teachers want such support to help them confirm whether or not the flow of instructional and learning activities they have designed will achieve a given educational goal. By the "problem framing and reframing strategy", he means that expert teachers are so flexible that they can easily adapt to a situation without persisting in the pre-set plan and their thoughts. By contrast, the instructional design process conducted by most teachers, including some expert teachers, is a waterfall type process like the instructional design process model described by Gagne [4] which is still typical among the models presented to date. So, it is important to facilitate teachers' "problem framing and reframing strategy" when they design instruction. To facilitate this thinking, it would be effective to control teacher's instructional design process flexibly; for example, to stimulate teacher to reconsider educational goals according to the progress of the instructional design process.

Supporting teachers by facilitating the above three thinking skills simultaneously in the design process rather than independently must be done dynamically, because modification of part of an instruction requires reconsideration of the whole instruction by "multiple viewpoints thinking" and "contextualized thinking". In order to realize such support, we have proposed a Flexible Instructional design support Multi-Agent system, called FIMA. The characteristic goals of FIMA are as follows:

- Not to design instruction automatically, but to support teachers dynamically in designing instruction by themselves
- Not to enhance teachers' skill, but to facilitate teachers' multiple viewpoints and contextualized thinking
- To facilitate a flexible instructional design process
- To provide teachers with support information adaptively to their situation [2][3]
- To evaluate the flow of instructional and learning activities based on instructional/ learning theories described in the OMNIBUS ontology [6] and to support teachers according to the results [5]

The remainder of this paper is structured as follows: in section 1, we describe the structure and support functions of FIMA, which we have designed based on the support principles of this study. In section 2, we show an example of concrete supports by a prototype FIMA system. Finally, in section 3, we present a summary and plans for future work.

1. Structure and Support Functions of FIMA

We defined and created five agents for FIMA. Each agent has a function that can support teachers from each viewpoint that teachers should consider in the instructional design process. All agents can be the first functional module fired by the first action taken by a teacher as the user. First, an agent that supports teachers from the viewpoint of the ability and states of students is the SM (Student Model) Agent. Second, an agent which supports teachers from a viewpoint of their own ability is the TM (Teacher Model) Agent. Third, an agent that supports teachers from the viewpoint of the relationships between the learning activity and instructional activity is the I_L (Instruction and Learning) Agent. Next, in this study, because we regard support for the computerization of school education as important, support from the viewpoint of suitable use of ICT as a tool by teachers and students is important. So, we introduce an ICT (Information and Communication technology) Agent, which supports teachers from the viewpoint of the relationship between the use of ICT as a tool and the learning/instructional activities. The functions of these four Agents are designed to support teachers after instructional design as well. We prepare an ID (Instructional Design) Agent which provides support teachers in designing instruction dynamically. The ID Agent facilitates teachers' multiple viewpoints and contextualized thinking dynamically during the process of instructional design. The ID Agent also controls the instructional design process flexibly to facilitate their problem framing and reframing strategies. Thanks to the agent-structure, in which different agents perform different functions that teachers should employ in the instructional design process, as well as the interaction between the agent functions, FIMA can support teachers dynamically in designing instruction by themselves.

FIMA has the following three kinds of support functions to support teachers dynamically in the instructional design process.

- To facilitate necessary thinking
- To offer suggestions
- To diagnose designed lesson plans

First, FIMA facilitates the three types of thinking by providing teachers with messages indicating what they should consider in designing instruction. For realization of this support function, the ID Agent serves as the first functional module and interacts with other agents if necessary.

Second, FIMA provides suggestions whenever a teacher asks for this type of support during the instructional design process. When teachers ask FIMA for suggestion, they specify the viewpoint and premise of the needed suggestion. Viewpoints which teachers can select are "learning/instructional activities", "students' ability", "instructor's ability" and "ICT use in instruction". Premises which teachers can specify are the "educational goal", "ICT" and "learning/instructional scene" which have been already described in the lesson plan. For example, a teacher can ask FIMA for a suggestion from the viewpoint of learning/instructional activities to attain a particular educational goal, by specifying the educational goal as the premise and selecting the viewpoint of learning/instructional activities.

Finally, diagnostic support is provided when teachers ask for diagnosis of the whole/parts of lesson plans which they have designed. When teachers ask FIMA for diagnosis, they select the viewpoint of diagnosis and can specify a particular focal point if necessary. Here, the viewpoints and the diagnostic points which teachers can select and specify are the same as in the suggestion function. For example, a teacher can ask FIMA for diagnosis from the viewpoint of the flow of the instruction which he/she has designed to attain an educational goal, by selecting the viewpoint of learning/instructional activities and specifying the educational goal as the diagnosis point. For realization of the suggestion and the diagnosis supports, the agent which has the specific role selected by the teacher becomes the first functional module and interacts with other agents if necessary.

For realization of these support functions, FIMA has various conceptual structures which are defined as ontologies and knowledge which is described based on the concepts. To put it concretely, the SM Agent has an ontology which defines the conceptual structures of the educational goals and contents, and the TM Agent has an ontology which defines the conceptual structure of the teacher's competency. And, the I_L Agent and the ICT Agent has knowledge about suitable relationships between the concepts which are defined in the ontologies and learning/instructional activities and use of ICT. To describe the relationships, we have prepared concepts which represent the essence of learning and instructional activities and concepts which represent the expression way of digital materials and reasons for making use of ICT. FIMA asks teachers to select these concepts in the instructional design process. The concepts which teachers can select as the essence of instructional and learning activities have been extracted based on the OMNIBUS ontology. We have prepared the concepts of activities with which teachers are familiar and that have concrete relationships with the concepts defined in the OMNIBUS ontology. Thanks to this description of the relationships, FIMA can align with the OMNIBUS ontology.

So, FIMA can realize three kinds of supports invoking various ontologies which contain the OMNIBUS ontology and knowledge described in relation to those ontologies.

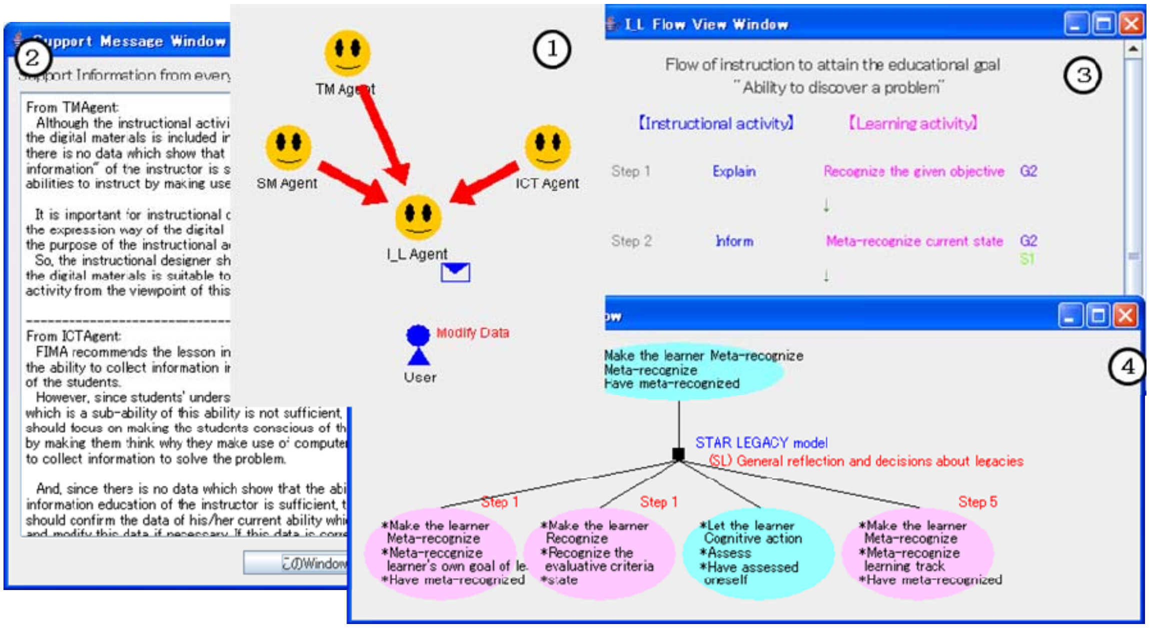

Figure 1. The Example of the Screen Shots for the Diagnostic Support

2. An Example of Using the Support to Diagnose by FIMA

In this section, we show an example of FIMA's diagnostic supports that were provided when the first author of this paper designed an instruction using FIMA. And, we explain interaction between the agents to realize the supports. In this case, we assumed that students were novices at making use of ICT and the teacher was novice at IT education, because one purpose of this study is to support teachers who are not specialists of IT education for the computerization of school education. And we set data of students' learning history and teacher's current ability based on this assumption.

Figure 1 shows an example of screen shots which were presented when the teacher asked FIMA to diagnose from the viewpoint of the flow of the instruction which he had designed to attain the educational goal which is to enhance the "ability to discover a problem". In this example, the I_L Agent serves as the first functional module and provided the teacher with various results of diagnosis and support information by interacting with the ICT Agent, the SM Agent and the TM Agent, shown at ① in Figure 1. The messages from these four agents were shown in the window at ② in Figure 1. For example, the message actually provided by the TM Agent is that "*Although the instructional activity which the instructor makes use of the digital materials is included in the flow of the instruction, there is no data which show that understanding of "knowledge to express information" of the instructor is sufficient which is one of the necessary abilities to instruct by making use of the digital materials suitably. It is important for instructional designers to judge whether the expression way of the digital materials is more suitable to achieve the purpose of the instructional activity. So, the instructional designer should confirm whether or not this use of the digital materials is suitable to achieve the purpose of the instructional activity from the viewpoint of this knowledge*". And, to facilitate "contextualized thinking" of the instructional designer, the I_L Agent presented the flow of the learning and instructional activities designed to achieve the educational goal, shown at ③ in Figure 1. Furthermore, to support to confirm suitability of "contextualized thinking", the I_L Agent translated every instructional and learning activity into concepts defined in the OMNIBUS ontology, and extracted and presented the instructional/learning theories related to this flow of the learning and instructional activities, shown at ④ in Figure 1. Although we cannot describe in detail how to extract the relevant theories due to space limitation, the I_L Agent extracts a set of theories reasoned that it is most related to the flow based on the relationships between learning and instructional activities in each step and the flow which is composed of the steps. Based on the explanation of these theories, the instructional designers themselves can confirm suitability of the instruction and try to improve it by their "contextualized thinking".

3. Summary

Through the consideration of the thinking of expert teachers, this study aims to support teachers in designing high quality instruction through facilitating the three types of thinking: 1) multiple viewpoints thinking, 2) contextualized thinking, and 3) the problem framing and reframing strategy. For the support, we proposed FIMA which is based on multi-agent architecture in consideration of these support's principles. In this paper, we showed the examples of concrete supports by the prototype FIMA system and the agent-structure to realize these supports.

The prototype system of FIMA has been implemented. The first author could design an instructional plan by getting various supports which included the support examples described in section 2 which were provided by this prototype of FIMA. We could confirm that these supports were suitable to achieve the purpose of this study. However, because various ontologies and knowledge description which are basis of FIMA are not yet sufficient in the current implementation, its functionality is limited. To put it concretely, the concepts of goals and contents of education cover only the field of subjects "science" and "technology" in elementary and secondary education, and the concepts of teacher's ability cover only the ability to instruct IT education and to instruct using ICT. And, because there are some forty knowledge descriptions as yet about suitable relationships between the concepts which the I_L Agent and the ICT Agent have, the supports realized based on these knowledge descriptions are limited. In future work, we intend to extend these description ranges and to deploy FIMA into the practice of designing instruction by teachers.

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References

[1] Sato M., Iwakawa N., & Akita K. (1991). Pratical Thinking Styles of Teachers: Comparing Experts' Monitoring Processes with Novices, *Bulletin of the Faculty of Education, University of Tokyo, 30*, 177-198.

[2] Kasai T., Yamaguchi H., Nagano K., & Mizoguchi R. (2006). Building an ontology of IT education goals, *International Journal of Counting Engineering Education and Lifelong Learning*, *16*(1/2), 1-17.

[3] Kasai T., Yamaguchi H., Nagano K., & Mizoguchi R. (2007). A Semantic Web System for Supporting Teachers Using Ontology Alignment, *International Journal of Metadata, Semantics and Ontologies*, *2*(1), 35-44.

[4] Gagne, R.M. & Briggs, L.J. (1974). Principles of Instructional Design, *Holt, Rinehart and Winston*, New York.

[5] Kasai T., Nagano K., and Mizoguchi R. (2009). An Ontological Approach to Support Teachers in Designing Instruction Using ICT, *Proceedings of ICCE2009*, pp.11-18.

[6] Mizoguchi, R., Hayashi, Y., & Bourdeau, J. (2007). Inside Theory-Aware and Standards-Compliant Authoring System, *Proceedings of the Fifth International Workshop on SWEL2007*, 1-18.

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The Relationships Between Sequences of Affective States and Learner Achievement

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Abstract. We study the relationships between affective states and sequences and learner achievement using sequential pattern mining techniques. We found, in accordance with prior research, that boredom is an undesirable state that is both persistent and detrimental to learning. We also found that confusion punctuated with periods of engaged concentration contributes to learning. However, confusion alone has a negative impact on student achievement, possibly indicating that students are stuck. These results shed light on past results finding inconsistent relationships between confusion and learning.

Keywords: boredom, confusion, engaged concentration, student affect, affect sequences, student achievement, Scatterplot tutor

Introduction

Past studies that examine relationships between affective states and achievement typically consider these states in isolation [cf. 4, 8]. However, learners experience affective states seamlessly and successively, implying that studies of affect in learning can be enriched by including time in the analysis. Affective dynamics are the study of natural shifts in learners' affective states over time [7]. Studies regarding affective dynamics determine which affective states tend to persist and which transitions, given a start state, are most likely or unlikely to occur. The combination of these analyses has led to the discovery of "virtuous cycles" where learning-positive behaviours (such as engaged concentration [3]) persist and "vicious cycles", where learners remain in learning-negative behaviours such as frustration [9] and boredom [3]. As of the time of this writing, though, published studies have not yet shown relationships between affective dynamics and student achievement. Our goal is to determine which combinations of states are associated with poorer and better learning.

1. Methods

We studied 127 students from a large public school in Quezon City (a part of Metro Manila – the 5th largest city in the world), the Philippines. Student ages ranged from approximately 12 to 14. Students used a short Cognitive Tutor unit on scatterplot generation and interpretation [2], for 80 minutes. Sixty nine of the participants (experimental group) were randomly assigned to use the tutor with an embodied conversational agent, "Scooter the Tutor" designed by Baker, et al. [2]. The remaining 58 participants (control group) used the Scatterplot Tutor without the conversational agent.

The number of students assigned to the conditions was unbalanced because of data gathering schedule disruptions caused by inclement weather.

A quantitative field observation method similar to the method used in [3, 11] was used to collect the affective states of the students by a team lead by the first author. Each participant was observed 24 times, with an interval of 180 seconds between observations lasting 20 seconds. Two coders observed the participants such that the participant would not know that he/she is the one being observed, in order to reduce the degree to which affect is altered by the observation process. The coding scheme included seven categories: boredom, confusion, delight, engaged concentration (a subset of flow [5]), frustration, surprise and neutral (for more details on these affective states, see [3, 11]). The observers' inter-rater reliability was found to be acceptable at κ=0.54.

We then generated three sets of affect sequences. The first set consisted of single affective states. The second set consisted of sequences of two consecutive affective states (2-step affective sequences). The third and final set consisted of sequences of three consecutive affective states (3-step affective sequences). We counted the number of occurrences of each state or sequence within each set, across all students regardless of condition. We selected the 4 most frequently occurring single affective states from and the 10 most frequently occurring sequences from the 2-step and 3-step affective sequences, as highly rare affective states would be difficult to achieve statistical power for. The remaining sequences in each group were summed under a catchall "Other" category. We then split the generated the incidences of each state or sequence for both the control and experimental groups.

2. Results

In order to determine whether the relationship between a sequence's frequency and learning was significantly different between conditions, we set up a linear regression predicting post-test from pre-test and the interaction between the frequency of the sequence in each student and the condition, and examined the statistical significance and additional r^2 of the interaction term. Positive beta in this context means that the experimental condition has a more positive relationship between the frequency of the sequence and learning than the control condition; negative beta means the opposite.

Among the single affective states of Set 1 (Table 1), we found that confusion and delight have negative impacts on the achievement of students in the control condition. Engaged concentration, on the other hand, has a positive impact on learning for students of both the control and experimental groups (Table 4). However, the only single affective state that was significantly different (or marginally so) was boredom, which was marginally significant, two-tailed p=0.09, additional r^2 = 0.022, with negative beta (e.g. the relationship is more negative in the experimental condition). This may imply that some boredom was disrupted by the agent, but that the remaining boredom was the most intransigent, durable boredom, and that this "super-boredom" is more strongly associated with poorer learning; there is some evidence for particularly persistent boredom impacting learning differently than less stable boredom [3], potentially according with this hypothesis.

Table 1. Set 1 relationships between affective states and achievement.

States	**Control Group**			**Experimental Group**		
	Additional r^2	p	Beta	Additional r^2	p	Beta
CON	0.06	0.043	-0.265	0.012	0.384	-0.108
ENG	0.143	0.001	0.413	0.06	0.043	0.245
BOR	0.014	0.329	-0.121	0.032	0.147	-0.177
DEL	0.053	0.058	-0.238	0.011	0.403	-0.104

Among the 2-step affective sequences (Table 2), engaged concentration (ENG-ENG) among students in the control condition or confusion coupled with engaged concentration (CON-ENG or ENG-CON) among students in the experimental condition have a positive impact on learning. Confusion alone (CON-CON) has a negative effect on learning among students in the control group. Among students in the experimental group, boredom followed by engaged concentration (BOR-ENG) was found to harm learning. Two affective sequences were found to be significantly different between conditions: BOR-ENG and NULL-ENG. BOR-ENG were associated with significantly better learning in the control condition, two-tailed $p<0.01$, additional $r^2 = 0.06$, with negative beta. One possible hypothesis is that the agent induced BOR-ENG transitions that nonetheless did not emerge from the same processes as "natural" (non-induced) BOR-ENG transitions, and therefore did not impact learning in the same way. NULL-ENG (e.g. ENG in the first observation) was also associated with significantly better learning in the control condition, two-tailed $p=0.02$, additional $r^2 = 0.039$, with negative beta.

Table 2. Set 2 relationships between affect sequences and achievement.

Sequences	**Control Group**			**Experimental Group**		
	Additional r^2	p	Beta	Additional r^2	p	Beta
CON-CON	0.065	0.035	-0.270	0.016	0.305	-.0127
ENG-ENG	0.152	0.001	0.428	0.024	0.207	0.154
CON-ENG	0.015	0.316	0.124	0.065	0.035	0.256
ENG-CON	0.013	0.350	0.115	0.084	0.016	0.290
BOR-BOR	0.013	0.344	-0.118	0.024	0.213	-0.152
NULL-CON	0.003	0.664	-0.058	0.004	0.611	-0.063
NULL-ENG	0.027	0.174	-0.182	0.051	0.063	-0.229
CON-BOR	0.007	0.483	-0.087	0.003	0.684	-0.050
BOR-CON	0.00	0.844	-0.024	0.105	0.007	-0.324
BOR-ENG	0.004	0.592	0.066	0.105	0.007	-0.324

Set 3 findings (Table 3) were similar overall, but some interesting findings about the relationships between engaged concentration, confusion, and learning emerged. Confusion alone (CON-CON-CON) was detrimental to the learning of the control group. Engaged concentration (ENG-ENG-ENG) was positive. Among both groups, some combinations of confusion and engaged concentration—CON-ENG-ENG and ENG-CON-ENG in both groups, ENG-ENG-CON in the control group, and CON-ENG-CON in the experimental group—had positive effects on learning. In particular, the relationship between CON-ENG-CON and learning remained statistically significant in the experimental condition even when the frequency of engaged concentration itself was controlled for, $p=0.05$. This result suggests that confusion interspersed with occasional engaged concentration may be particularly felicitous for learning.

Table 3. Set 3 relationships between affect sequences and learning.

Sequences	**Control Group**			**Experimental Group**		
	Additional R^2	P	Beta	Additional R^2	p	Beta
CON-CON-CON	0.065	0.036	-0.265	0.018	0.277	-0.135
ENG-ENG-ENG	0.128	0.001	0.430	0.012	0.378	0.108
CON-CON-ENG	0.002	0.694	-0.050	0.024	0.212	0.153
ENG-CON-CON	0.001	0.799	-0.032	0.024	0.210	0.153
CON-ENG-ENG	0.078	0.020	0.280	0.066	0.034	0.256
ENG-ENG-CON	0.070	0.028	0.266	0.004	0.634	0.060
CON-ENG-CON	0.007	0.486	-0.087	0.112	0.005	0.334
ENG-CON-ENG	0.049	0.069	0.223	0.046	0.079	0.214
BOR-BOR-BOR	0.016	0.302	-0.128	0.015	0.320	-0.122
NULL-CON-CON	0.012	0.370	-0.117	0.00	0.957	-0.007

3. Discussion and Conclusion

Many of the findings of this study are consistent with findings from previous work. Boredom, for example, is a decidedly undesirable state. It tends to persist: A student who is bored will tend to remain bored [3]. It tends to co-occur and precede gaming the system [11], which is known to have a negative impact on student achievement [1]. This study's findings were not inconsistent with the prior finding that boredom has a detrimental effect on learning, but in this study this relationship was not significant.

Confusion, on the other hand, may affect learning positively or negatively. It occurs when a student encounters an anomaly or an impasse, at which time one of two things can occur: The student can think, deliberate, reflect and eventually resolve the problem, alleviating the confusion and returning to an engaged state (productive confusion) or the student can become stuck (hopeless confusion) [6]. Craig et al [4] found that productive confusion predicts achievement among students using AutoTutor. In our study, we found that confusion punctuated with periods of engaged concentration can contribute to learning. We equate this with D'Mello and Graesser's productive confusion. Persistent confusion, on the other hand, which may indicate "hopeless" or at least "unresolved" confusion, undercuts student achievement.

In previous work on the same dataset, we examined the likelihood that one affective state would succeed another [10]. We found that, of the 2-step affective sequences that have an effect on learning, CON-CON and ENG-ENG are likely to occur [11]. ENG-CON and CON-ENG are not likely to occur. These findings coupled with the results of this study imply that, although confusion is not inherently harmful for learning, the CON-CON transition is not desirable and should be disrupted. The ENG-ENG, ENG-CON, and CON-ENG transitions can help learning and should be fostered to the extent possible.

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References

[1] Baker, R.S., Corbett, A.T., Koedinger, K.R., and Wagner, A.Z. (2004) Off-Task Behavior in the Cognitive Tutor Classroom: When Students "Game the System". Proceedings of ACM CHI 2004: Computer-Human Interaction, 383-390.

[2] Baker, R. S. d. J., Corbett, A. T., Koedinger, K. R., Evenson, S. E., Roll, I., Wagner, A.Z., Naim, M., Raspat, J., Baker, D. J., & Beck, J. (2006). Adapting to when students game an intelligent tutoring system, In *Proceedings of the 8th International Conference on Intelligent Tutoring Systems*, 392-401.

[3] Baker, R. S. d. J., D'Mello, S., Rodrigo, M. M. T. & Graesser. (2010). Better to be Frustrated than Bored: The Incidence, Persistence, and Impact of Learners' Cognitive-Affective States During Interactions with Three Different Computer-Based Learning Environments. International Journal of Human-Computer Studies, 68(4), 223-241.

[4] Craig, S. D., Graesser, A. C., Sullins, J., & Gholson, B. (2004). Affect and learning: an Exploratory look into the role of affect in learning with AutoTutor. Journal of Educational Media, 29(3), 241-250.

[5] Czikszentmihalyi, M. (1990). *Flow: The Psychology of the Optimal Experience*. New York: Harper Row.

[6] D'Mello, S. & Graesser, A. (under review). Dynamics of Cognitive-Affective States During Deep Learning.

[7] D'Mello, S. K., Taylor, R., & Graesser, A. C. (2007). Monitoring affective trajectories during complex learning, In D. S. McNamara & J. G. Trafton (Eds.), Proceedings of the 29th Annual Cognitive Science Society (pp. 203-208). Austin, TX: Cognitive Science Society.

[8] Lagud, M. C. V. & Rodrigo, M. M. T. (2010). The affective and learning profilesof students while using an intelligent tutoring system for algebra. 2010 Intelligent Tutoring Systems Conference.

[9] McQuiggan, S. W., Robinson, J. L., & Lester, J. C. (2010). Affective transitions in narrative-centered learning environments. *Educational Technology & Society, 13*(1), 40-53

[10] Rodrigo, M. M. T., Agapito, J., Nabos, J., Repalam, M. C., Reyes, S. Jr., & Baker, R. S. J. d. (in preparation). The effects of an embodied conversational agent on student affective dynamics while using an intelligent tutoring system.

[11] Rodrigo, M. M. T., Baker, R. S. J. d., Lagud, M. C. V., Lim, S. A. L., Macapanpan, A. F., Pascua, S. A. M. S., Santillano, J. Q., Sevilla, L. R. S., Sugay, J. O., Tep, S., & Viehland, N. J. B. (2007). Affect and usage choices in simulation problem-solving environments. In R. Luckin, K. R. Koedinger, J. Greer (Eds.), *Artificial Intelligence in Education: Building Technology Rich Learning Contexts that Work*, 145-152. Amsterdam, The Netherlands: IOS Press.

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Towards Generic Visualisation Tools and Techniques for Adaptive E-Learning

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Abstract: In this paper, we describe the work on the visualisation tools and techniques currently developed in the GRAPPLE research project. Since the GRAPPLE project aims at developing a generic solution for adaptive e-learning, also the visualisation tools need to be as generic as the GRAPPLE approach and its data models are. This paper also discusses related work in this field and outlines differences and advantages of the newly developed visualisation tools and techniques. Especially comparisons are made with a tool which relies on visualizing competence-based knowledge structures.

Keywords: adaptive e-learning, open learner model approach, visualisation technique, meta-cognitive support

Introduction

Visualisation has often been used in e-learning to stimulate meta-cognition by providing feedback to the learners about their learning process. In order to provide visual information to learners, learner models are needed which can be used as basis for this information. This approach is well known as Open Learner Model (OLM) approach and has been often described in literature (for example in [4] and [8]). In adaptive e-learning systems user and adaptation models are used to achieve adaptation of learning resources to the learners' characteristics. Traditionally, these models are not revealed to the learners, but used for adaptation algorithms only. Especially adaptive systems make use of user models which often are available at a detailed level. Therefore, opening up these models can provide rich information which can support the learner in his or her self-reflection activities.

Obviously, presenting user model data to the learner highly depends on the available information of a learning system and how this information is organised and structured. Based on that data visualisation techniques are be employed to make accessible the user models for the learner. Making understandable the presented data is a key factor for achieving reflective and meta-cognitive activities of learners.

This paper presents a new visualisation approach which aims at being more generic than existing visualisation strategies in adaptive e-learning systems. This approach is currently developed in the context of the GRAPPLE (Generic Responsive Adaptive Personalized Learning Environment) research project [6] which aims at delivering generic adaptation functionality for various Learning Management Systems. To this end, flexible learner models are used for adaptation functionality. Therefore, also the visualisation technique has to cover the same flexibility, which brings new possibilities to the learner regarding the visually accessible information.

1. Visualisation in Adaptive E-Learning

In order to outline some of the key features of visualisation approaches in adaptive e-learning systems, an example from previous work in this field is introduced in this section. The visualisation tools for making visible and accessible learner models based on Competence-based Knowledge Space Theory (CbKST Tools) [3][9] has been developed in the research project iClass [7]. Instead of providing a general overview of visualisation in adaptive e-learning and OLM, the newly developed approach is compared with the CbKST Tools, which reveals the advantages, but also limitations of the GRAPPLE visualisation approach.

The CbKST Tools are based on a domain and user model which both follow the mathematical-psychological approach of Competence-based Knowledge Space Theory [2]. The central element is the set of skills and prerequisite structure on skills which arise due to psychological dependences (see Figure 1). In order to model a domain, the skills necessary to cover this domain are modelled and the structure of these skills is identified. Learning resources are associated with skills, whereas learning objects can convey skills and assessment items can test skills.

The user model relies on the domain model and can express different user characteristics. Goals can be defined as a set of skills which should be attained. The skill or knowledge state of a learner can also be defined as a set of skills which the learner already has available. This is outlined in Figure 1 with red circles in the skill structure. The learning history can be shown either as sequence of learning resources or as sequence of the skills associated with the performed learning resources.

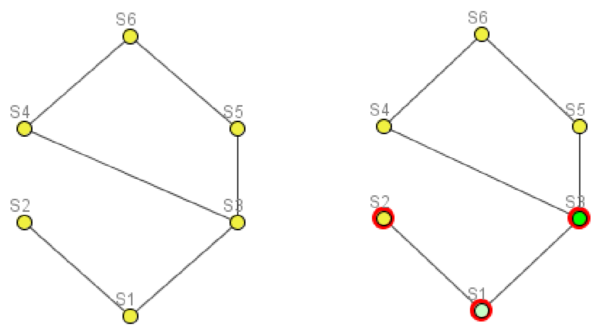

Figure 1: Prerequisite structure on skills (a) and possible competence state of a learner (b).

The logical structure of the prerequisite relations of the skills can be depicted as acyclic directed graph with the special property that transitive relations are not drawn. In the example in Figure 1 the skills below other skills connected with a line are prerequisite for those skills. For example, skills S1 is prerequisite for skills S3, but also for skills S4, S5, and S6. This structure can be visually displayed to the learner as it is shown in Figure 1. In this way the conceptual part (skills, but not associated learning resources) are visualised and opened up to the learner.

The user model consisting of goals, skill state, and learning history is directly depicted on the skill structure. Since all of these elements are related to skills, the respective skills can be marked and highlighted (Figure 1b). In this way the learner is always presented with the same structure (for a specific domain), but the user model values are changing on this visual structure.

In addition to use these visualisations as display for domain and user model values, the same visualisation can be used to guide the learner though the learning process. Since it is meaningful to sequence the skills to be attained according to the prerequisite structure, a learning path reveals as learners should start with easier skills at the bottom of the structure and continuing with higher levelled skills. Learners see their skills state easily, so they can choose skills one level higher as their available skills. The visualisations have been made interactive, so that by clicking on a skill, the associated learning resources are offered to the learner. Hence, the learner gets interactive navigational support by using this visualisation.

Using that visualisation technique learners are supported to perform meta-cognitive aspects on their own learning process. They can set goals by picking skills, they can make plans by choosing learning resources associated with the goal, and they get feedback and orientation about their current learning state and progress.

Other approaches also take into account group work and collaboration and reflect them in visualisations. For example the technique presented in [8] aims at mirroring the activity of small teams engaged in a task. Each individual is contributing to the group and the ways that team members interact with each other are displayed in a so-called Wattle Tree visualisation.

2. Domain and Learner Model in GRAPPLE

The models in GRAPPLE follow a different approach than described in Section 1, except that there are also domain and user models (see Figure 2). The domain model [5] basically consists of a concept map of the learning domain. The relations between concepts can express semantic relations between concepts (as usually done in concept maps), but also hierarchical relations between concepts can be expressed. In addition to the domain model, the Conceptual Adaptation Model (CAM) is the basic model where adaptive lessons are defined by using concepts of the concept map and connecting them with pedagogical relations. Pedagogical relations can freely be defined and used in adaptive lessons to indicate the sequence of concepts for the adaptive engine.

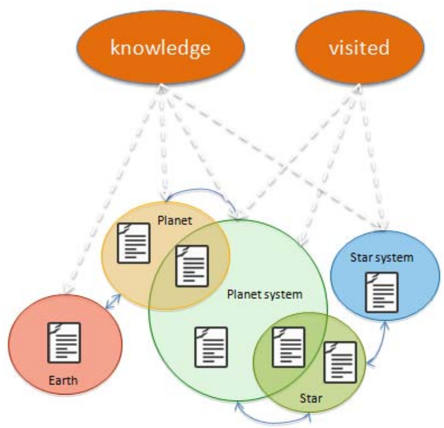

Figure 2: GRAPPLE domain model (concepts with related learning resources) with user model variables defined on these concepts.

The user model [1] is totally flexible, since every kind of user model variable can be defined upon a domain model. A user model variable is a variable of any data type and is associated with all concepts of an adaptive lesson. For example the variable *knowledge* can be defined as integer with a range from 0 to 100, so that the user model can express the knowledge level for all concepts. Another example is the variable *visited* defined as boolean, which is used to express all concepts a user has visited with associated learning resources.

The user model of the CbKST tool has a simpler structure, since the skills can be seen as the knowledge dimension of concepts. Hence, in the notation of GRAPPLE there is only one predefined user model variable knowledge, which cannot be altered. Also the relation between concepts of the CbKST Tool can be seen as a special case of the GRAPPLE approach, since in GRAPPLE every kind of relationship can be defined. However, defining such relations in GRAPPLE is rather a pedagogical design than psychologically proven dependences between skills.

3. Visualisation Tools and Techniques

Following the flexible user and domain model approach described in Section 2, also the visualisation techniques have to be flexible in order to capture the information provided in these models. According to the domain and especially user model, there are several dimensions which can be displayed to the learner:

- a distinction between a single and a multiple learner view
- different user model variables defined on concepts
- performed activities in terms of learning resources
- goals in terms of concepts and user model variable values on concepts

In order to achieve flexibility also for the visualisation technique, standard visualisation techniques have been developed which can capture all or most of the information dimensions described above. For example, Figure 3 shows two of the developed visualisation techniques. Figure 3a depicts the knowledge user model variable for the concepts of a lesson for one learner (purple bars). Furthermore the average values of the other learners are shown (red bars) and the expected level (goal) is also shown for each concept (top black line). Figure 3b outlines which learner has performed which activity (purple circle on crossings in matrix). Furthermore, the average values for learners and activities are expressed with the small bar diagrams. Both representations can be employed for other representations, whereas the information to be represented can freely be chosen.

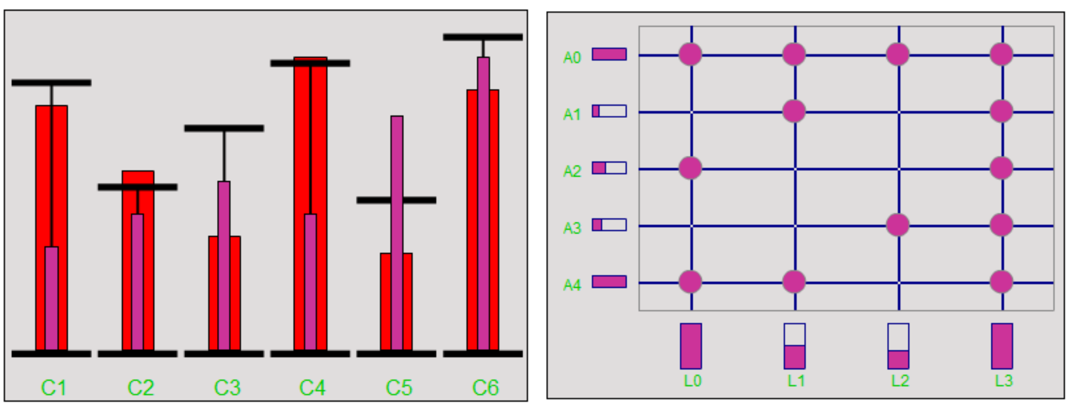

Figure 3: Two different visualisations: (a) knowledge level of the concepts of a lesson for a single learner, and (b) activities performed for a class.

A set of visualisation widgets has been implemented where each widget uses a specific visualisation technique or user model representation respectively. Some of them are simpler in terms of the presented information and others are rather complex connected information is displayed in one widget. Furthermore, some of the widgets are intended to be used by learners and others are rather suitable for teachers or tutors.

A data format has been defined (in JSON format) which can contain all the information and each visualisation tool gets the same data for a lesson. Depending on the visualisation technique and the chosen information dimensions to be visualised, the tool selects the respective parts and renders them. These tools have been implemented as Flash objects (using Macromedia Flex), which get the data over HTTP from a Web application having access to the user and domain model data. The visualisation tools can be included in Web pages of Learning Management Systems connected to GRAPPLE. According to the configuration settings different information dimension can be displayed.

4. Conclusion and Outlook

In this paper visualisation techniques and according tools have been presented which are capable of rendering flexible user model data. These tools visually open up the data used for adaptation of learning resources, which should help learners to get an overview on their current learning progress. Furthermore, they can compare themselves with other learners, which should have positive effect on their motivation. A limitation can be identified, that no meaningful guidance can be provided with these tools as it easily could be done with the CbKST Tools.

An initial evaluation has been conducted with 43 students and 32 university lectures. The overall result of the student and teacher visualisations indicated a medium to good quality in all aspects (suitability for the task, self-descriptiveness, usability, meta-cognition, cognitive load, benefits for instructors, and acceptance). This result suggests that these visualisations are suitable for their intended purpose and also largely self-descriptive and understandable. Learners think that this visualizations are suitable for getting an overview of the current status in learning process. The result of the more complex visualisation (Figure 3b) is significantly inferior to those of the simpler visualisations (e.g. Figure 3a). The reason might be that it is more difficult for students to understand the complex information.

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References

[1] Abel, F., Heckmann, D., Herder, E., Hidders, J., Houben, G.-J., Krause, D., Leonardi, L., & Sluijs, K. van der (2009). A Framework for Flexible User Profile Mashups. Paper at the International Workshop on Adaptation and Personalization for Web 2.0 (APWEB 2.0 2009).

[2] Albert, D., & Lukas, J. (Eds.) (1999). Knowledge Spaces: Theories, Empirical Research, and Applications. Mahwah, NJ: Lawrence Erlbaum Associates.

[3] Albert, D., Nussbaumer, A., & Steiner, C. (2008). Using Visual Guidance and Feedback Based on Competence Structures for Personalising E-Learning Experience. Proceedings of the 16th International Conference on Computers in Education (ICCE 2008), 27-31 October 2008, Taipei, Taiwan.

[4] Bull, S., & Kay, J. (2008). Metacognition and Open Learner Models. In: The 3rd Workshop on Meta-Cognition and Self-Regulated Learning in Educational Technologies, at ITS2008.

[5] De Bra, P., Smits, D., Sluijs, K. van der, Cristea, A., & Hendrix, M. (2010). GRAPPLE: Personalization and Adaptation in Learning Management Systems. To appear in: Proceedings of the 22nd World Conference on Educational Multimedia, Hypermedia & Telecommunications (ED-MEDIA 2010)

[6] GRAPPLE (2010). Generic Responsive Adaptive Personalized Learning Environment. EC-funded FP7 research project, http://www.grapple-project.org/

[7] iClass (2010). Intelligent Distributed Cognitive-based Open Learning System for Schools. EC-funded FP6 research project, http://www.iclass.info/

[8] Kay, J., Kalina, Y., & Reinmann,.P. (2007). Visualisations for Team Learning: Small Teams Working on Long-term Projects. Proceedings of the Conference on Computer-supported Collaborative Learning (CSCL 2007), International Society of the Learning Sciences.

[9] Steiner, C., Nussbaumer, A., & Albert, D. (2009). Supporting Self-Regulated Personalised Learning through Competence-Based Knowledge Space Theory. In Policy Futures in Education, Vol 2009/7/6.

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Development of an Intelligent Practice Supporting System for High School Chemistry

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Abstract. In this paper, we discuss on development of an Intelligent Practice Support System (IPSS) for high school chemistry. IPSS can solve problems and evaluate learner's problem solving process using the result. IPSS has several functions for supporting learner's problem solving and reflection: Helping function, Interruption function, History function and Searching function. We also report on experimental evaluation of IPSS.

Keywords: Intelligent Educational System, Practice supporting, High school chemistry

Introduction

In this paper, we construct a learning environment for high school chemistry that supports learners' problem solving and reflection process. We call it IPSS (Intelligent Practice Supporting System). IPSS has the following features:

I. IPSS can evaluate answers and descriptions of problem solving process input by learners. Learners describe problem solving process by using templates which are prepared for typical steps of solving process of problems that our system can handle.
II. IPSS has several functions for supporting learners reaching in impasse.
III. IPSS has functions for supporting some types of reflections: Reflection on process of problem solving, on themes of an exercise and on expression style for answers.

We have already constructed Exercise Solver capable of solving problems using chemical knowledge [1] [2], and Explanation Generator capable of generating adaptive explanations of the problem solving processes output from Exercise Solver [3].

As an existing educational system supporting practice, Andes [4] is well-known. It also has functions to accept description of problem solving process, to evaluate it, and to help learners reaching in impasse. However, it is designed for physics and few systems having such functions are known for high school chemistry.

We also report on an experiment to evaluate effectiveness and usability of IPSS.

1. Outline of IPSS

We consider that conventional methods of exercise which use paper media (workbooks and notebooks) have several issues. Firstly, learners who reach in impasse tend to easily give up thinking, and then they finish exercise by only reading the explanation of solution in workbooks. Secondly, even if learners cannot understand some knowledge in problem solving process clearly, most of such learners don't consult chemical knowledge in order to understand it more clearly, because it needs much effort to consult it by textbook or other materials. Thirdly, learners tend to concentrate only on finding the answer, so they may miss the important parts that are themes of the exercise. Finally, when a leaner retries solving problems which he failed to solve formerly, it is not so easy to remember mistakes that he/she made. We designed IPSS to solve these issues (mentioned in chapter 2).
IPSS covers the domain of inorganic chemistry for high school in Japan. We adopt a

standard textbook [5] as a resource of our chemical knowledge base and a problem collection [6] as a resource of problem database. We classify the problems into the following four types [1] [2]. Currently, IPSS supports the types (1)-(3) of problems.
(1) Simulate a chemical phenomenon; a part of result on simulation is the answer.
(2) Find a material attribute value using numerical relation knowledge.
(3) Problems composed of (1) and (2).
(4) The answer is written in domain knowledge base directly.

2. Functions for supporting learners in IPSS

Supports for learner's reflection by IPSS: Lin et al. [7] classify methods to support reflection technologically. Based on the paper and the issues mentioned in chapter1, we design the features for supporting reflections as follows.

[For reflection on problem solving]

A) Listing up learner's mistakes: IPSS shows a learner lists of his/her mistakes in the current problem solving to let him/her overview their weak points.
B) Retrying an exercise from any steps: When learners retry a problem that they failed, they don't have to solve from the beginning but can restart any step of problem solving. The feature helps learners concentrate on what he/she really want to learn.
C) Pointing out the past mistakes: Helping learners to remember their mistakes, IPSS call learners' attention when learners try the same problem which they tried before.

[For meta-level reflection on themes of an exercise and expression style for answers]

D) Calling learner's attention the themes of exercise after a leaner finishes answering.
E) Advising on methods to describe problem solving process: IPSS shows learners both exemplary description of answer generated by itself and learner's answer. It helps learners find the deference in order to learn good style to express the answer.

Function evaluating learners' problem solving process: Exercise solver solves problems and generates two types of representation of problem solving process: CWM (Chemical World Model) and PSPM (Problem Solving Process Model). CWM represents chemical phenomenon in the problem. PSPM represents calculation process (Figure 1). IPSS can evaluate learner's input by comparing them with CWM and PSPM.

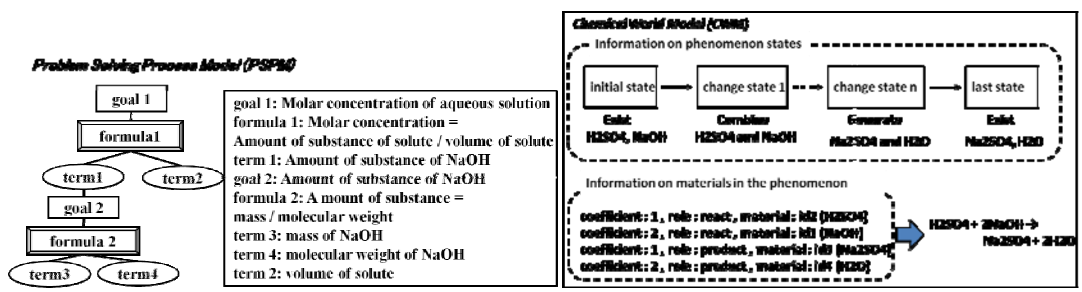

Figure 1: Problem solving process model (PSPM) and Chemical World model (CWM)

Helping Functions for learners reaching in impasse: IPSS supports learners when they reach in impasse. We classify the impasse into 4 levels and provide 3 types of helping functions for each impasse. Learners can choose any types of supports that they needs.

(i) A Learner cannot make a plan for problem solving: IPSS gives the learner hints that show what the learner should do next (Hint function).
(ii) A Learner can make a plan, but the learner is short of chemical knowledge that is necessary to execute the next step of the plan: IPSS provides Search function that helps the learner search chemical knowledge easily.

(iii) A Learner cannot proceed with solving process even if the learner has used Hint function and Search function: IPSS provides Skip function that proceeds with one step of problem solving process instead of the learner.

(iv) A Learner cannot see what to do even if the learner has used Helping functions of (i)~(iii): After the learner gives up problem solving, IPSS shows him/her explanation of exemplary description generated by Explanation generator.

Interruption functions during problem solving: IPSS has 3 interruption strategies for specific conditions on exercise. Firstly, when a learner input problem solving process using a template, IPSS judges whether the type of the template is acceptable to the current context of the solving process. If it is unsuitable, IPSS suggests his/her mistake. Secondly, when a learner fills a blank in a template with mistaken or useless description, IPSS points out that it is invalid and then requests input again. Finally, when a learner retries a problem and the learner reaches the part that mistook in the past, IPSS warns on the mistake.

History functions: History function records learner's history on operations and mistakes and shows the leaner his/her history when he/she wishes. IPSS provides three types of history functions. First, history of mistakes: IPSS records the location of mistakes in the solving process, mistakes of choosing template, and mistakes of filling blanks in templates. Secondly, IPSS records the parts of the problem solving process where each learner is helped. In addition, hints given by IPSS, and searched knowledge by Searching function are also recorded. Finally, learner's input and correct answers are also recorded.

Searching function for chemical knowledge: Learners can consult chemical knowledge appeared in the current exercise relatively easily by Searching functions. For searching, IPSS accepts the following keys: By name of a concept (material, phenomenon, unit, etc), and by (a part of) formula. Combination of the keys is also acceptable.

3. Implementation of IPSS

At first, the learner inputs a problem number. Exercise solver solves the problem and generates CWM and PSPM. Explanation Generator generates explanation by referring CWM and PSP. The learner inputs the problem solving process with templates. IPSS evaluate the input and gives him/her the result. IPSS helps the learner by Helping function, Interruption function, History function, and Searching function.

Figure 2 shows interface of IPSS. (A) is the main frame. (A)-(i) is frame for displaying learner's answer. Characters in this window are displayed in three kinds of colors: black is correct part, red is wrong part, and blue is skipped part (inserted by IPSS). (A)-(ii) shows history of wrong inputs, used Helping function and messages from IPSS such as explanation of themes of the exercise. (A)-(iii) are buttons for selecting templates. When learners push a button, a template window appears. An example of template windows is (D). In IPSS, learners use templates to describe problem solving processes. We design 12 kinds of templates by case study on representation of problem solving processes in the textbook [6], and interview with teachers of high-school chemistry. IPSS has two types of simple templates: on phenomenon and on calculation. We also prepare compound templates which are composed of simple templates. They work as scaffolds for learners to pay attention to good style of describing problem solving process. For example, template window (D) means "Variable x means [Mass], x=[1.0 / 2]=[0.5]" ([__] are blanks in the template). (A)-(iv) are buttons for Helping functions. (A)-(v)shows the current problem. Learner can select a problem from problem collection by (A)-(vi). Learners can retry from any step of the problem by (A)-(vii). (B) is the window for Searching function. Learners can input keywords to (B)-(ii), then the results are displayed in (B)-(i). When learners finish answering, the answer and adaptive explanation generated by IPSS appear in (C). Learners can compare them and do reflection on styles of describing answers.

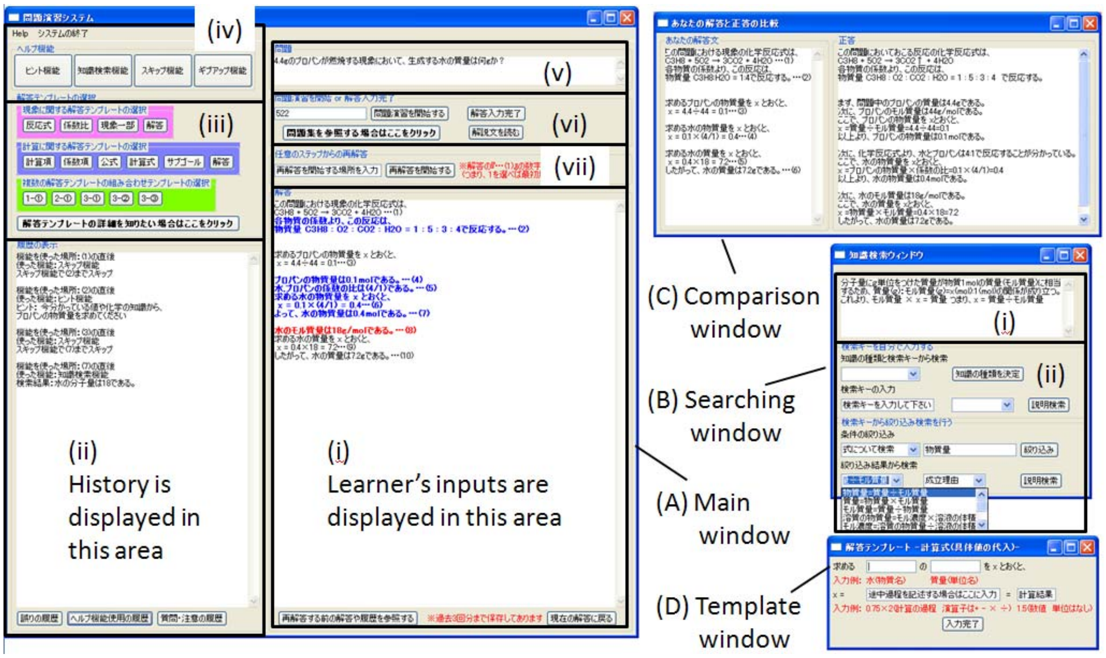

Figure 2: Interface of IPSS

4. Experimental Evaluation

We perform an experiment to evaluate effectiveness and usability of IPSS. We measure the effectiveness by comparing learners using IPSS with ones using paper media. Moreover, we ask learners using IPSS the usability by questionnaire. A purpose of the experiment is to measure how much sense of resistance they feel. There are 10 subjects of this experiment who are undergraduate students or graduate students. They major in computer sciences and have learned chemistry in their high school days.

(1) At First we performed pre-test that consists of 50 basic problems in order to measure each subject's understanding level on chemistry. Then the subjects are separated into two groups (group A, B) of which average scores are nearly the same level. The result of the pre-test is also used for making each subject's learner model. Explanation Generator can generate adaptive explanation by referring the learner model [3].

(2) We lecture in 10 minutes to remind the subjects of chemical knowledge that is themes of problems used in the following experiment.

(3) We give the subjects 25 minutes to solve 4 problems and to do reflection on them. In this phase, learners in the group A exercises on IPSS and ones in the group B exercises on papers (Group A is lectured on methods to operate IPSS before solving the problems).

(4) We performed post-test to measure effectiveness of each exercise. The post-test includes 10 questions; 8 are basic questions which are also used in the pre-test, and 2 are advanced questions. We can see the effectiveness of the exercises in increase of the basic question's scores from the pre-test to the post-test.

(5) We measure usability of IPSS by questionnaire. We let the group B use IPSS in 10 minutes in order to they also have experience using IPSS.

Table 1 shows scores of each group. Comparing the group A with B, group A's average scores of both the basic questions and advanced ones are better than B. Moreover, The group A's average of score increase on basic questions is also better than B. The results suggest exercises using IPSS is more effective than using paper media.

Table 2 shows the result of questionnaire on usability and the sense of resistance. At question1 (How about usability?: bad (=1) to good (=5)). On question2 (What do feel if you have to do problem exercise on IPSS: feel the sense of resistance (=1) to feel comfort (=5)). By the result on question1, we find IPSS has both good and bad factors on usability. The opinions of subjects are as follows: As a positive comment, all subjects wrote that Helping functions and History functions are useful. But some subjects wrote "choosing correct template takes costs", and "learners have to describe answers along with discipline made by IPSS developers". These opinions suggest we will have to improve usability in order to apply IPSS to actual educational field. In particular, input method using templates is important. On the other hand, result on question2 shows that learners don't feel so critical sense of a resistance on IPSS (even if they don't feel so better than paper media). However, we have to point out that all subjects are familiar with operation on PC, so the score might be lower if the subjects are usual high school students.

These results suggest that supports of IPSS will be accepted by learners. On the other hand, we find only weak evidence on effectiveness on learning using IPSS. We have to develop more effective pedagogical strategy.

Table 1: Scores of the pre test and post test

	Common 8 problems			All (10) problems
	pre test	post test	increase	
Group A	3.4	5.6	2.2	7.0
Group B	3.0	4.6	1.6	5.4

Table 2: Result of questionnaire

	Group A	Group B	Total Average
Q1	3.6	3.4	3.1
Q2	3.4	2.8	3.1

5. Conclusion

We constructed IPSS and performed a simple experimental evaluation. The result of this experiment shows we have to improve usability of IPSS. Although IPSS isn't evaluated in actual schools, we are planning to test IPSS in a high school. We are also planning to apply IPSS on a network based homework system.

References

[1] Ishima, N., Ueda, T., Konishi, T., Itoh , Y(2006). Developing a Practical Domain Knowledge Base and Problem Solving System for Intelligent Educational System of High School Chemistry. *Proc. of ICCE2006*. pp.115-118,

[2] Ueda,T., Nanko, R., Konishi, T., Itoh,T (2007). Extension of Problem Solving System for Intelligent Educational System of High School Chemistry. I*CCE2007, Supplementary Proc.:Poster*, pp. 49-50.

[3] Okada, Y., Konishi, T., Itoh, Y (2009). Explanation Generator based on Themes of Exercises and Learnder Moderl in TIS for High School Chemistry. *Proc. of ICCE2009*. pp. 137-141.

[4] VanLehn, K. , Lynch, C. , Schulze, K. , Shapiro, J. A. , Shelby, R. , Taylor, L. , Treacy, D. , Weinstein, A. , Wintersgill . M. (2005). The AndesPhysics Tutoring System: Lessons Learned. *International Journal of Artificial Intelligence and Education , Volume 15*(3) , pp. 147-207.

[5] Suuken Syuppan (2002) Koutou gakkou Kagaku I, Suuken Syuppan (in Japanese).

[6] Kihon mondaisyu Kagaku IB (2003), Shinkou syuppansya Keirinkan (in Japanese)

[7] Lin, X. , Hmelo, C. , Kinzer, C. K. , Secules, T. J. (1999). Designing Technology to Support Reflection. *Educational Technology Research and Development, 47*(3), pp. 43-62.

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Predicting Student's Appraisal of Feedback in an ITS Using Previous Affective States and Continuous Affect Labels from EEG Data

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Abstract: Students have different ways of learning and have varied reactions to feedback. Thus, allowing a system to predict how students would appraise certain feedback gives it the capability to adapt to what would help a student learn better. This research focuses on the prediction of a student's appraisal of feedback provided in an intelligent tutoring system (ITS). A regression model for frustration and excitement is created to perform prediction. The frustration model was able to achieve a 0.724 correlation with a 0.164 RMSE and the excitement model was able to achieve 0.6 a correlation with a 0.189 RMSE. These results indicate the potential of using these models for allowing systems to adjust feedback automatically based on student's reactions while using an ITS.

Keywords: intelligent tutoring system, machine learning, brainwave signals, feedback appraisal

Introduction

Intelligent Tutoring Systems (ITS) help students learn by providing assistive feedback. Recent ITS have incorporated affective models motivated by researches that show the importance of emotions in learning [7]. Affective models allow systems to identify the student's emotional state and allow it to provide more appropriate feedback while learning.

The content, timing and presentation of feedback provided are based on an expert's view of what the student needs to progress in learning. However, because of the diversity of students, it is not ensured that the feedback identified by the expert will always work. So not only should a system provide feedback, but also assess its effect on the student so it can adjust the feedback to something more appropriate for the student in the future. This research focuses on automatically assessing the effect of feedback to the student as he uses an ITS in real time.

1. Related Work

Identifying the student's emotion is not a trivial task. Different approaches are taken to identify them like self-reporting, annotation, use of web cameras and physiological sensors [1][3][9]. Manual methods suffer from the amount of work required to identify emotions and noise due to human error, personal biases or fatigue while automated methods suffer from costs and inherent noise picked up by the devices.

In [5], students were asked to report their reactions to test results before and after it was given and their self-assessment about the test. They represented emotions using discrete labels and used ID3 and Naïve Bayes to create a model which got 82.4% and 62.93% accuracy respectively [4][6]. Robison [12] analyzed student's reaction to feedback in a virtual narrative-centered inquiry-based learning environment where they would report their emotions using discrete labels before and after feedback is given. Including personality, goal orientation and empathetic tendency in recent work improved the accuracy of their models where they were able to get 75.2% accuracy using Naïve Bayes, 72.9% using decision trees and 73.11% using support vector machines (SVM) [13].

2. Modeling Student Appraisal of Feedback

Appraisal theory views emotions as the result of evaluations or appraisals of events that are happening or have happened to a person [14]. A particular perspective views it as a continuous interplay between cognition and emotion. Given a stimulus, there is a continuous reassessment of the situation based on the current emotion, past experiences and other relevant factors until it stabilizes [10][15]. Automatically identifying the appraisal of a stimulus, in our case feedback from an ITS, would require emotions to stabilize first. When self-reporting we may consider that a student is able to report his emotion since he has finished appraising the situation. The case will be different however when sensors are used as it will not know when the appraisal process is complete.

In this research students were asked to use an ITS for object oriented programming (OOP). Their appraisal of the system's feedback was collected using the Emotiv EPOC Neuroheadset[1], a commercial electroencephalogram (EEG) based product. The use of brainwave signals minimizes human error seen in self-reporting or annotation and noise as it is not as susceptible to movement compared to other physiological sensors. The device is capable of identifying continuous emotional states instead of discrete emotion labels.

3. POOLE III

The Programmer's Object Oriented Learning Environment III (POOLE III) [2] is an ITS designed to help students learn class design using the Unified Modeling Language (UML). It was modified to incorporate a virtual conversational agent that communicates with the student and gives feedback regarding his work. Haptek People Putty Player[2] was used to render the agent and synthesize speech. Importance was given to the agent's facial expressions and supportive dialogue to provide feedback to the student. Figure 1 shows a screenshot of the system where the agent provides feedback about the student's answer.

The system tracks the student's knowledge using a Bayesian network and is used as basis for feedback. Feedback is categorized into activity transition, solution evaluation and hints. The words and facial expressions of the agent were chosen to appear supportive of the student's activity.

[1] http://www.emotiv.com
[2] http://www.haptek.com

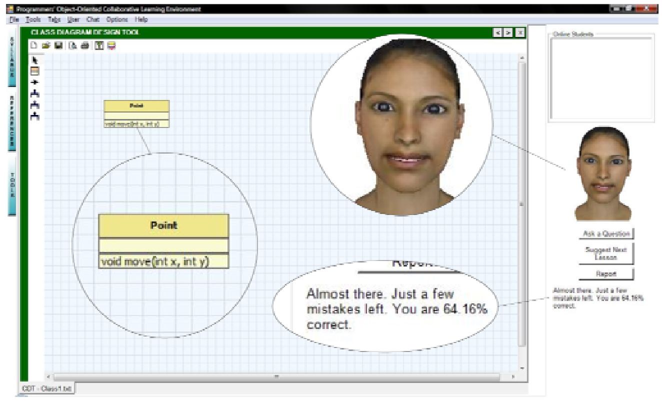

Figure 1: Screenshot of POOLE III's interface

4. Data Collection

Data was gathered from five male and five female first year students taking an introductory course on OOP at De La Salle University. The experiment conductor first gives a tutorial on using POOLE III then the student is asked to wear the Emotiv Epoc while a video of his face was recorded and feedback was logged. Students used the system for 20 minutes. Afterwards they answered a survey to get their profile and the results of their Big Five personality test. Figure 2 shows the experiment setup.

Figure 2: Experiment setup with the student wearing the Emotiv Epoc

5. Data Preparation

Since the focus of the research was to predict appraisal of feedback, only the excitement and frustration values after each feedback was considered. The student's appraisal of feedback was considered complete when there is a change of only 0.08 in both values. This was chosen based on the manual observation of the data. The value for frustration and excitement at this point was considered as the label for the frustration and excitement models that would be created later.

Based on the appraisal theory, previous emotional states affect appraisal. So apart from including the frustration and excitement values when the feedback is given, the average frustration and excitement values from the previous three seconds are also included. Lastly, the feedback given and the student's profile are appended to the data. This gives a total of 14 features namely: (from Emotiv Epoc) frustration, excitement, average frustration, average excitement, (from POOLE III logs) feedback, time elapsed from last feedback, (from survey) age, gender, class standing, extroversion, orderliness, emotional stability, accommodation and inquisitiveness.

6. Modeling Feedback Appraisal

The RapidMiner data mining software [11] was used for selecting the most relevant features from the data through the sequential forward floating selection algorithm [8]. It was used together with linear regression, k-nearest neighbor and support vector machine wrappers. Each wrapper was used for its corresponding machine learning algorithm. Also using RapidMiner, Linear regression, k-nearest neighbor (kNN) and support vector machine (SVM) were used to create the predictive models. The correlation coefficient and root mean squared error (RMSE) of the two models are shown in Figure 3.

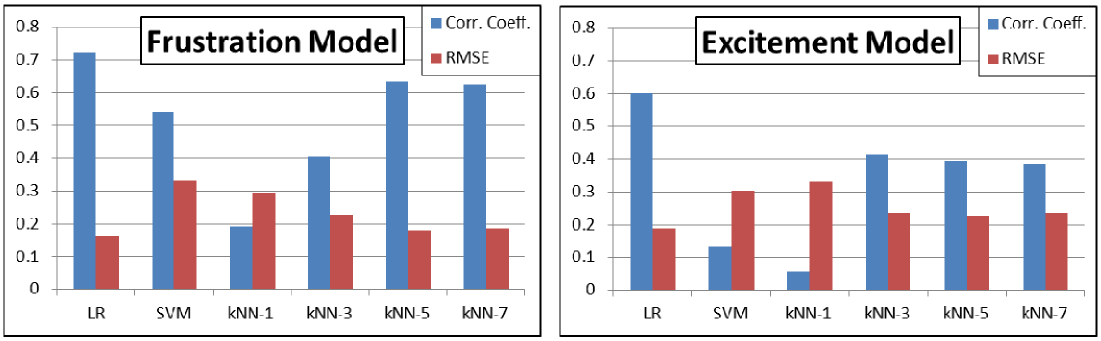

Figure 3. Correlation coefficient and RMSE of the frustration and excitement model

Linear regression gave the best results with a correlation of 0.724 and a RMSE of 0.164 for predicting frustration which is quite promising given that the data was gathered from an actual scenario in real time and that the data from brain waves are quite noisy. The excitement model is less powerful compared to the frustration model, where linear regression also gave the best results but with a correlation of 0.6 and a RMSE of 0.189.

The features commonly selected by the feature selection algorithms for the frustration model were frustration, average frustration, excitement, time elapsed from the previous feedback, extroversion and accommodation. The selection of frustration, average frustration and excitement support the appraisal theory indicating that previous emotions affect appraisal. It was interesting that a relationship was found with the time elapsed from the previous feedback because it was observed in many cases where students continuously ask the system for hints which are behaviors indicative of frustration. Lastly it was also found that certain personality traits have an effect on the student's emotional state supporting the findings of Robison [13]. Similar features were selected in the excitement model except for the replacement of the accommodation personality with orderliness.

7. Conclusions and Future Work

The results gathered are quite promising. The frustration and excitement models are able to predict the student's appraisal of feedback with fairly acceptable correlation and error. Results from feature selection have showed empirically that previous emotional states have a relationship with the appraisal of feedback, supporting appraisal theory. Similarly it was shown that frustration and excitement values do stabilize after feedback is given supporting the recursive view of appraisal. Personality was also seen to have relationships with student's appraisal of feedback supporting previous works on the same domain.

The methodology used gives a good alternative to self-reporting, where student's appraisal of feedback can be identified without interrupting their learning task. The models created are simple and can work in real time allowing it to be incorporated into tutoring systems. The use of continuous affect values in the form of frustration and excitement are capable of capturing more information regarding the student's emotional state unlike discrete emotion labels making it richer and allowing more analysis of the data.

This capability of predicting the student's appraisal of feedback can be used to improve current tutoring systems by identifying what feedback is helpful to the student or not, allowing it to adjust accordingly. This will hopefully improve the support students receive and will allow them to have better learning experiences.

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References

[1] Arroyo, I., Cooper, D. G., Burleson, W., Woolf, B. P., Muldner, K., and Christopherson, R. (2009). Emotion sensors go to school. In Proceeding of the 2009 Conference on Artificial Intelligence in Education, pages 17-24, Amsterdam, The Netherlands, The Netherlands. IOS Press.

[2] Aurellano, M., Tabuñar, B., Tan, R., Tuason, E., and Suarez, M. (2007). POOLE III: Using a Bayesian Network for Individual and Group Student Modelling. In Proceedings of the 7th Philippine Computing Science Congress, Boracay, Philippines.

[3] Bailenson, J., Pontikakis, E., Mauss, I., Gross, J., Jabon, M., Hutcherson, C., Nass, C., and John, O. (2008). Real-Time Classification of Evoked Emotions Using Facial Feature Tracking and Physiological Responses. International Journal of Human-Computer Studies, 66(5):303-317.

[4] Chalfoun, P., Chaffar, S., and Frasson, C. (2006). Predicting the Emotional Reaction of the Learner with a Machine Learning Technique. In Workshop on Motivaional and Affective Issues in ITS, ITS'06, International Conference on Intelligent Tutoring Systems. Citeseer.

[5] Chaffar, S. and Frasson, C. (2006). Predicting Learner's Emotional Response in Intelligent Distance Learning Systems. In Proc. 19th Int. FLAIRS Conference, AAAI Press, Melbourne, FL, USA, pages 383-388.

[6] Chaffar, S., Cepeda, G., and Frasson, C. (2007). Predicting the Learner's Emotional Reaction towards the Tutor's Intervention. In Seventh IEEE International Conference on Advanced Learning Technologies, 2007. ICALT 2007, pages 639-641.

[7] Goleman, D. (1995). Emotional Intelligence. Bantam Books, New York.

[8] Hall, M. A. (1999). Correlation-based Feature Subset Selection for Machine Learning. PhD thesis, Department of Computer Science, University of Waikato, Hamilton, New Zealand.

[9] Heraz, A., Razaki, R., and Frasson, C. (2007). Using Machine Learning to Predict Learner Emotional State from Brainwaves. In Seventh IEEE International Conference on Advanced Learning Technologies, 2007, pages 853-857.

[10] Lewis, M. D. and Granic, I. (1999). Self-organization of Cognition - Emotion Interactions. In Dalgleish, T. and Power, M., editors, Handbook of Cognition and Emotion, chapter 32, pages 683-701. John Wiley & Sons, Chichester.

[11] Mierswa, I., Wurst, M., Klinkenberg, R., Scholz, M and Euler, T. (2006). YALE: Rapid Prototyping for Complex Data Mining Tasks, in Proceedings of the 12th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD-06).

[12] Robison, J., McQuiggan, S., and Lester, J. (2009). Evaluating the Consequences of Affective Feedback in Intelligent Tutoring Systems. In Proceedings of the 3rd International Conference on Affective Computing and Intelligent Interaction.

[13] Robison, J., McQuiggan, S., and Lester, J. (2010). Developing Empirically Based Student Personality Profiles for Affective Feedback Models. In Aleven, V., Kay, J., and Mostow, J., editors, Intelligent Tutoring Systems, volume 6094 of Lecture Notes in Computer Science, chapter 33, pages 285-295-295. Springer Berlin / Heidelberg, Berlin, Heidelberg.

[14] Scherer, K. R., & Shorr, A., & Johnstone, T. (Ed.). (2001). Appraisal Processes in Emotion: Theory, Methods, Research. Canary, NC: Oxford University Press.

[15] Scherer, K. R. (2003). Introduction: Cognitive Components of Emotion. Handbook of Affective Sciences, pages 563-673.

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A Learning Environment for Solution-based Problem-Posing in Multi-Digit Subtraction

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Abstract: In this paper, we describe developing and evaluation of a learning environment for *Solution-based Problem-Posing* in the case of multi-digit subtraction. One of the ways to learn by problem-posing is to make learners pose problems which can be solved by a solution. We call the type of problem posing *Solution-based Problem-osing*. The *Solution-based Problem-Posing* helps the learners understand the solution. In the case of multi-digit subtraction, however, it is difficult to provide the solutions directly because the solutions in the multi-digit subtraction are complex for learners who are elementary school students when they learn them. We suggest a method they are required to solve problems to be conscious the solution of the problems and then pose problems based on the solution.

Keywords: Interactive Learning Environment, Problem-Posing, Multi-Digit Subtraction

Introduction

In this paper, we describe a development an Interactive Learning Environment (ILE) for multi-digit subtraction and report an evaluation in a lecture of a class in an elementary school experimentally. In learning for multi-digit subtraction, even if learners can solve a problem, they don't always understand a meaning of a solution of the problem and condition of the solution [1]. Several researchers suggested that it is effective to master solution that a learner poses problems which can be solved by the solution [2] [3]. We called the type of problem-posing *Solution-based Problem-Posing.* We have already developed some ILEs for arithmetical word problems solved by an addition or a subtraction [4]. Kojima and his colleagues have also developed ILEs for posing arithmetical word problems [5]. Instead of mastering solution, their ILEs intend to diversify learners' problem posing. Solution in arithmetical word problems can be shown in terms because its structure is relatively simple compared with problem structure, but solution in multi-digit subtraction is complex. Besides, it is difficult for early elementary school children to understand the provided explanation in terms. So, in multi-digit subtraction, it is difficult to pose problems with a same method as *Solution-based Problem-Posing* for arithmetical word problems. We suggest a method that learners solve and consider a problem and pose the problem which can be solved by the used solution.

1. Problem-posing for multi-digit subtraction

1.1 Solution-based Problem-Posing

We proposed a problem-posing method composed of the two steps following: First, learners solve a problem. Second, they pose a problem which has same solution of the solved problem. This method makes it possible for them to pose a problem based on solution without explanation about complex solution method of multi-digit subtraction. This method is effective in multi-digit subtraction because the solution is complex to be explained by sentences and elementary school students are too young to understand it.

1.2 Categorizing Structure of Problems

A calculation procedure of multi-digit subtraction was decided by relation between each digit number of minuend and subtrahend. In our system, 3-digit subtraction is focused because it is last step of multi-digit subtraction at elementary school in Japan. The problems and solutions are categorized 5 types show as Fig. 1. Problems become difficult in the order of number from smallest to biggest because learners learn in this order. Learners are required to solve and pose based on the 5 types in our system.

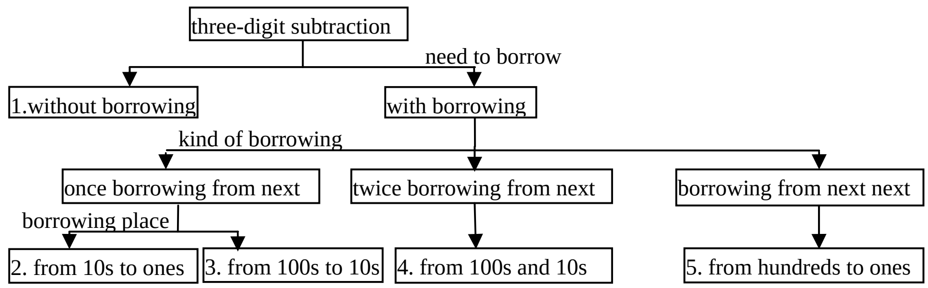

Fig. 1: Categorizing of Problem

2. Design of the ILE

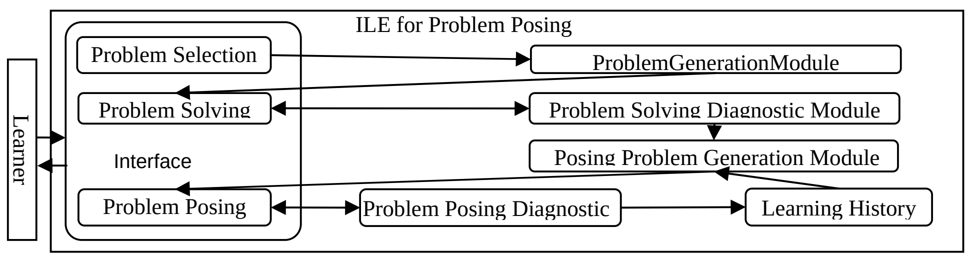

Fig. 2: Structure of the ILE

Fig 2 shows a structure diagram of our ILE which is implemented by java application.

2.1 Problem Solving

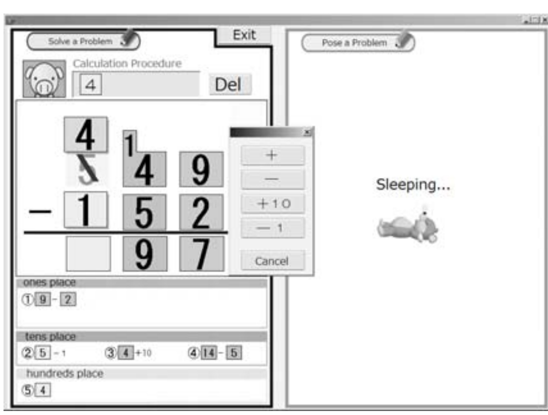

Fig. 3: Problem Solving Process

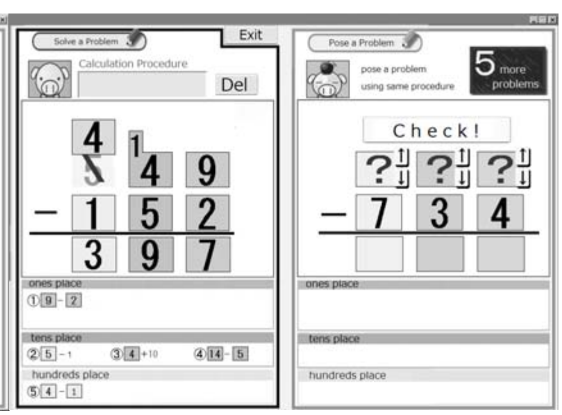

Fig. 4: Problem Posing Process

Problem Solving Interface is shown in left part of Fig. 3 This interface requires learners to solve a problem and to recognize calculation procedure clearly by interaction to the ILE. The procedure in multi-digit subtraction composed of actions which are subtracting numbers, increasing by 10 with borrowing and decreasing by 1 with borrowing. In the ILE, learners can use these action and adding numbers. These modeling of calculation procedure in multi-digit subtraction are based on research for buggy [6].

2.2 Problem Posing

Problem Posing Interface shown in right part of Fig. 4 requires learners to pose a problem which requires a same calculation procedure they solved. Posing Problem Generation Module generates numbers at random and changes some of the numbers to blank space. The blanks are filled by clicking upper arrow or downer arrow. They are required to pose six times for one type problem. In the problem posing, there two type of difficulty. Another one is type of solution type shown in Fig. 1. The difficulty of types of solution increases as number of type increase because a learner must consider more elements as number of type increase and they appear in this order in textbooks. In our ILE, however, now learners can select type of problem, so the difficulty about type isn’t controlled. Another one is number of blank spaces of one type. Blank spaces are increased by learning history is decided by number they posed same type correctly. The difficulty about blank space increases this order of the steps in our ILE. The Learning History about Difficulty Step which a learner achieved is recorded. The ILE referrers the history and generates posing problem. All problems which learners can pose are 120 (5 types of problem * 6 times for one type of problem * 4 Difficulty Step).

Blank spaces (BS) one or two -> Difficulty Step 1
BS two or three -> Difficulty Step 2
BS four or five -> Difficulty Step 3
BS five or six -> Difficulty Step 4

Problem Posing Diagnostic Module specifies types of solved problem and posed problem based on the category shown in Fig. 1. If both problems are belong same type, the posed problem is correct. If types of problems are different, the posed problem is incorrect. Messages are provides about differences by level in Fig. 1. The detail of different part is also represented by comparing solution for solved problem to solution for posed problem. If solved problem belongs type 4 but a learner poses a problem belongs type 2. The ILE provides a message that tens place is different. Next, the ILE provides a message that is same at the view point of checking for borrowing but different at the view point of kind of borrowing under level of Fig. 1. Calculation procedure of posed problem is also represented beside calculation procedure of solved problem and backgrounds of different place are colored for representation about detail of different place. Development of the ILE is also considered proper because it is evaluated by opinions of some elementary school teachers.

3. Experimental Use

Our ILE was used experimentally in elementary school. Purpose of the experimental use is to confirm that our system is useful tool for solution-based problem-posing in multi-digit subtraction. In multi-digit subtraction, learning by problem-posing is difficult without support of computer because of difficult solution structure, thus our system is considered of value if learners can pose problems in multi-digit subtraction and accept our system.

132 students and 5 teachers including class teachers used our system. The students were third-grade level and just finished learning for three-digit subtraction. The teachers used our ILE before students used in arithmetic classes, and they evaluated that our system can be used at the third-grade level. In the arithmetic classes, we explained our ILE for 10 minutes at first. Next, students learned on our ILE for 50 minutes. In the learning, each learner used his own computer. Finally, we asked them and the teachers several questions.

3.1 Result of Using our ILE

Each student posed 122 problems on an average for 50 minutes. There were 93 correct problems and correct rate was 76%. Table 1 shows amount of posed problems, amount of correct problems and rate of them on each student per 10 minutes. The result shows that students continuously posed problems on our ILE for 50 minutes. Table 2 shows a relationship between posed problems, students and correct rate. The result shows that students can pose a problem at least per minute.

Table 1: Amount of posed problems and correct problems a person per 10 minutes
(Column after 40 minutes includes the use after 50 minutes in circumstances of execution)

Time	0-10	10-20	20-30	30-40	40-	All
Posed problems	25.8	26.4	21.4	22.3	25.7	122
Correct problems	19.1	20.9	16.8	16.8	19.4	93
Correct rate	74%	79%	78%	75%	76%	76%

Table 2: Distribution of correct problems rate of total posed problems a student

Posed Problems	60-79	80-99	100-119	120-139	140-159	160-
Students	11	26	56	29	6	4
Correct rate	63%	71%	86%	77%	66%	42%

From the results, two concerns are occurred. One is (A) that they could pose problems without careful consideration. Another one is (B) why they posed for such a long time continuously. About (A), if they posed problems without consideration, they could not pose correct problems on this high rate. On our ILE, easiest problem posing is filling only one blank on problem type 1 in Fig. 1. Even if they pose this easiest problem, they cannot pose correct problem 50% of the time without consideration because filling number is required to be smaller or bigger than other number on same place. The rate of correct problems, however, is 76%. Therefore we guess that they considered solution structure and conducted posing problems activities. About (B), I think there are several reasons. It may be interesting for them to pose problems, to learn on our ILE, and so on. We cannot specify which element is most important, but the result about (B) is caused by interaction to actual teachers at elementary school when we developed our ILE. From the results, however, one feature is also occurred. We should discuss that (C) rate of correct problems doesn’t increase with time though rate increases with time by learning usually. I guess that this feature is occurred by feature of difficulty on our ILE. Difficulty of posing problems increases with time our ILE. Amount of blank spaces increases gradually when they posed the same type of problems, and they are easy to select easy type of problem by bias. Actually, 89% students selected type 1 at first and 65% selected from type 1 to type 5 in order. Though the two difficulties increased on our ILE with time for 50 minutes, the rate of correct problems didn’t decrease. There is possibility that their abilities of posing problems are improved.

Table3: Correct problems rate of each type and each difficulty
(Line: Type of Problems, Dif: Difficulty step, Num: Amount of students that even achieved difficulty 4 of the type)

	Dif. 1	Dif. 2	Dif. 3	Dif. 4	Num
Type 1	90%	94%	95%	96%	97
Type 2	77%	85%	87%	91%	84
Type 3	87%	92%	93%	90%	68
Type 4	87%	87%	83%	89%	60
Type 5	77%	80%	80%	80%	54

Table 3 shows relationship between the rate and the two difficulties that are difficulty step (is amount of blank space) in 2.2 and difficulty of type of problems. Time line is secured in each problem type because the rate in Table 3 is counted about only students who finished difficulty step 4. The rates are the worst value in difficulty step 1 in each type of problem though difficulty step 1 is the easiest. The abilities of students may be improved in posing problem of each type from the result.

3.2 Result of Questionnaires

Table 4 shows students' answers of questionnaires after they finished learning on our ILE. (s-2) and (s-3) show that over 80% (110/134=0.82, 110/134=0.82) of them felt importance of posing problem and considering solution structure (calculation procedure). (s-1) show that over 70% (94/134=0.70) of them felt that provided feedbacks from our ILE were useful. Table 5 shows teachers' answers of one of questionnaires. All teachers answered that our ILE was useful for the class. There are also some comments such as "Though I think it is impossible for children who are not a good scholar, it is enough useful by using more than once", "It is useful as brush up on senior children at elementary school or use in introductory lecture depending on usage situation" in comment of free description.

Table 4: An evaluation of the students

	Yes	So-So	No
(s-1)Were feedbacks helpful?	94	19	21
(s-2)Did you consider calculation procedure?	110	22	2
(s-3)Do you think it is important to consider it	110	21	3

Table 5: Our ILE is useful for the class? (an evaluation of the 5 teachers)

I think that it is useful as it is.	2
I think that it is useful if it is improved a little.	3
I think that it is useful if it is improved greatly	0
I don't think that it is useful.	0
I don't know	0

4. Conclusion

In this paper, we described developing and evaluation of a learning environment for *Solution-based Problem-Posing* in the case of multi-digit subtraction and an experimental use at elementary school. We realize it with the method that learners solve a problem at first and pose problem which has same solution because it is difficult to provide solution of multi-digit subtraction in terms. The results of experimental use show that students can learn by posing problems on our ILE and that students and teachers accept the activity and our ILE. Though the learning effect isn't confirmed yet, the activity can be not realized without our ILE. Thus, it has meaning. It is our futures work to research a quantitative evaluation of the learning effect using our ILE.

References

[1] Resnick, L. B. (1987) Constructing Knowledge in School. *In Development and Learning, Conflict or Congruence?*, edited by L. S. Liben, Hillsdale, N. J., LEA., 19-50.

[2] Brown, S. I. & Walter, M. I. (1993) *Problem Posing: Reflections and Applications*. L. E. A.

[3] Silver, E. A., Cai, J. (1996) An Analysis of Arithmetic Problem Posing by Middle School Students, *Journal of Research in Mathematics Education*, 27(5), 521-539.

[4] Hirashima, T., Yokoyama, T., Okamoto M. & Takeuchi, A.. (2006) A Computer-Based Environment for Learning by Problem-Posing as Sentence-Integration, *Proc. International Conference on Computers in Education*, 127-130.

[5] Kojima, K., Miwa, K. & Matsui, T. (2009) Study on Support of Learning from Examples in Problem Posing as a Production Task, *Proc. International Conference on Computers in Education*, 75-82.

[6] Brown, J. S. & Burton, R. B. (1978) Diagnostic models for procedural bugs in basic mathematical skills. *Cognitive Science*, 2, 155-191.

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Drawing Dynamic Geometry Figures with Natural Language

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Abstract: This paper presents a tool for drawing dynamic geometry figures by understanding the texts of geometry problems from common textbooks. With the tool, teachers and students can construct dynamic geometry figures on a webpage by inputting a geometry problem in natural language. First a knowledge base for understanding geometry problems is built. With the help of a knowledge engineering tool InfoMap, geometric concepts are extracted from an input text. The concepts are then used to output a multi-step JavaSketchpad script that constructs a dynamic geometry figure step by step. Finally, the system outputs the script as a HTML document that can be read and visualized with an internet browser.

Keywords: natural language understanding, dynamic geometry, JavaSketchpad, geometry education, e-learning

1. Introduction

The National Council of Teachers of Mathematic has published two important documents on K-12 mathematics curriculum: Curriculum and Evaluation Standards for School Mathematics [13], and Principles and Standards for School Mathematics [14]. The latter focused more on the skills of writing formal proofs of geometry [6]. Furthermore, mathematicians and educators agree that the ability in writing geometry proofs involve important skills that are difficult to learn [7] [16].

Some computer programs are used in teaching geometry in school. In fact, using geometry software also increases the motivation of students in learning geometry. Some popular programs include Geometer's Sketchpad (GSP), Cabri Geometry II, Geometry Expert, and Cinderella’s Café. These programs share one common focus on dynamic geometry (DG) figures. In a DG figure, students can drag a geometry object such as a vertex of a triangle and change the figure dynamically while preserving the given conditions of the figure and all geometric invariants, which are the consequences of the given conditions. Thus these programs are commonly used to demonstrate geometry theorems.

Dynamic geometry can also be used by students to discover conjectures about a figure in some given conditions. Students can explore various configurations of a DG figure and try to discover conjectures about the figure on their own. For some learning activities in classroom, students are given work sheets to fill in measurements of some properties of geometric objects and write down conjectures they discover in a DG figure. There are two common problems in such activities. First, teachers and students have to learn to use the DG software and the learning process can be difficult and time consuming. Second, there is little record on how students manipulate the dynamic figures in order to conclude their findings. Both problems make it difficult to evaluate the effectiveness of learning from DG systems.

To address the above two problems, we build an online dynamic geometry system that can “understand” common, basic geometry problems. With this system, the teachers and students can construct DG figures on a webpage for their learning activities, such as making geometry conjectures and proving a theorem. Furthermore, this tool can help researchers design user interface that collects data of students' interactions with DG figures. Based on the data, researchers can get more insights on how students make inferences from their interactions with the dynamic figures.

2. Background

Studies indicated that when students explored conjectures in a dynamic geometry environment (DGE), they could explain the formal proof they wrote based on their experiences in the exploration [4]. Furthermore, students would strengthen their beliefs in the geometry conjectures they made from their observation of the changes of dynamic figures in DGE [1] [2]. In DGE, students can notice the variation and invariance of conditions in a dynamic figure, deepening their understanding of geometry theorems [8]. Some studies also found that object dragging in DGE could reduce the gap between DG experimentation and the generation of theorem proving ideas by learners [10] [4] [3]. When DGE is used in some learning activities, students need both basic geometry knowledge and skill of working with DG tools such as GSP. Sometimes, they need to add geometric components to a dynamic figure. This can be an obstacle to students who are not expert users of DG tools, reducing the effectiveness of learning in DGE [15].

Lees and Cowie [9] proposed an enquiry system for training students to learn UNIX commands. The system provides a natural language interface for learners so that they can learn UNIX commands by themselves. Li and Chen [11] proposed a Chinese enquiry system about fundamental knowledge of computer. The system uses a Linguist String Parser to understand the question inputted by a learner, and then outputs an appropriate answer. A model is proposed to simulate procedural knowledge of basic arithmetic operations [12]. The model helps teachers design appropriate curriculum and teaching strategy from the records of students solving arithmetic problems. The model is used in an intelligent tutoring system that can accumulate and reproduce the knowledge from teachers and students and help teachers build a good learning map for students. The system LIM-G [17] is used to understand geometry word problems and help elementary school student comprehend geometry word problems, which are about the area or circumference of a geometric object. After a student inputs a geometry problem to LIM-G, the system understands the text using a pre-built geometry knowledge base and constructs the figure of the problem.

In this study, we help to make DGE more accessible to teachers and students. We propose to build a system that can draw dynamic geometry figures by understanding texts of geometry problems. In this way, teachers and students are not required to spend so much time in constructing figures in DGE. Moreover, if the system is available on a website, then there is no need to install any expensive commercial software in school, making DGE more accessible to schools in poor school districts.

3. Core technologies of the system

3.1 System architecture

There are three main components in this system. The first is the knowledge inference engine InfoMap. When a user enters a geometry problem in natural language, InfoMap analyzes the problem and extracts the attributes of the geometric concepts in the problem. This information is sent to the second component of the system. This component generates a JSP script that draws a DG figure of the problem, which can then be manipulated by the user to explore various conjectures. The third component outputs the drawing script of JavaSketchpad as a HTML document that can be loaded by any web browser to display the DG figure. Figure 1 shows the system architecture with the three components.

Figure 2 shows a snapshot of the user-interface in a web browser. A user can input the geometry problem in Chinese and simple mathematical symbols in the text area at the bottom. The canvas at the top displays the dynamic figure according to the input problem. The figure is drawn with a JavaSketchpad script embedded in a HTML document.

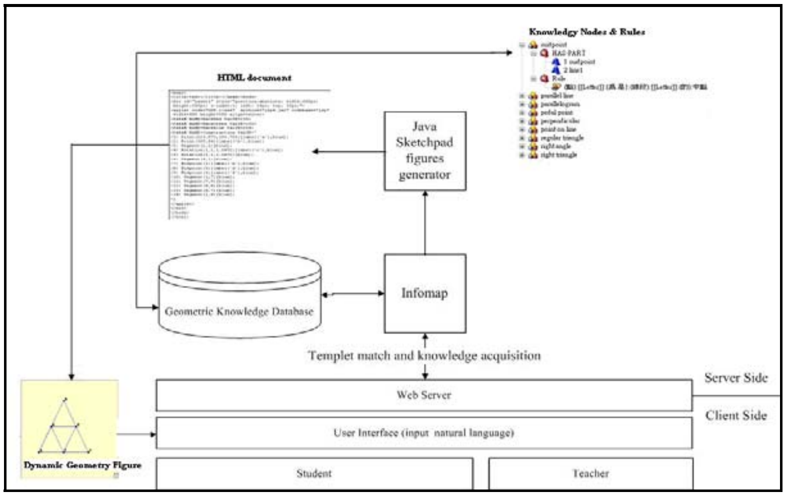

Figure 1. The system architecture

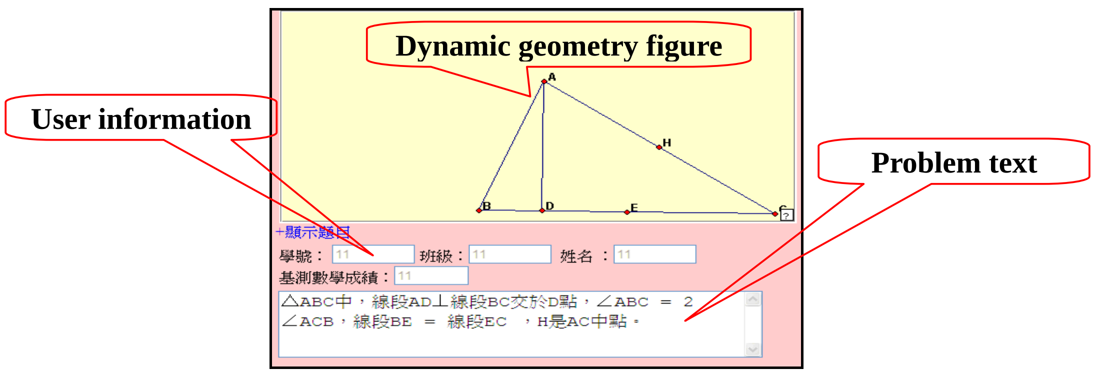

Figure 2. A snapshot for the user-interface

3.2 Infomap and knowledge base of geometry concepts

InfoMap is a knowledge engineering tool provided by the Intelligent Agent System Lab, Institute of Information Science, Academia Sinica. InfoMap is an ontology-based system for knowledge representation and template matching [5]. InfoMap works as an agent by understanding texts in any domain and can answer questions about them, if the needed domain knowledge is provided. In a knowledge base in InfoMap, nodes represent geometry concepts and each template of a node specifies the syntax of sentences that use the concept of the node. Templates are matched to input sentences and concepts can be extracted from the sentences.

Figure 3 shows part of the knowledge base, which includes many concepts, e.g., midpoint, pedal point, intersection, triangle, isosceles triangle, parallelogram, parallel line, point on line. In this study, we have built more than 50 concept nodes of geometry. A concept node is also a knowledge frame, which includes a rule node and two attribute nodes. The rule node generally includes multiple templates, which describe the syntax of sentences about the concept. The HAS-PART node specifies the component nodes that make up the concept. The component nodes can store the concepts and their names that are extracted from an input sentence.

Suppose the user inputs a Chinese sentence meaning “Point A is the midpoint of segment BC” or “A is the midpoint of BC”. The sentence is matched against the InfoMap template of midpoint, and the node “midpoint” is triggered. InfoMap will extract the component concepts of midpoint point A and segment BC, and then label the component “midpoint” as “A” and component “line1” as “BC”. The template for an equivalent English sentence is “(Point) [[Letter]] is (the) middle point (of) (segment) [[Letter]]”. So the sentences “Point A is the midpoint of segment BC” and “A is the midpoint of BC” both match the template of the "midpoint" concept. One matched result is shown in Table 1.

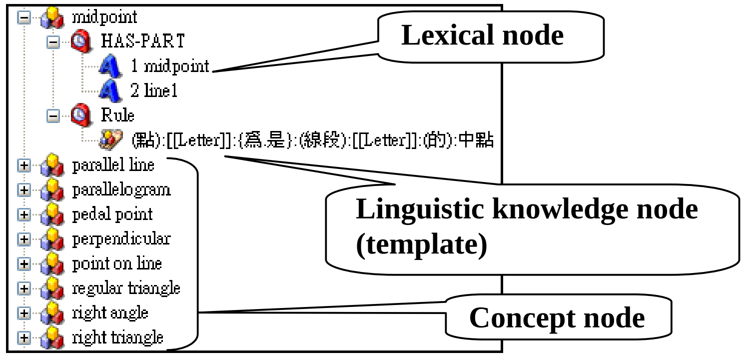

Figure 3. Knowledge base of geometry concepts

Table 1. Result of template matching for one sentence

Geometry proof description	Point	A	is	the	middle point	of	segment	BC
Template	(Point)	[Letter]	is	(the)	middle point	of	segment	[[Letter]]

3.3 JavaSketchpad and text understanding

JavaSketchpad (JSP) is a computer program with which authors publish DG figures of Geometer's Sketchpad as a Java applet embedded in a HTML file so that users can interact with the figures with a web browser on the internet [3]. Geometer's Sketchpad from Key Curriculum Press is a DGE that runs on a personal computer. Moreover, instructors can publish interactive, DG content in learning activities so that students can participate in the activities over the internet. GSP supports a web solution by publishing a HTML document embedding a Java applet containing the JavaSketchpad script into the document (Figure 4).

Figure 4. JavaSketchpad Script and HTML document

There are two different methods for parsing an input geometry problem text. The first method parses all sentences of a text at a time [17]. This method is not flexible as it requires many templates of possible combinations of the sentences in the text. A better method is to parse one sentence at a time and then integrate the results for all sentences. Consider the following problem: *"Consider parallelogram ABCD. The point E is the midpoint of segment AB. F is the midpoint of segment CD. Prove the length of segment DE is equal to the length of segment FB."* This text is segmented into four sentences. Each sentence is matched in InfoMap and the concepts of the sentences are extracted and mapped to JavaSketchpad command, which is then generated. The system needs to map the concepts of a sentence into one or more JavaSketchpad (JSP) commands in order to draw the concepts. The example of *"parallelogram ABCD"* is mapped to the JSP commands in Figure 4. Since there is no parallelogram command in JSP, we have to design a specific multi-step script for drawing a parallelogram.

4. Conclusion

Dynamic geometry environment such as Geometer's Sketchpad is recognized as a tool with great potential educational value. In a DGE, student can see some invariant results, among other varying conditions, under given geometric premises. Unfortunately, it can be difficult for instructors and students to use tools in a DGE to construct dynamic figures. We propose to address this problem by automatically drawing dynamic figures from input problem texts. A system is built for this purpose, using a knowledge base of basic geometry concepts and an inference engine InfoMap to map problem texts into JavaSketchpad scripts. A JavaSketchpad script embedded in a HTML document can be viewed by a browser on the internet.

Acknowledgement

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References

[1] De Villiers, M., 1996, “Some Adventures in Euclidean Geometry”, University of Durban-Westville, South Africa.
[2] De Villiers, M., 2003, “Rethinking Proof with Geometer's Sketchpad 4”, Emeryville: Key Curriculum Press, USA.
[3] Furinghetti, F. & Paola, D., 2003, “To produce conjectures and to prove them within a dynamic geometry environment: a case study”, In N. A. Pateman, B. J. Dougherty, J. T. Zilliox (Eds.), Proc. of the joint meeting PME 27 and PMENA, Vol. 2, pp. 397-404.
[4] Hoyles, C. & Healy, L., 1999, “Linking Information Argumentation with Formal Proof Through Computer-Integrated Teaching Experiences”, In Zaslavsky (Ed.), Proceedings of the 23nd conference of the International Group for the Psychology of Mathematics Education, Haifa, Israel.
[5] Hsu, W. L., Wu, S. H. & Chen, Y. S., 2001, “Event identification based on the information map – INFOMAP”, Proceedings of the 2001 IEEE Systems, Man, and Cybernetics Conference, Tucson, Arizona, USA, pp. 1661-1672.
[6] Knuth, Eric J., 2002, “Teachers’conception of proof in the context of secondary school mathematics”, Journal of Mathematics Teacher Education, 5(1), pp. 61-88.
[7] Koedinger, K., 1998, “Conjecturing and argumentation in high-school geometry students,” In R. Lehrer & D. Chazan (Eds.), Designing Learning environments for developing understanding of geometry and space, Mahwah, NJ： L. Erlbaum, pp. 319-347.
[8] Laborde, C., Kynigos, C., Hollebrands, K., & Strasser, R., 2006, “Teaching and learning geometry with technology”, In A. Gutierrez & P. Boero (Eds.), Handbook of research on the psychology of mathematics education: Past, present and future, Rotterdam: Sense publishers, pp. 275-304.
[9] Lees, B., & Cowie, J., 1996, “Applying natural language technology to the learning of operating systems functions”, Proceedings of the 1st conference on integrating technology into computer science education, pp. 11-13.
[10] Leung, A. & Lopez-Real, F., 2003, “Properties of tangential and cyclic polygons: an application of circulant matrices”, International Journal of Mathematical Education in Science and Technology. 34(6), pp. 859-870.
[11] Li, P. Y., & Chen, J. D., 1988 “A Computer Training Tool Using Chinese Natural Language”, IEA/AIE, Vol. 2, pp. 899-904.
[12] Lu, C. H., Wu, S. H., Tu, L. Y., & Hsu, W. L., 2005, “Ontological Support in Modeling Learners' Problem Solving Process,” Journal of Educational Technology & Society, 8(4), pp. 64-74.
[13] National Council of Teachers of Mathematics, 1989, “Curriculum and Evaluation Standards for School Mathematic”, Reston, VA: NCTM.
[14] National Council of Teachers of Mathematics, 2000, “Principals and standards for school mathematics”, Reston, VA: NCTM.
[15] Talmon, V, & Yerushalmy, M., 2004, “Understanding Dynamic Behavior: Parent-Child Relations in Dynamic Geometry Environments”, Educational Studies in Mathematics, Vol. 57, pp. 91-119.
[16] Whiteley, W., 1999, “The decline and rise of geometry in 20th century North America,” In John Grant McLoughlin (Ed.), Canadian mathematics education study group, St. John’s, NF： Memorial University of Newfoundland, pp. 7-30.
[17] Wong, W. K., Hsu, S. C., Wu, S. H., & Hsu, W. L., 2007, “LIM-G： Learner-initiating instruction model based on cognitive knowledge for geometry word problem comprehension”, Computers and Education Journal, 48(4), pp. 582-601.

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Evaluating the Effectiveness of Multiple Open Student Models in EER-Tutor

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Abstract: Open Student Models (OSM) are beneficial for improving students' domain knowledge and meta-cognitive skills. The way in which the student model is displayed may be an important factor which has not been investigated adequately in the context of Intelligent Tutoring Systems (ITS). In our study, the control group had skill meters, while the experimental group additionally could access the OSM represented as a concept list, concept hierarchy or a concept map. The results show that OSM do have a positive effect on students' learning. However, the students showed clear preferences towards simpler representations than the more complex ones.

Keywords: open student models, constraint-based tutors

Introduction

Student models provide the basis for adaptive instruction, but students are very often not aware of their existence. By opening the student model, the system becomes more user-friendly. More importantly, the OSM serves as a learning tool on its own; by showing the system’s understanding of the student’s knowledge, the student is encouraged to reflect on his/her knowledge. Students are capable of scrutinising their models [4], and are able to understand and control the adaptation. OSMs engage students in thinking about their own knowledge, thus involving the student at the meta-cognitive level. Studies show that OSMs raise students’ awareness of their knowledge and encourage reflection [2, 3, 7, 10, 11].

OSMs have been used in a variety of systems, ranging from the text editors [5] to ITSs [1, 11]. In some cases, developing the open student model is the primary activity the student is involved with (e.g. [6]). The actual representations used for OSM range from simple skill meters, represented as progress bars indicating the percentage of material a student has learned for a particular topic or concept [1, 2, 11], to more complex representations. A concept/topic hierarchy is a tree structure built on the basis of conceptual relationships in a domain [5, 9, 10]. Concept maps have also been used for OSM [6, 13], but they are more complicated and may be difficult to design and understand [9].

Any visualization chosen for the OSM has pros and cons, and might be preferable in terms of domains, system types, educational goals, and students’ knowledge levels. Therefore the use of *multiple* visualizations for the OSM may be more preferable for both educators and learners [8]. Recently, Mabbott and Bull [10] investigated the effect of multiple presentations of the OSM, and note that students show appreciation of OSM and do have preferences for a particular presentation. However, their study was done in a context of a simple educational system, where students answered multiple choice questions. Our study focused on the effect of multiple OSMs in an ITS, where the primary student activity is problem solving. We compared skill meters, a simple representation of the student model, to three other representations: concept list, concept hierarchy and concept map. The study was done in the context of EER-Tutor, a constraint-based tutor that teaches conceptual database design [14, 15]. Domain knowledge is represented in terms of constraints [12], and the student model shows how much the student has learned. The OSM is shown on request, in the form of eight skill meters representing the student’s progress on the major components of the EER model. The length of a bar indicates the relative amount of knowledge (in terms of constraints) for that particular component. The bar is divided into three distinct sections. The first (green) section represents correct knowledge (i.e. the percentage of relevant constraints that the student used correctly). The second (red) section gives the measurement of misconceptions, by presenting the percentage of relevant constraints that the student has not learnt, and the last (white) section shows the percentage of relevant constraints the student has not used at all. In addition to the skill meters, the OSM also presents two numerical indicators for each component, one for covered knowledge, and the other for correctly learned knowledge. We define *covered* as the fraction of the constraints relevant for the particular component the student has used over all relevant constraints for that concept. *Learned* is calculated as the fraction of relevant constraints the student has used correctly over all relevant constraints.

1. The Study

Although skill meters are easy to understand, they do not provide details and need to be complemented by other views of the OSM. We designed three additional visualizations of the OSM: concept list, concept hierarchy and concept map. In all three of them, we show the covered and learnt percentages, calculated as specified in the previous section. The concept list represents the full list of domain concepts represented as skill meters. A concept hierarchy shows all the concepts, and additionally shows the relationships between concepts, thus providing more information about the domain structure.

Some relationships among EER concepts are intricate and require a map-like view to visualize them. We have designed an EER diagram to represent the concept map of EER domain. By examining this EER diagram, students have a chance to enhance their meta-cognitive skills, learn about the domain, and study an example of EER modelling.

We conducted a study in March 2009 at the University of Canterbury, with students taking an introductory database course. The control group was given access to the original EER-Tutor, which presented only skill meters. In contrast, the experimental group used the EER-Tutor with extended OSMs. We wanted to see whether students show any preferences over the new OSMs, and also whether elaborate OSMs affect student learning.

The students started with a pre-test, followed by problem solving. To promote the use of OSM, the student model was shown at the beginning of each session. The participants could access EER-Tutor for three weeks, and then post-test and a questionnaire were administered. Table 1 presents the results, which show that the groups had similar pre-existing knowledge, spent comparable times with the system, and viewed/requested the OSM similar number of times (*Viewings total/Viewings self*). The amount of time they spent viewing the OSM (*Viewing time*) is also similar.

Only 36 students completed the post-test. We analyzed the pre-test results for only those 36 students, and the t-test reveals no difference (*Pre-test - subset*). There is also no significant difference on the post-test. The performance of the control group did not increase significantly between pre- and post-test, but there was a significant improvement for the experimental group (p=0.04). The experimental group learned more than the control group. Using normalized gains, calculated as (post-test – pre-test)/(100 – pre-test), the effect size (Cohen’s d) is 0.22. Although the effect size is small in the absolute value, it is still important, as the only difference between the two groups is the OSM provided and it still resulted in an improvement for the experimental group.

Table 1. Some statistics from the study (sd given in parentheses)

	Control (42)	Experimental (44)	p
Pre-test (%)	61 (24)	53 (25)	ns

Interaction time (min)	353 (304)	327 (253)	ns
Viewings total	18.6 (13.1)	15.3 (10.9)	ns
Viewings self	2.3 (2.4)	2.5 (3.7)	ns
Viewing time (min)	4.2 (7)	4.9 (8.5)	ns
# Post-test completed	19	17	
Pre-test - subset (%)	63 (24)	57 (18)	ns
Post-test mean (%)	69 (15)	68 (16)	ns

27% of the experimental group never requested to see the OSM, while that percentage for the control group is 23%. The experimental group participants spent more time on concept hierarchy, compared to concept list and concept map, although the differences are not significant. The average numbers of viewings were similar for the three presentation styles, but the concept map was the least popular.

The questionnaire replies show 72% of the control and 75% of the experimental group participants found OSM useful for their learning. Students were also asked whether the OSM correctly reflected their ability in solving EER problems. 53% of the control group thought the OSM was correct, compared to 80% of the experimental group; the difference is marginally significant (Fisher's exact test, p=0.1). Therefore, the more detailed OSM was more believable. The experimental group showed different preferences over the views we provided, with the majority favouring skill meters (53%) due to their simplicity, and no one preferring the concept map. These initial results are encouraging, and we plan to perform additional studies in the future.

References

1. Aleven, V., Koedinger, K.: Limitations of Student Control: Do Students Know When They Need Help? In Gauthier, G., Frasson, C., and VanLehn, K. (Eds.) *Proc. ITS 2000*, pp. 292-303 (2000)
2. Bull, S.: Supporting Learning with Open Learner Models. *Proc. ICTE 2004*, pp. 47-61 (2004)
3. Bull, S., Hghiem, T.: Helping Learners to Understand Themselves with a Learner Model Open to Students, Peers and Instructions. *Proc. ITS 2002*, pp 5-13 (2002)
4. Czarkowski, M., Kay, J.,Potts, S.: Scrutability as a core interface element. In: C-K Looi, G. McCalla, B. Bredeweg, J. Breuker (Eds.) *Proc. AIED 2005*, IOS Press, pp. 783-785 (2005)
5. Cook, R., Kay, J.: The Justified User Model. *Proc. UM 1994*, pp 145-150 (1994)
6. Dimitrova, V.: StyLE-OLM: Interactive Open Learner Modelling. *Artificial Intelligence in Education*, 13 (1), 35-78 (2003)
7. Kay, J.: Learner Know Thyself: Student Models to Give Learner Control and Responsibility. In Halim, Z., Ottomann, T., Razak, Z. (Eds.) *Proc. ICCE 1997*, pp.17-24 (1997)
8. Mabbott, A., Bull, S.: Alternative Views on Knowledge: Presentation of Open Learner Models. *Proc. ITS 2004*, pp. 689-698. Springer-Verlag (2004)
9. Mabbott, A., Bull, S.: Student Preferences for Editing, Persuading and Negotiating the Open Learner Model. *Proc. ITS 2006*, pp.481-490 (2006)
10. Mabbott, A., Bull, S.: Comparing Student-Constructed Open Learner Model Presentations to the Domain. R. Luckin et al. (Eds.) *Proc. AIED 2007*, 281-288. IOS Press (2007)
11. Mitrovic, A., Martin, B.: Evaluating the Effect of Open Student Models on Self-assessment. *Artificial Intelligence in Education*, 17(2): 121-144 (2007)
12. Ohlsson, S.: Constraint-Based Student Modeling. *Student Modeling: the Key to Individualized Knowledge-based Instruction*, pp. 167–189, Springer-Verlag (1994)
13. Perez-Martin, D., Alfonseca, E., Rodriguez, P., Pascual-Nieto, I.: Automatic Generation of Students Conceptual Models from Answers in Plain Text. *Proc. UM 2007*, pp. 329-333, Springer-Verlag (2007)
14. Suraweera, P., Mitrovic, A.: KERMIT: A Constraint-Based Tutor for Database Modelling. In Cerri, S. A., Gouarderes, G., Paraguacu, F. (Eds.), *Proc. ITS 2002*, pp. 376–387, Springer-Verlag (2002)
15. Zakharov, K., Mitrovic, A., Ohlsson, S.: Feedback Micro-Engineering in EER-Tutor. In Looi, C.-K., McCalla, G., Bredeweg, B., Breuker, J. (Eds.) *Proc. AIED 2005*, pp. 718–725, IOS Press (2005)

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A Tutoring System Using an Emotion-Focused Strategy to Support Learners

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Abstract: Many tutoring systems have employed problem-focused strategies for helping students regulate their emotional states. This paper describes an affective tutoring system that added an emotion-focused strategy (a relaxation exercise) to a standard problem-focused strategy (programming advice and feedback) in order to help students better regulate their emotional states when learning about data structure manipulation.. The evaluation indicated that this additional strategy improved learning outcomes and was helpful in emotionally supporting students with both good and poor performance.
Keywords: e-learning, affective tutoring system, emotion-focused strategies

1. Emotions and learning

Theories of achievement and motivation argue that emotions are central to learning because they affect cognitive function as well as motivation and engagement [9]. Emotions mediated by appropriate attention, self-regulation and motivational strategies can lead to positive effects on learning and achievement [10]. Emotion regulation is the process of modulating and managing an individual's emotional state [7]. Regulation activities, ideally, are directed towards achieving the person's goals and remediating or moderating any overly intense of negative or positive emotions. Lazarus classified the strategies used by individuals to deal with their emotional state into two categories [7]:

- An *emotion-focused strategy* refers to thoughts or actions whose goal is to relieve the emotional impact of stress. They are mainly palliative in the sense that such strategies do not actually alter the threatening domain or damaging environment but are aimed to just make the person feel better [7].
- A *problem-focused strategy* is the second category employed in regulating emotional states. [7] Refers to problem-focused strategies as active or as direct cognitive or adaptive behavioural efforts to work on the problem itself. They involve attempting to change the problem by generating and implementing options and steps to solve or make the problem less problematic [10].

2. How effective is an emotion-focused strategy applied by a tutoring system?

Many tutors have employed emotion regulation strategies, see e.g. [3]. The goal of this study was to explore whether the simple addition of an emotion-focused strategy to a tutor for undergraduate level data-structures produced enhanced learning outcomes and/or an enhanced sense of well-being in the students.

The study used a between-subjects methodology (N = 68) based on an experimental and a comparison group. Both groups were exposed by the tutoring system to the same problem-focused strategies (e.g. help and advice), but only the experimental group was exposed to the emotion-focused strategy. The experimental group is thus referred as the EF+PF group (emotion-focused *and* problem-focused strategies) and the comparison group is referred as the PF (problem-focused *only*) group. The relaxation exercise undertaken by the EF+PF group was a shorter version of Jacobson's and

Benson's relaxation techniques [2] which concentrated on the upper limbs only. Here we report only on the affective outcomes of the evaluation, *as the increased learning gains* for the EF+PF group have already been described [11].

There was a period of pre-testing for (i) skill in solving data-structure problems and (ii) to establish the initial sense of well-being of the students using the PANAS questionnaire [12]. As an initial part of the EF strategy, the EF+PF experimental group were trained in relaxation methods and undertook a relaxation exercise while the comparison PF group sat quietly. Both groups were asked whether they had experienced any change in their sense of well-being and then they worked through the same four lessons on data-structures in the same order. Each lesson posed a data-structure based programming problem that the students had to complete within a fixed time, and both groups received the same kind of problem-focused feedback on the quality of their answers. At the end of each lesson the experimental group undertook another relaxation exercise while the comparison group again sat quietly. After that both groups were again asked whether there had been any change in their sense of well-being since the previous lesson. After the four lessons were completed, both groups were post-tested for their skill in solving data-structure problems and for their final state of well-being, again using the PANAS questionnaire.

3. Results

Pre-Post: The sense of well-being of both groups as measured by the PANAS questionnaire declined over the course of the experiment, but there was no significant difference in the degrees of decline between the EF+PF group (mean= -0.38, SD 0.68) and the PF group (Mean -0.19, 0.48), (Mann-Whitney test U =1502.0, p >0.05, r = 0.36).

Table 1: Changes in the students' reported states of well-being during the experiment

Measures of change of state of well-being (during the experiment) all based on answers on a 5 point scale	**Comparison of the PF and EF+PF groups**
After the primary reaction stage after the initial relaxation exercise	PF = 0.14, EF+PF = 0.43, **Significant** **(**U =450.0, p <0.05, r = 0.26)
After the secondary reaction stage at the end of each lesson for those who **completed their lessons successfully**	PF = 0.20 EF+PF = 0.76, **Significant** (U=1421.0, p <0.05, r = 0.23)
After the secondary reaction stage at the end of each lesson for those who **failed to complete their lessons successfully**	PF = -0.21, EF+PF = 0.77, **Significant** (U=4325.0, p <0.05, r = 0.43)

During the experiment: At the start of the experiment, but before the data structure lessons began, the EP+PF students were trained in and undertook the relaxation exercise while the PF group sat quietly doing nothing. Following this both groups were asked to report any change in sense of well-being on a 5 point scale (-2 to +2). The EF+PF group reported (mean 0.43, SD 0.46) a significantly better (p <0.05) change in their state of well-being than the PF group (mean 0.14, SD 0.36), see Table 1.

At the end of each lesson, any change in state of well-being was again requested using the same online question. Because students had different degrees of success with their lessons, some completing a lesson successfully and some not, the following analysis examined each outcome separately. We had assumed that a student who completed lessons successfully would generally be in a more positive state of well-being and might not improve further as result of the EF strategy. We had also assumed that one who did not complete a lesson successfully would generally be in a more negative state of well-being, but might be cheered by the EF strategy. In fact both those in the EF+PF group who completed their lessons successfully and those in the EF+PF group who did not complete their lessons successfully showed significant positive changes in their self-reported sense of well-being, see Table 1.

4. Conclusion

Students in the EF+PF group showed greater learning gains than those in the PF group [11]. While there was no overall difference in pre-post change of well-being between the two groups by the end of the experiment as measured by the PANAS scale, there were differences between the two groups for each actual lesson, both for those students who had completed a lesson successfully and for those had done badly in that lesson. In other words doing the relaxation exercise to some extent improved the positive effects of completing lesson successfully as well as mitigated the negative effects of having done badly through failing to write the program correctly.

References

[1] Baker, J. P., Berenbaum,H. (2008). The Efficacy of Problem-Focused and Emotional Approach Interventions Varies as a Function of Emotional Processing Style *Cognitve Res 32, 66-82*.

[2] Benson, H. M., Wilcher, B., G., Huggins, E., Zuttermeister, M. E., Myers, P. C., & Friedman, R,. (2000). Academic performance among middle school students after exposure to a relaxation response curriculum. *Journal of Research and Development in Education, 33(3*).

[3] Conati, C., & Zhou, X. (2002). Modelling students' emotions from cognitive appraisal in educational games. *In International Conference on Intelligence Tutoring System. Biarritz, France.* Retrieved October, 2004, from http://www.cs.ubc.ca/~conati/my-papers/its2002.pdf

[4] Cornelius, R. R. (1996). The science of emotions: *Research and tradition in the psychology of emotion*: Prentice Hall.

[5] D'Mello, S., Graesser, A., & Picard, R. (2007). Toward an affect-sensitive AutoTutor. *IEEE Intelligent Systems, 22*(4), 53-61.

[6] Gross, J. J. (1999). Emotion and emotions' regulation. In L. A. Pervin, & John, O. P. (Ed.), *Handbook of Personality: Theory and Research (2nd Edition) (pp. 525-552). New York: Guildford.*

[7] Lazarus, S. R. (1991). Emotion and Adaptation: Oxford U. Press.

[8] McQuiggan, S. W., Lee, S., & Lester, J. C. (2007). Early Prediction of Student Frustration. In A. Paiva, R. Prada & R. W. Picard (Eds.), *Affective Computing and Intelligent Interaction: Second International Conference, ACII 2007, Lisbon, Portugal, Proceedings* (Vol. Lecture Notes in Computer Science 4738): Springer.

[9] Mesquita, B., Frijda, N. H., & Scherer, K. R. (1997). Culture and emotion. In P. Dasen, & Saraswathi, T. S. (Ed*.), Handbook of cross-cultural psychology (Vol. 2, pp. 255-297).* Boston: Allyn & Bacon.

[10] Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: *a program of qualitative and quantitative research. Educational Psychologist, 2(37), 91-105.*

[11] Yusoff, M. Z. & du Boulay, B: (2009). Can relaxation exercises improve learning? *The International Conference on Artificial Intelligence in Education (AIED2009), Brighton, IOS press*

[12] Watson D, Clark. L., & Tellegen A. . (1988). Development and validation of brief measures of positive and negative affect: the PANAS scales. *Journal of Personality and Social Psychology*, 54, 1063 –1070

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Experimental Study for Design of Computational Learning Support to Enhance Problem Posing

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Abstract: In the learning of problem posing, even though it is difficult for learners to generate diverse problems by associating and combining various situations expressed in problem texts and mathematical structures of solutions, they must do so. To design supporting methods for expanding the variety of problems, it is crucial to understand the types of problems that learners have difficulty in posing, and to draw crucial elements to facilitate diverse problem posing. We conducted an experimental investigation to obtain the empirical data of the variety of mathematical word problems posed by novice participants. The results indicated that the participants posed only a few problems that had situations identical to and solutions different from given base problems. It was also revealed that the problems constructed by the participants based on their own ideas were relatively simple and inappropriate. These results suggest that idea generation support for constructing solution structures of problems is effective in expanding the variety of problem posing.

Keywords: Mathematical learning, problem posing, production task, computational learning support strategies

Introduction

In general mathematical learning, students solve many problems provided by teachers or textbooks. But besides problem solving, problem posing has also been identified as an important activity in mathematics education [5]. In fact, recent studies in educational systems have adopted problem posing as a learning task or have approached to problem posing support (e.g., [3, 4, 6]).

Problem posing is a production task that requires idea generation. In problem posing, learners have to generate new ideas because new problems cannot be composed only from given information in the task. In the learning of problem posing, it is critical for learners to pose diverse problems, but it is also difficult for them. The problems generated by novice learners lack diversity [1]. Thus, supporting strategies must be designed to promote diverse problem posing for learners, and that need a method to describe the variety of ideas in it. In this study, the variety of problems is described in the dimensions of two attributes: contextual settings expressed in problem texts (*situations*) and mathematical structures in problem solutions (*solutions*). Analogy research in cognitive science focuses on these two attributes of the surface and the structural features of problems as key factors in human problem posing (e.g., [2]). They are also essential in problem posing.

To design supporting methods for the learning of problem posing, it should be an indispensable approach to understand problem posing from the viewpoint of the variety. This study experimentally investigated problem posing to obtain empirical data of the variety of problems posed by novices. We then discussed the difficulties in the problem posing and crucial elements in computational supporting approaches.

1. Experimental Investigation

Our investigation was conducted in a cognitive science class that included topics related to creativity. Undergraduates participated in two problem posing tasks. In each task, they were asked to pose as many new problems as possible from given problems as bases, and to write their texts and solutions on provided sheets in 20 minutes. In Task 1, a word problem solved by a unitary equation was presented as a base, and Task 2 used another problem solved by simultaneous equations. Prior to starting the tasks, the participants were strongly encouraged to pose diverse and unique problems.
The problems posed by the participants were classified into four categories shown in Figure 1, which denoting similarities in the two dimensions, by judging whether their situations and solutions were identical to or different from the bases.

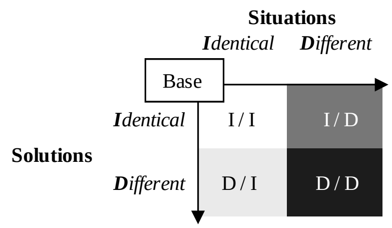

Figure 1. Categories for evaluating the variety of problems

2. Results and Discussion

Seventy six participants posed 146 problems in Task 1, and 73 participants posed 151 in Task 2. In data analysis, problems that were not solved by equations (29 in Task 1 and 39 in Task 2) and those that were unsolvable due to insufficient problem conditions (five in Task 1 and one in Task 2) were excluded. The following results include 112 problems in Task 1 and 111 in Task 2.

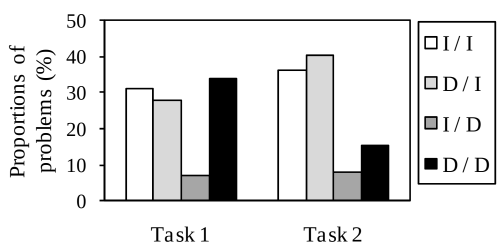

Figure 2. Proportions of posed problems in each category

Figure 2 indicates the proportions of the posed problems in each category in Tasks 1 and 2. Many problems in I / I and D / I were posed, but problems in I / D were few. The results of the two tasks were different in problems in D / D; many were posed in Task 1 and few in Task 2. These results revealed that posing problems in I / I and D / I was easy for the participants. They also posed problems in D / D to some extent, although the extent depended on the problem domains. On the other hand, problems in I / D were few in both of the two tasks. These facts confirm that it is difficult or unfamiliar for novices to pose new problems by only altering the solutions while controlling the situations.

To pose problems in I / D and D / D, the participants had to construct novel solutions by altering solutions of the bases in some ways. To do so, they partially altered the solutions of the bases by adding or removing operations, or they overall altered the solutions by constructing solution structures entirely different from the bases. Actually, 80.4 % of the problems in I /D and D / D were posed by the overall alteration in Task 1, and 65.4 % in Task 2. The participants may have tried to generate their own ideas entirely different from the bases because they had been encouraged to generate unique ideas. Thus, we have to examine the features of the solutions constructed based on the participants' own ideas from the aspect of solution complexity. Figure 3 indicates the proportions of the overall altered problems whose operations in the solutions increased more than bases in the tasks, whose operations were the same as the bases and whose operations decreased more than the bases. As the figure shows, half of the problems decreased the numbers of operations; that is, many problems were simpler than the bases. Particularly in Task 1, the operations for the absolute terms increased and those for the coefficients decreased, indicating that the participant problems had many numeric values but few descriptions related to their answers. Such problems were not excellent or appropriate as problems solved by setting up equations by extracting mathematical relations about answers. The participant problems varied from the bases but didn't necessarily successfully generate good ideas, although good responses in problem posing do not always generate problems with many solution steps. They may not have had sufficient ideas to adequately alter the solutions in problem posing. Based on these findings, to expand the variety of appropriate problem posing of novice learners, we need to design methods to support learners' idea generation for altering solutions.

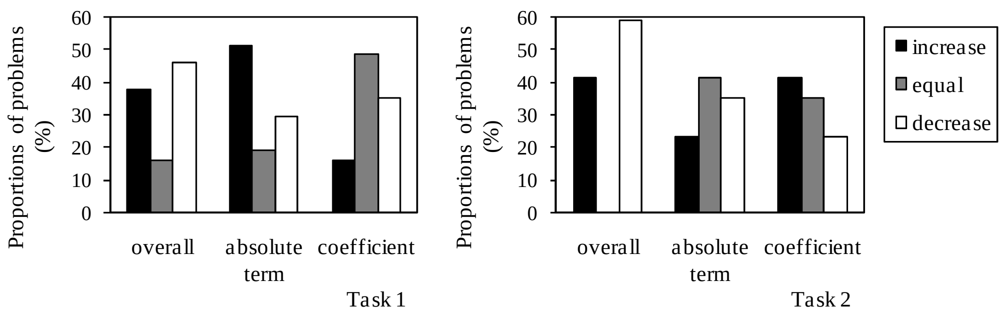

Figure 3. Proportions of overall altered problems increasing or decreasing operations

References

[1] English, L. D. (1998). Children's problem posing within formal and informal contexts. *Journal for Research in Mathematics Education*, 29(1), 83-106.

[2] Forbus, K. D., Gentner, D., & Law, K.. (1995). MAC/FAC: a model of similarity-based retrieval. *Cognitive Science*, 19(2), 141-205.

[3] Hirashima, T., Yokoyama, T., Okamoto, M., & Takeuchi, A (2006). Interactive learning environment by posing arithmetical word problems as sentence-integration. *ICCE2006 Workshop Proceedings of Problem-Authoring, -Generation and -Posing in a Computer-Based Learning Environment* (pp. 1-8).

[4] Kojima, K., & Miwa, K. (2008). A system that facilitates diverse thinking in problem posing. *International Journal of Artificial Intelligence in Education*, 18(3), 209-236.

[5] Silver, E. A. (1994). On mathematical problem posing, *For the Learning of Mathematics*, 14(1), 19-28.

[6] Yu, F., Liu, Y., & Chan, T. (2005). A web-based learning system for question-posing and peer assessment. *Innovations in Education and Teaching International*, 42(4), 337-348.

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Designing an Interactive and Visual Environment for Term Paper Grading Support System in Higher Education

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Abstract: The author has already developed and evaluated a term paper grading assistance map. The map was designed to visualize scores graded for term papers assigned to a class at the university level or the equivalent. The map is a new visualization technique to show the amount of words and word use. This paper introduces prototype system of an assistance map using singular value decomposition technique for grading term papers and proposed five core ideas to improve that system's use.

Keywords: Visualization, Natural Language Processing, Term Paper Scoring, Higher Education, Human-Computer Interaction

1. Introduction

Contemporary university education strives to nurture in students a wide range of abilities regarding writing, including comprehension/explication and production of essays. In recent years the physical burden placed on university instructors related to the grading of "term papers" submitted by students has clearly been increasing (Tsubakimoto et al. [1]), which in turn has created a need for seeking improved methods for the grading of term papers at universities.Concerning grading methods for term papers submitted in large numbers as well, Deerwester et al. [2] have been testing the use of Latent Semantic Analysis (hereafter "LSA"), not only for grading written term papers, but also for the guidelines for their production and comprehension/explication, and several important related experiments have also been carried out in Japanese. LSA is a type of vector space method which makes possible the expression through multidimensional vector spaces of not just terms and documents, but also topics and sentences. Through the application of LSA it is possible to create clusters from the frequency of similar items in document content, which in turn promises to make the grading of large volumes of term papers more efficient.

The significance of visualization of the degree of similarities within documents lies in the fact that the text grader can display, in an easily understood form, large amounts of usable information, and thus makes possible quick access to these items (Landauer et al.[3]).

2. Designing Interactive Environment for Term Paper Grading

2.1. Past Studies

Tsubakimoto et al. [4] used the visualization method developed by Deerwester et al. [2] to create a two-dimensional map visualizing report contents and scores (hereafter "D map"), and investigated the possibility of its application to term paper grading assistance. However, the visualization information previously handled by Tsubakimoto et al. [5] concerning term papers written in Japanese by Japanese university students was limited in terms of question forms and holistic evaluation criteria because the students were made to use selected keywords, and therefore the knowledge gained from the results was confined to a limited range. Consequently, there was inadequate verification of the effects on visualization results when other question forms or evaluation criteria were employed.

2.2. Visualizing Term Papers and its Scores

The author developed the term paper-grading assistance map shaped as a circular cone (see **Figure 1**).First, the author visualized the pre-graded term papers by colored dots: red indicates grade A; orange indicates B; green indicates C; and blue indicates D. Second, the authors visualized the important words for the theme of term papers on the left arc. Actually, there are noteworthy aspects in Deerwester et al. [2]'s map; (1) If the document leaves from the original point of the map, the word quantity which included in the document becomes many, (2) The document is arranged according to the direction of the word which from original point face to the arc.

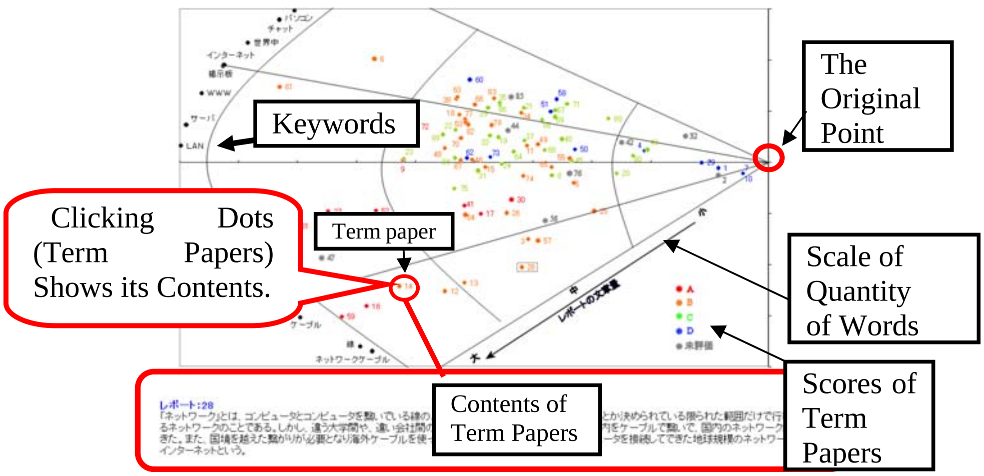

Fig.1 Term Paper Grading Assistance Map (Prototype) []

The author set data of 245 words in matrix X as 100 times frequency and showed all words maintaining every angle from the original point to the left arc automatically. Second, the author selected the 15 most important words and plotted them on the map. These words were as follows: personal computer; chat; all over the world; internet; BBS; WWW; server; LAN; protocol; client; network; computer; cable; line; network cable. Third, the author suggested the scale showing length of each term paper. Kaplan et al. [6] pointed out the holistic score of essays could be predicted by the number of words included in each essay. Therefore, the author estimates something effectiveness about this scale to help term paper grading by human raters. Last, the users can read the contents of the term papers by clicking dots on the map.

2.3. Purpose of This Research

This system is important because it can give users a substantially more efficient and accurate way of grading term papers. This system can significantly reduce the stress of grading [4], save time [4], and remove the error caused by the recency effect [5]. This system is applicable to any level (high schools, universities, etc.) and could be modified so that papers of various languages could be used. The ease, precision, and effectiveness of this system translates into a cost-saving procedure for employers who desire their teachers to spend less time grading and more time performing other tasks, such as research and teaching. In this research, the author focuses on a more practical and useful implementation

of this system based on the prototype system. The prototype's functions were limited because it was developed for an educational experiment, not for practical use. If evaluators want to use the prototype for their practical grading work, they must use extra tools or software, such as Microsoft Excel, to record each term paper's grade.
Therefore, the author proposes the development of a term paper grading support system for more practical use. Some specified ideas are as follows:

- The system will visualize classification results based on calculated similarities among contents of term papers via SVD and tentative grades added automatically by the system on the D map.
- The system will add grades to each term paper and plot those grades on the D map. Human evaluators will be asked to re-grade only those specific papers which require re-grading.
- Human evaluators will be able to re-grade and accommodate their grades for term papers as many times as they want. This function indicates interactivity between human evaluators and the system.
- When human evaluators refresh their D map, the system will show the re-graded information for the term papers. However, the system does not recalculate similarities among contents of term papers, but just change the sign (color) of grades.
- After finishing grades, evaluators will be able to acquire a data table containing grades corresponding to students who wrote the term papers. The accessible data format will be CSV by Microsoft Excel or plain text.

The author is preparing to start developing these features now. After testing the effectiveness of this system, the author is contemplating free public release of this system.

Acknowledgements

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References

[1] Tsubakimoto,M., Yanagisawa,M., & Akahori,K. (2008). A Survey about current holding and assessing the term papers for college teachers specializing in arts and social sciences [in Japanese], *Journal of Multimedia Education*, *5*(2), 121-129.
[2] Deerwester,S., Dumais,S.T., Furnas,G.W., Landauer,T.K., & Harshman,R. (1990). Indexing by latent semantic analysis. *Journal of the American Society for Information Science, 41*(6), 391-407.
[3] Landauer,T.K., Laham,D., & Derr,M. (2004). From paragraph to graph: Latent semantic analysis for information visualization. *Proceedings of the National Academy of Sociences of the United States of America, 101*(1), 5214-5219.
[4] Tsubakimoto,M., Yanagisawa,M., & Akaori,K. (2007). The Development and Evaluation of the Circular Cone Report-Grading Assistance Map which Visualizes Contents of the Reports and its Scores [in Japanese], *Japan Journal of Educational Technology*, *31*(3), 317-326.
[5] Tsubakimoto,M., & Akahori,K. (2007). Development and Evaluation of a Tool to Reduce Recency Effect in Human Report Evaluation [in Japanese], *Japan Journal of Educational Technology*, *30*(4), 275-282.
[6] Kaplan,R.M., Wolff,S.E., Burstein,J.C., Lu,C., Rock,D.A. & Kaplan,B.A. (1998). Scoring Essays Automatically Using Surface Features. Educational Testing Service Research Report, *GRE Board Professional Report No.94-21P*, 98-39.

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Interactive Learning Environment Designed Based on A Task Model of Problem-Posing

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Abstract: Learning by problem-posing is a promising way to learn arithmetic and mathematics. In this paper, we report the design and development of an interactive learning environment for problem-posing as sentence-integration in arithmetic word problems. In this research, we have paid a special attention to "reverse thinking" problems. To find the characteristics of the reverse thinking problems, we built a task model of problem-posing and design the learning environment based on the model. This leaning environment has been already developed and experimentally used in a class of fourth grade at an elementary school.

Keywords: Problem-posing, Task model of problem-posing, Reverse thinking problem

Introduction

Problem-posing is well known as a promising learning method to master the use of solution methods [1]. In the learning by problem-posing, because there are various problems that the learner can make correctly, the way to evaluate the posed problems is an important issue to realize this learning practically. We have been investigating computer-based learning environments that can assess and give feedback to each posed problem [2, 3] (we call this way of assessment as "agent-assessment", in contrast with "teacher-assessment" or "peer-assessment").

MONSAKUN is a learning environment of problem-posing which realized agent-assessment as simple sentence integration for arithmetical word problems that are solved by one operation of either addition or subtraction. In MONSAKUN, one simple sentence is composed of an object or event, an attribute and its value. A learner is provided with a set of simple sentences and is required to pose a problem by selecting and ordering them. This problem-posing process corresponds to "integration phase" of a model of problem-solving process of arithmetical word problems.

In previous version of MONSAKUN, however, only "forward thinking" problems are dealt with. In the forward thinking problem, a story represented in the problem has the same structure with the calculation to derive the answer. The previous version is enough to confirm the possibility of this learning environment through a short term use. However, it can not cover the arithmetical word problems solved by one addition or subtraction because learning of arithmetical word problems includes "reverse thinking" problems as advanced step. In the reverse thinking problem, since the structure of the story and calculation are different, a learner should comprehend the problem more deeply.

In this research, we modeled tasks of problem-posing including "reverse thinking" problems. An interactive learning environment that can deal with the reverse thinking problems have been designed and developed. Moreover, the learning environment is practically used by fourth grade students of an elementary school for the eight lesson times. In this paper, under Section 1, a task model of problem-posing as sentence-integration is introduced. An interactive learning environment has developed based on the model.

Because of page limitation, the implementation and the results of the practical use are omitted.

1. Task Model of Problem-Posing as Sentence-Integration

1.1 Task Model of Problem-posing at Reverse Thinking Problems

In a reverse thinking problem, the story operation and the calculation operation structures are different. Following is an example.

There were seven apples.
Several apples were eaten.
There are four apples now.
How many apples were eaten?

In this problem, the story operation structure is “7-?=4”, and the calculation operation structure is “7-4=?”. Because the two structures are different, a learner is required not only to understand the story but also has to derive the calculation operation structure from the story. This kind of problem is usually called “reverse thinking problem”. In this problem, operations in the story structure and in calculation structure are the same. Therefore, it is not so difficult to derive the calculation operation structure. Here, the operation is consistent in the story operation structure and the calculation operation structure, hence this kind of problem is called “forward operation reverse thinking problem” (called as “forward operation problem”). If the operation is a reverse one, it is called as “reverse operation problem”. Below is an example of the reverse operation problem.

There are several apples.
There are three oranges.
There are seven apples and oranges in total.
How many oranges are there?}

Since the story operation structure is “?+3=7” and the calculation operation structure is “7-3”, we can say the operation is different. This problem is required to derive the calculation operation structure from the story operation structure with the change of the operation. Therefore, a learner often feels difficult to solve this kind of problem.

1.2 Problem-Posing based on the Task Model

Based on the above considerations, we have proposed a task model of problem-posing as sentence-integration shown in Figure 1. The task model of problem-posing consists of following four tasks, (1) deciding calculation operation structure, (2) deciding story operation structure, (3) deciding story-structure, and (4) deciding problem sentences. A learner should complete these tasks to pose a problem correctly though the execution procedure of the tasks is not decided in the model.

In the first step of problem-posing in MONSAKUN, subtraction or addition is selected as a calculation operation. In the second step, a story operation structure is decided. For example, for subtraction, four story operation structures can be selected. Only one story operation structure is same from the calculation operation structure and two of them have different story operation, that is, addition. Because this is an abstract transformation, it is often very difficult for learners.

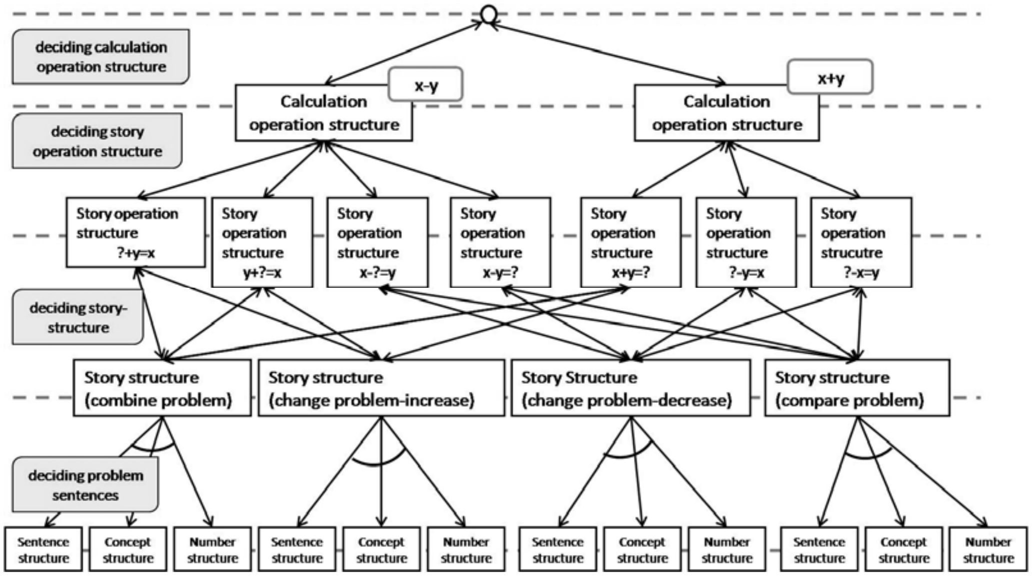

Figure 1. Task model of problem-posing as sentence integration

Arithmetical word problems solved by one addition or subtraction are usually categorized into the following four types: 1) increase-change problem, 2) decrease-change problem, 3) combine problem, and 4) compare problem. For example, decrease-change problem is composed of “existence sentence (there were seven apples)”, “decrease sentence (several apples were eaten)” and “existence sentence (there are four apples now)”. In the phase of deciding story structure, a learner should select one of them.

In deciding problem sentences, sentences are put into the story structure following the story operation structure. This task is divided into three more tasks: deciding sentence structure, deciding concept structure and deciding number structure. The deciding sentence structure means that to select and order sentences following the story structure. For example, if the story structure is the decrease-change, make a sentence structure composed of the existence sentence, the decrease sentence, and the existence sentence in turn.

2. Concluding Remarks

We have already developed MONSAKUN for the reverse thinking problems. We then conducted a practical use of MONSAKUN at formal arithmetic lesson times (8 lesson times) at an elementary school. These results suggested that MONSAKUN is a useful tool to improve student's ability of problem posing and it is accepted by learners and teachers as a useful learning tool.

Acknowledgement

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References

[1] Polya, G. (1945) *How to Solve It*, Princeton University Press.
[2] Nakano, A., Hirashima, T., Takeuchi, A.(1999) Problem-Making Practice to Master Solution-Methods in Intelligent Learning Environment, *Proc. of ICCE'99*, pp.891-898.
[3] Hirashima, T., Yokoyama, T., Okamoto, M., Takeuchi, A. (2007) Learning by Problem-Posing as Sentence-Integration and Experimental Use, *Proc. of AIED2007*, pp254-261.

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Developing an Intelligent Tutoring System for Palm Oil with ASPIRE

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Abstract: Although Intelligent Tutoring Systems (ITSs) have well proven their effectiveness in many learning domains, building them have always required extensive effort and time. ASPIRE authoring system has been used in developing constraint based tutors (CBTs) before but this will be the first attempt to develop a CBT and embed it within an existing system. We present the research and development of DM-Tutor, the first CBT to be embedded within the Management Information System (MIS) for palm oil plantation management. We discuss the research and development of DM-Tutor with the help of ASPIRE. We also include future work planned for DM-Tutor.

Keywords: authoring systems, intelligent tutoring systems, embedded constraint based tutor, DM-Tutor

Introduction

Intelligent Tutoring Systems (ITSs) have provided their effectiveness in increasing learning performance [3]. Over the years, ITSs have been used in various teaching and learning domains. SQL-Tutor [1] and KERMIT [5] are among the many successful constraint-based tutors (CBTs) developed and implemented. Our approach is to develop ITSs using ASPIRE [2], a complete authoring and deployment environment for constraint-based ITSs.

This paper describes the research and development stages of DM-Tutor (Decision-Making Tutor), an ITS for the palm oil domain. Although ASPIRE has been used to develop CBTs before, no previous attempt has ever been made to embed a CBT into an existing live operational system. This will be the main contribution of this paper. This paper is organized as follows. In the next section we describe DM-Tutor. Section two discusses the development of DM-Tutor with the help of ASPIRE. Section three describes conclusions and future work planned for DM-Tutor.

1. DM-Tutor

DM-Tutor is the first ITS to be developed for palm oil plantation management. The aim of DM-Tutor is to provide scenario-based decision making training on real life operational and management challenges for managers of palm oil plantations. DM-Tutor will be embedded within a Management Information System (MIS) [4] currently being used for the palm oil industry in Malaysia. With DM-Tutor embedded within the MIS, students will be presented with real-life management scenarios and would practice making operational analyses with actual plantation data. By practicing with real cases, students would acquire the necessary abilities for improving their decision making skills in the actual plantation management environment. DM-Tutor focuses on three main analyses that are of the biggest concern in palm oil plantation management: yield gap analysis, fertilizer management and yield forecasting.

2. Development of DM-Tutor

ASPIRE assists with the development and implementation of CBTs using a semi automatic process. The development of DM-Tutor is described in five main stages:

The first development step in DM-Tutor is identifying the most suitable pedagogical approach for this domain and the targeted students who would be using DM-Tutor. We modularized DM-Tutor into three tasks: Yield Gap Analysis, Fertilizer Analysis and Yield Forecasting. All the tasks in DM-Tutor are procedural, which means that problem solving has to be carried out in pre-ordered steps and that every step of the problem solving process is important and necessary in order to arrive at the correct solution. We specified all the problem solving steps using the Domain Details tab/window of ASPIRE. We provided additional information to provide clear task descriptions and problem specific instructions for each task.

In the second stage we developed domain ontology for each of the tasks in DM-Tutor using the ontology workspace in ASPIRE. Developing domain ontologies is crucial for the authoring process because it contributes to the building of syntax constraints. In the domain ontology we identified important concepts for each task in DM-Tutor and the relationship between these concepts using a hierarchical structure. A concept may be related to another concept through an *is-a* relationship and this is depicted by the arrows between concepts in the ontology workspace. By creating ontologies we were able to study the domain in greater detail and this enabled ASPIRE to organize constraints in a meaningful way to develop more accurate constraint bases.

In the third stage we modeled the problem and solution structures. DM-Tutor consists of procedural tasks, and each problem-solving step might require several solution components. We specified the problem steps for each task when we developed the domain details in stage 1. As mentioned previously, each solution component comes from the ontology for each task. For palm oil plantations, it is very important to ensure that the amount of fertilizer used in the estates is accurate and cost efficient. Partial Factor Productivity (PFP) and Agronomic Efficiency (AE) are two suitable techniques used to gauge fertilizer or nutrient efficiency that we have included in DM-Tutor. Fertilizer Management analysis in DM-Tutor consists of several problem solving steps. Steps 1 and 2 require students to select the correct formula to calculate PFP and AE so the student has to select the correct formula from the list of formulas available in the solution component. Step 3 of the problem requires the student to calculate PFP and AE for the estate and enter the correct value into DM-Tutor's interface. DM-Tutor will check student's answer in each step and also check to see if students accessed the relevant fertilizer consumption information from the MIS. If the student's solution for any step is incorrect, DM-Tutor will give increasing levels of feedback that would help guide the student to the correct solution before allowing her/him to proceed to the next step of problem solving.

In the fourth stage ASPIRE generated the default interface for DM-Tutor automatically, from the information provided in the solution structure and the ontology. DM-Tutor's student interface is divided into three parts. The top pane is where the problem statement is placed, so that students always know the problem they are attempting. The bottom pane presents the solution workspace where students need to work on their solutions to the problem and the side pane is used to provide feedback to the students on the problems they are attempting. The interface design for DM-Tutor is aimed at reducing memory load of the students. Currently DM-Tutor provides a textual interface where students are expected to provide text based input. DM-Tutor's tasks require students to access various reports and analyses of the MIS. This is necessary as the information required for solving problems in DM-Tutor comes from the MIS.

In the next stage ASPIRE generated constraints. Syntax constraints are generated by ASPIRE based on the domain ontologies we created earlier. The syntax constraint generation algorithm extracts all useful syntactic information from the ontology, such as the restrictions on concepts, properties and relationships with other concepts [6]. This is then translated into constraints. Each constraint checks that the relevance condition and satisfactory conditions of the constraint are not violated. Since DM-Tutor consists of procedural tasks ASPIRE created additional set of constraints called path constraints. This was necessary in order to ensure that problem solving occurs in the correct order. Semantic constraints are generated by ASPIRE based on the solutions we provided for each problem in DM-Tutor. Semantic constraints look for semantics or meaning based on errors in students' solutions enabling DM-Tutor to model alternative correct solution approaches.

3. Conclusions

In this paper we demonstrated how we developed DM-Tutor, an ITS for the palm oil domain with the help of ASPIRE, an authoring system that assists in the development and deployment of CBTs. Based on the domain characteristics we specified in DM-Tutor, ASPIRE was able to create the domain model for DM-Tutor. Developing ontologies by identifying concepts, their properties and the relationships between concepts was a very important step in the development of DM-Tutor as this enabled ASPIRE to generate constraints and an accurate constraint base as well. After ensuring that the information supplied for DM-Tutor was complete and consistent, DM-Tutor was successfully deployed as an ITS.

There are many potential research benefits in embedding ITSs with live systems and we hope to demonstrate that through our research. We have planned for DM-Tutor to be evaluated by users of different knowledge levels including students, trainee managers and managers in the palm oil industry. Upon completion of our research, we hope to demonstrate the potential of ITSs in increasing workplace training and efficiency.

References

[1] Mitrovic, A. (2003) An intelligent SQL tutor on the Web. *International Journal Artificial Intelligence in Education*, vol. 13, no. 2-4, 173-197.

[2] Mitrovic, A., Martin, B. Suraweera, P., Zakharov, K., Milik, N., Holland, J., McGuigan, N. (2009) ASPIRE: An Authoring System and Deployment Environment for CBTs. *International Journal Artificial Intelligence in Education, vol 19, no 2, 155-188.*

[3] Ong, J. & Ramachandran, S. (2003). Intelligent tutoring systems: Using AI to improve training performance and ROI. Stottler Henke Associates. http://www.stottlerhenke.com/papers/ITS_Using_AI_to_improve_training_performance_and_ROI.pdf

[4] Ravan, S. (2007). MIS for Palm Oil. RANN Consulting. http://www.rann-consulting.com

[5] Suraweera, P., Mitrovic, A. (2002). KERMIT: a CBT for Database Modeling. In: S. Cerri, G. Gouarderes and F. Paraguacu (eds.) *Proceedings of the 6th International Conference on Intelligent Tutoring Systems*, Biarritz, France, LCNS 2363, 377-387.

[6] Suraweera, P., Mitrovic, A, Martin, B.(2004) The use of ontologies in ITS domain knowledge authoring. In: Jack Mostow and Patricia Tedesco (eds), Proc. 2nd Int. Workshop on Applications of Semantic Web for E-learning, ITS 2004 conference (http://wwwis.win.tue.nl/SW-EL04/), pp. 41-49, Maceio, Brazil.

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Mining Collective Knowledge for Reconstructing Learning Resource

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Abstract: There currently exist a lot of Web resources, which are useful for learning. However, it is hard for learners to learn the Web resources since the hyperspace is not always well-structured. Our approach to this issue is to mine collective knowledge from a group of learners who learned the Web resources to reconstruct the hyperspace including useful pages and links to be learned. This paper proposes a collective knowledge mining method that can extract these pages and links from learning histories gathered from the group of learners.
Keywords: Collective Knowledge, Mining, Hyperspace, Learning Resource Reconstruction

Introduction

There currently exist a lot of hypermedia/hypertext-based resources on the Web, which are useful for learning. Such Web resources generally provide learners with hyperspace, which consists of Web pages and their links. In the hyperspace, the learners can navigate the pages in a self-directed way [1][6]. Such self-directed navigation involves constructing knowledge, in which the learners would integrate the contents learned at the navigated pages [6].

However, there are the following problems with regard to hyperspace provided by a Web resource. First, the hyperspace could be navigated/learned in multiple goals. It might accordingly become difficult for learners to follow their own learning goal to learn. The hyperspace is also too huge to learn, and is not always well-structured.

Our approach to these problems is to reconstruct the hyperspace so that the learners can readily navigate and learn the pages to achieve their learning goal. This paper proposes a method of mining collective knowledge from a group of learners who have learned the same Web resource with the same goal to reconstruct the hyperspace [5]. In order to obtain such collective knowledge, this paper demonstrates a learning history mining, which can extract pages and links useful for learning, with learning histories that could be gathered from the group of learners.

1. Framework

Figure 1 shows the framework for reconstructing a Web resource with learning history mining. The learning history mining method can extract Web pages and links useful for learning from histories that could be gathered from a group of learners who learned the same Web resource with the same learning goal. Such useful pages and links can be viewed as collective knowledge of the group, which could be instructive for other learners to learn the resource with the goal. In this framework, learning histories are generated with Interactive History system (IH for short).

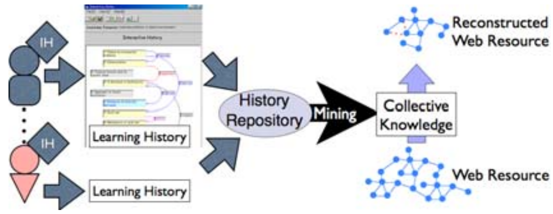


Figure 1.Framework for Web Resource Reconstruction.

The extracted pages and links compose a partial hyperspace of the Web resource as reconstructed resource, which is represented as partial hyperspace map where the partial hyperspace is highlighted on the original hyperspace map. Such representation is informative for learners to achieve their learning goal.

In the following, let us demonstrate IH and learning history mining.

1.1 Interactive History

Learners generally start navigating the Web pages for achieving a learning goal. The movement between the various pages is often driven by a local goal called navigation goal to search for the page that fulfills it. Such navigation goal is also regarded as a sub goal of the learning goal. The navigational learning process includes producing and achieving a number of navigation goals. We refer to the process of fulfilling a navigation goal as primary navigation process (PNP for short) [2]. PNP is represented as a link from the starting page where the navigation goal arises to the terminal page where it is fulfilled.

The knowledge construction process can be modeled as a number of PNPs [4]. In each PNP, learners would integrate the contents learned at the starting and terminal pages. Carrying out several PNPs, learners would construct knowledge from the contents they have integrated in each PNP.

IH monitors learners' navigation in the Web browser to generate the navigation history in the *Annotated Navigation History* window. The learners can make annotations of the PNPs, which they have carried out. (See [3] in more detail.)

1.2 Learning History Mining and Example

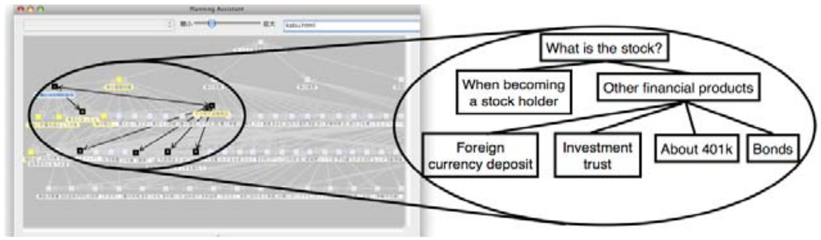
In order to reconstruct a Web resource to help a learner learn, our framework prepares a repository that accumulates annotated navigation histories precedent learners generated with IH. It also generates a set of annotated navigation histories called *focused set* from the repository, which have been generated from the same Web resource as the learner uses and the same learning goal as he/she has. The focused set is inputted into learning history mining.

Each PNP in the focused set is regarded as association rule *Ps->Pt* that represents an association between two learning events in the starting and terminal pages. It means that learning event in the starting page *Ps* is concurrent with learning event in the terminal page *Pt*. In order to extract useful PNPs from the focused set, we introduce the minimum support (*Sth*) as thresholds.

Each annotated navigation history generated from each learner in the focused set is called transaction. The number of the learners in the set becomes the number of transactions. The support value is then calculated as follows:

Support (*Pi->Pj*) = the number of transactions including (*Pi->Pj*)
/ the number of transactions

The higher support value means that more learners carry out the PNP. The learning history mining method basically outputs the PNPs whose support values are higher than *Sth*.



(a) Reconstructed Hyperspace. (b) Highlighted Part of the Hyperspace Map.

Figure 2.An Example of Learning History Mining Result.

The details of the mining are as follows. First, the support value of each PNP included in the focused set is calculated. If the value is less than *Sth*, the PNP is excluded. A set of the first degree PNP is then generated. Second, the support values of the second degree PNPs to be extracted from the set are calculated, and are excluded if the values are less than *Sth*. The second degree PNPs mean the two PNPs connecting via the starting or terminal pages. A set of the second degree PNPs is the generated.

In the same way, a set of (K+1) degree PNPs is generated from a set of K degree PNPs. When the set of (K+1) degree PNPs is not generated, the history mining outputs the set of K degree PNPs as useful pages and links composing a part of the hyperspace.

Figure 2(a) shows an example of the reconstructed Web resource, which was obtained from the focused set that included learning histories generated by 16 graduate and undergraduate students who learned the Web resource (including 85 pages) about stock investment with the goal of learning the basics about the stock investment. *Sth* was 25%. The highlighted part of the hyperspace map in Figure 2(a) shows the sixth degree PNPs (including pages and links) output by the learning history mining, which is represented in detail as shown in Figure 2(b). Such reconstructed hyperspace could facilitate navigational learning process with the same learning goal.

2. Conclusion

This paper has proposed a method of reconstructing Web resources with learning history mining. The important point of this method is to extract useful pages and links from learning histories of a learner group who learned the same learning resource with the same learning goal, which can be viewed as collective knowledge.

In future, we would like to evaluate the effectiveness of the Web resource reconstruction.

Acknowledgements

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References

[1] Hammond, N. (1993) Learning with Hypertext: Problems, Principles and Prospects. In McKnight, C., Dillon, A., and Richardson, J. (eds): *HYPERTEXT A Psychological Perspective*, 51-69.

[2] Kashihara, A., and Hasegawa, S., (2003) LearningBench: A Self-Directed Learning Environment on the Web. Proc. of ED-MEDIA2003, 1032-1039.

[3] Kashihara, A., and Hasegawa, S. (2004) Meta-Learning on the Web. Proc. of ICCE2004, 1963-1972.

[4] Kashihara, A., and Hasegawa, S. (2005) A Model of Meta-Learning for Web-based Navigational Learning. International Journal of Advanced Technology for Learning, 2, 4, ACTA Press, 198-206.

[5] Powers, J.:The Wisdom of Crowds : Why the Many Are Smarter Than the Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations, 2004

[6] Thuering, M., Hannemann, J., and Haake, J. M., (1995) Hypermedia and cognition: Designing for comprehension. Communication of the ACM, 38, 8, 57-66.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Predicting the Difficulty Level Faced by Academic Achievers based on Brainwave Analysis

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Abstract: Students who performed well in their college mathematics subjects, referred to here as *academic achievers*, were divided into two groups according to the self-reported level of difficulty faced by them while performing several programming tasks in LOGO - a programming language using turtle-graphics. It is shown that, to some extent, the level of difficulty of tasks faced by academic achievers can be predicted, based on their measured affective levels of excitement, frustration and engagement. These affective states are measured using brainwaves sensors that are attached to the head of the student. Those who assessed the learning experience as easy tend to have higher levels of excitement than those who reported to have experienced difficulty in learning the language. On the other hand, the level of frustration among those having difficulty with the tasks registered slightly higher frustration levels. Three machine learning algorithms were used to predict whether or not a learner finds the tasks to be easy. The average predictive accuracy is 70%.

Keywords: Learning Environment, Affective Computing, Brainwaves Sensors, Academic Achievers

Introduction

When designing computer assisted learning environments, it is useful to be able to predict the level of difficulty and affective state that a specific learner is experiencing for a specific problem or task. This would guide the learning environment when making corresponding adjustments to the learning module in real time. Indeed, it had been shown that the affective states of learners can be predicted with high accuracy using brainwaves information [3]. Guided by another study conducted by Jausovec [4] that found differences among gifted and non-gifted students in the mental effort that they exert, this study delves into the affective behavior of academic achievers while immersed in a learning activity, and seeks to predict the level of difficulty that they face based on an analysis of their brainwaves. The study focuses on high achieving students as these are the students who would benefit most from self-regulated learning using automated, computer assisted learning environments [1][6].

1. Experiment, Results and Discussion

Based on their cumulative grade point average in their college mathematics courses, 17 undergraduate students (10 males and 7 females) who were among the top 10% of their cohort were involved in this study. Each subject was asked to learn the LOGO language [5] in a single session by watching a tutorial video prior to the performance of each task. The tutorial videos teach the basic commands of the language and the tasks involve drawing of various geometric figures. At the end of each session, a student is asked to assess the level of difficulty of each programming task. Group I (easy) was composed of those who found the tasks to be “easy” or “less than moderately difficult”. Those who found the tasks to be “moderately difficult”, “difficult”, or “very difficult” were placed under Group II (“challenging”).

The whole time that a student is watching a video or performing a task, an EEG sensor is attached to his/her head. Using 14 channels based on the International standard 10-20 locations [7], the EEG sensor is an *Emotiv EPOC*, a commercial product capable of capturing brainwaves signals that translate into three affective states, namely *excitement*, *frustration* and *engagement.* Based on the levels of excitement, frustration and engagement, the experiments were conducted to test the following hypotheses:

i. A learner who finds a task easy would tend to be more excited than someone who finds the task challenging.
ii. A learner who finds a task easy would tend to be less frustrated than someone who finds the task challenging.
iii. A learner who finds a task easy tends to be more engaged than someone who finds the task challenging.

The average levels of the three affective states are presented in Table 1. From these very general, aggregated data, hypothesis i and iii do seem to be plausible. Indeed, those who found the tasks to be easy did seem, on the average, to register higher levels of excitement and engagement while performing the tasks. However, upon closer examination of the data, hypothesis iii may have to be reconsidered.

Table 1. Average excitement, frustration and engagement of the 2 groups of students on all activities.

	Excitement		**Frustration**		**Engagement**	
	Challenging	*Easy*	*Challenging*	*Easy*	*Challenging*	*Easy*
Video	0.45	0.48	0.5	0.59	0.58	0.62
Task	0.44	0.5	0.57	0.57	0.61	0.64
Average	0.45	0.49	0.53	0.58	0.59	0.63

Based on the dis-aggregated data, as shown in Figure 1 and Table 2, only hypothesis i is consistently true for all three tasks, while hypothesis ii holds only for Tasks 2 and 3, and hypothesis iii by the data shown in Figure 1 but not in Table 2. Extending the analysis to include both the watching of videos and performing the assigned programming tasks, the *easy* group tends to be more excited to be assigned programming tasks rather than watching a video - since they register higher excitement and engagement levels. For the challenging group, it is the reverse. As for frustration levels, the students who found the tasks to be easy tend to be more frustrated while watching a video as shown in Figure 1. As for engagement, both groups registered higher engagement levels on programming the tasks than watching videos as shown in Tables 1 & 2 and Figure 1.

On top of the comparisons based on average levels of excitement, frustration, and engagement, the detailed brainwaves data, which were collected from the participants every 3 seconds, were used to predict the level of difficulty that a learner is facing while performing the programming task. The average prediction accuracy was 70% using 3 different WEKA classifiers [2] namely, C4.5 (69.9%), Multilayer Perceptron (70.5%) and Decision Table (69%) with 10-fold cross validation. These classifiers predicted which group, *easy* or *challenging*, a student belongs to. The F Measure of the *easy* group (0.71 - 0.72) is found to be higher than the *challenging* group (0.66-0.68). This may suggest that those students who found most tasks easy to program are more predictable than those who are having difficulty with the tasks.

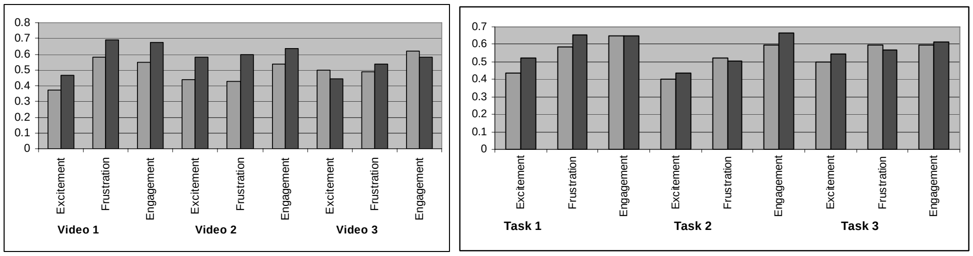

Figure 1. Average affective states for each of the three videos and tasks. Dark bars are for the *easy* group.

Table 2. Outlier percentage for engagement and excitement for each of the three videos and tasks. Low and high outlier is 1 standard deviation from the left and right of the mean, respectively.

	Video						Task					
	Low Outlier			High Outlier			Low Outlier			High Outlier		
Excitement	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Challenging	16.3%	34.1%	30.0%	19.7%	20.4%	27.5%	21.8%	15.3%	23.2%	15.9%	14.9%	18.2%
Easy	25.5%	24.0%	22.0%	16.8%	30.2%	22.7%	17.4%	19.7%	17.8%	19.6%	21.8%	26.8%
Engagement												
Challenging	58.0%	41.7%	36.2%	23.1%	32.5%	29.6%	43.0%	18.3%	19.6%	33.6%	14.1%	22.6%
Easy	40.7%	36.3%	33.3%	27.5%	21.4%	16.5%	40.3%	4.8%	7.0%	25.2%	19.7%	20.5%

2. Conclusion

The academic achievers who were the subjects of this study showed some differences as to their levels of excitement, frustration, and engagement depending on whether they found the tasks to be easy or not. Also, their general affective states differed depending on whether they were passively watching a video or were actively performing some programming task. Moreover, these affective states can be used to predict, with an accuracy of about 70%, the level of difficulty that a learner is facing. Further work would look into the use other input features such as gaze and facial expressions, voice, mouse and keyboard strokes and physiological signals like heartbeat, skin conductance, and body temperature.

References

[1] Ablard, K. and Lipschultz, R. (1998). Self-regulated learning in high-achieving students: Relations to advanced reasoning, achievement goals, and gender. *Journal of Educational Psychology,* 90(1), 94-101.

[2] Hall, M., Frank E., Holmes, G., Pfahringer, B., Reutemann, P. & Witten, I. (2009). The WEKA Data Mining Software: An Update. *SIGKDD Explorations*, 11(1), 10-18.

[3] Heraz, A., Razaki, R., and Frasson, C. (2007). Using machine learning to predict learner emotional state from brainwaves. In *Seventh IEEE International Conference on Advanced Learning Technologies,* 853-857.

[4] Jausovec, N. (2000). Differences in cognitive processes between gifted, intelligent, creative, and average individuals while solving complex problems: An EEG study. *Intelligence,* 28, 213–237.

[5] Mills, G. and Harvey B. MSWLogo. Retrieved from http://www.softronix.com/logo.html.

[6] Risemberg, R., and Zimmerman, B. Self-Regulated Learning in Gifted Students (1992)., *Roeper Review,* 15(2), 98-101.

[7] Sergo, P. (2008). Head Games: Video Controller Taps into Brain Waves. *Scientific American.* Retrieved June 1, 2010 from http://www.scientificamerican.com.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

A Statistical Approach on Automatic Passage Level Checking Framework for English Learner

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Abstract: In this paper, we develop a preliminary research on passage grading system. We propose an approach to examine an English reading passage that meets students' ability and level. CRF has been applied to create a level characteristic model from passage corpus. The system calculates by using three features; word, syllable and sentence complexity. The system does not require manual criteria to grade a passage, but passages are automatically graded by comparing their scores to a model. The output of the system shows a level of passage based on Thai academic school level.

Keywords: grading system, readability, English passage, characteristic model, CRF

Introduction

In ICT community, a large amount of interesting documents are provided in many locations, such as Wikipedia, knowledge sharing, and social network website. However, appropriate reading passages in English class are normally assigned by teacher's decision alone. From the reason, students do not gain their motivation and lose their eagerness to read those passages since the passages apparently do not meet their interest especially for non-native English learners such as Thai. To allow student to use their own passages, teacher otherwise loads more burden to approve an appropriation on those passage level to suit students' ability. Improving reading motivation is another difficult issue for Thai learner. This paper focuses on the questions "How to match between reading passage and student level if students want to select their own reading passage?"

Readability level checking is one of the most important issues in ESL and EFL. Many tools were implemented focusing on this topic such as Kincaid formula, SMOG-grading, Fox index and Flesch reading easy formula. The Flesch reading easy formula [1] was developed by Flesch in 1948 and it is based on school text covering grade 3 to 12. Unfortunately, it has not been updated for a decade. The Kincaid Formula [2] has been developed for grading Navy training manuals. It is accountable in technical document grading because it is based on adult training manuals rather than school book text. The SMOG-Grading [3] is a tool for grading English texts. It has been developed by McLaughlin in 1969. Its result is a school grade. The Fog index [4] has been developed by Robert Gunning. It especially concerns a proper name issue and handles it separately. All of those systems compute a readability score based on syllable, word, and sentence amount and their scores are graded by manually constructed criteria. The purposed system also use those three features but it differs from them in terms of we build a level model automatically with examples of reading passage provided in corpus. Therefore, we do not need to construct a criterion for grading manually.

1. System architecture

In this system, there are two main processes; training and testing process. For determination of passage level, three features of English information are focused in this work; syllable, word, and sentence complexity score. System overview is shown in Figure 1.

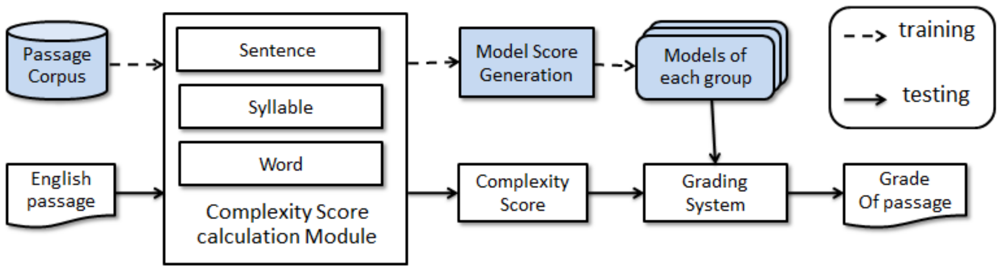

Figure 1. System overview of training characteristic model

For training, English passage corpus is separated by level regarding to Thai academic system (grade 1-12). Pre-processes, which are sentence segmentation and word segmentation, are required to handle data. Sentence list is computed for a sentence feature in sentence complexity module. Word list is calculated for a word and syllable feature in vocabulary and syllable complexity module respectively. A supervised learning method, called conditional random field (CRF) [5], is exploited to produce a characteristic model of each passage level with above mentioned features by (1). A result of training is characteristic models.

$$argmax\, P(Lev_i|Doc) = \lambda_1^i f_1 + \lambda_2^i f_2 + \lambda_3^i f_3 \qquad (1)$$

where $P(Lev_i\,|\,Doc)$ the probability of document in each level is, λ_x^i is a feature constant generated from CRF and f_n is features score from the three sub modules.
Once characteristic models are obtained, they are used as a reference set for grading an unknown levelled reading passage. The system apparently compares the scores calculated upon the same three features with models, and it results an appropriate level that the given passage belongs to.

1.1 Word Complexity Module

When word list is sent to this module, it is classified into two groups, content word and function word. Content words are words that have a stable lexical meaning, such as noun, verb, adjective. Function words are words that have little lexical meaning, but instead serve to express grammatical relationships with other words. In this module, content words are extracted into their lemma for checking their level. Lemma extraction using in this work is *morpha* [6][7] which is an open source tool. All words are matched to assign a level with reference word list collected from training corpus. The frequency of each word is also accumulated. Finally, word complexity score is calculated by (2).

$$WordComplexityScore = \frac{\sum_{i=1}^{N}\left[\left(Lv_{c_i}\cdot\beta_c\cdot n_c\right)+\left(Lv_{f_i}\cdot\beta_f\cdot n_f\right)\right]}{\sum_{i=1}^{N}\left(Lv_{W_i}\cdot n_i\right)} \qquad (2)$$

where Lv refers to a level of a word in reference list, C indicates a content word, f is a function word, β is a parameter, n is a frequency, W_i is the frequency of i^{th} word.

1.2 Syllable Complexity Module

Syllable is a measure to point out a difficulty of a word. The more syllable a word has, the more difficult level it could be. All words are applied to (3).

$$SyllableComplexityScore = \frac{\sum_{i=1}^{n}(n_{syl_i})}{W} \quad (3)$$

where n_{syl_i} the number of syllable of word i^{th} and W is the total number of words in a passage.

1.3 Sentence Complexity module

In general, there are four main types of sentence: simple sentence, compound sentence, complex sentence and combination between compound and complex sentence. We calculate sentence types by (4).

$$SentenceComplexityScore = S \cdot X^{nX} \cdot P^{nP} \quad (4)$$

where S refers to a simple sentence, X indicates a complex sentence and P is a compound sentence. N_x is a number of a recursion of a complex sentence and N_p is a iterative number of compound sentence.

2. Conclusion and future work

We present a system framework to grade a level of English reading passage that student personally chooses by their own since the passage tends to enthuse student to read it excitingly and joyfully. In this work, three features, which are word complexity, syllable complexity and sentence complexity, are set to represent language phenomena. The system begins with training a level characteristic model from given English passage corpus using CRF. The trained model is used to compare with the test passage to grade it.

In the future, we plan to compare other supervised learning methods, such as neural network and expectation maximisation, to find the best supervised learning suitable to the system. Moreover, other significant features, such as proverb and idiom usage, domain specific vocabulary, are planned to include in the system.

References

[1] Flesch, R. (1948). "A New Readability Yardstick," Journal of Applied Psychology 32: 221-233.
[2] Luo, S. and Callan, J. (2001). A Statistical Model for Scientific Readability. In Proceedings of the tenth international conference on Information and knowledge management.
[3] McLaughlin, G. Harry (1969). "SMOG Grading — a New Readability Formula". Journal of Reading 12 (8): 639-646.
[4] Fuller, S., Horlen, C., Cisneros, R., and Merz, T. (2007). "Pharmacy Students' Reading Ability and the Readability of Required Reading Materials". American Journal of Pharmaceutical Education 2007; 71 (6) Article 111.
[5] Lafferty, J., McCallum, A., & Pereira, F. (2001). Conditional random fields: Probabilistic models for segmenting and labeling sequence data. In Proceeding of 18th International Conf. on Machine Learning.
[6] Minnen, G., Carroll, J. and Pearce, D. (2000). Robust, applied morphological generation. In Proceedings of the 1st International Natural Language Generation Conference, Mitzpe Ramon, Israel. 201-208
[7] Morphological and Orthographic Tools for English (morpha): available at http://www.informatics.sussex.ac.uk/research/groups/nlp/carroll/morph.html

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Effects of Knowledge Building on Elementary Students' Views of Collaboration

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Abstract: This study investigates the impacts of knowledge building on students' views on collaboration. Participants were 53 fifth graders. Data mainly came from students' online activities and pre-post interview with regard to students' view on collaboration. Findings indicate that engaging students in knowledge building helped broaden students' view of collaboration, enabling them to see collaboration not just from a task-driven, group-based perspective, but also from a more idea-centered perspective.

Keywords: group collaboration, idea-centered collaboration, knowledge building

1. Introduction

A type of collaboration commonly seen and practiced during industrial age is perhaps group-based collaboration, during which the assembly-line type of production and team work have been playing an essential role in deciding how individuals work together. As such, mastery of one's own part of work in order to achieve maximum efficiency in team production is usually considered an important learning goal. Corresponding to such collaboration in industry, collaborative learning in schools is also highly group-based, during which students are often assigned a well-defined task and then asked to complete the whole task by doing parts of it based on division of labor [1]. This task-driven concept of teamwork that favors division of labor has been deeply rooted in school learning.

In contrast with group-based collaboration that favors division of labor, an alternative way of collaboration is perhaps idea-centered. Underlying such collaboration is a rationale that sees ideas as fundamental knowledge units or conceptual artifacts [2]. The ideas and theories created by knowledge workers such as scientists, engineers and architects are among the conceptual artifacts. These theories and ideas, once created, have a life of their own in that they can be improved and transformed by people who interact with them. The implication of treating ideas as basic knowledge unit in the world is that collaboration can therefore be centered on ideas, rather than based on pre-defined content of a task. Examples of such collaboration can be commonly found in research, science, technology, and business communities [3][4][5][6][7][8]. In these communities, collaboration is emergent based on need of idea improvement, rather than on division of labor. For example, new technologies are increasingly created by self-organizing knowledge workers [9] such that the open source operating system, Linux, has been developed and continues to evolve through an essentially volunteer, self-organizing community of thousands of programmers who collaborate on diversified ideas through constant exchange of open source code [3]. Putting ideas at the center around which people work collectively and interact with one another to improve these ideas thus represents an alternative view of collaboration, as well as a new opportunity for more creative learning and knowledge work [10][11][12]). To this end, the present study employed an idea-centered knowledge building approach in order to help students develop a more idea-centered view on collaboration. In brief, knowledge building is a social process with focus on the production and continual improvement of ideas of value to a community [13], and is supplemented by the use of a software program called Knowledge Forum which enables an online knowledge-building environment. Previous research suggests that the integral use of knowledge-building pedagogy and technology has been an effective means to support more interactive learning activities in class settings [14][15][16][17]. As such, it is posited that engaging students in such environments perhaps also has effects on their views of collaboration. Yet, such assumption remains to be tested, especially in the Taiwanese society. The present research thus intends to answer the following two research questions: (1) Whether engaging students in knowledge building would facilitate them to work beyond group collaboration? (2) Whether engaging students in knowledge building would help students develop a more informed view of collaboration?

2. Method

Participants and context. Participants were two classes of fifth-grade students (N=53). Most of them are from low-to-middle income families. They were sampled from a total of eight fifth-grade classes in an elementary school in Taipei. The two classes were then randomly assigned to be a control class (n=26) and an experimental class (n=27). As baseline comparison, we analyzed students' academic scores from the previous year, and no significant difference was found between the two classes ($F = .486$, $df = 52$, $p > .05$). The whole duration of the study was eighteen weeks, and they can be divided into two phases. In phase 1 (weeks one to nine), the topic of inquiry was light. For example, student studied the nature of light, how light travels, different lenses and types of eyeglasses, the relationship between light and human eyes, and light pollution. In phase 2 (weeks ten to eighteen), the topic of inquiry was sounds. For example, students studied the nature of sounds, how sounds travel, different types of sounds and music instruments, the relationships between sounds and human ears, and noise. In each week, students spent one class-session (40 minutes) engaging in their science inquiry.

Instructional design. For both classes, students were explicitly instructed to assume the role of scientists and to work together collaboratively. The immediate instructional goal was to help students learn the curriculum materials and the long-term goal was to eventually help them find and work on a science fair project. All instructional activities were designed to be similar for both the control and experimental classes (e.g., both classes were taught by the same science teacher and used the same learning materials), except that the students in the experimental condition were engaged in knowledge building. One thing to note is that a conventional routine practiced by the participating teacher in his science class is to divide students into groups, and to implement all instructional and learning activities based on these fixed groups. The classroom was consisted of six big rectangle desk, around which four to five students of the same group sit. In the present study, both the control and experimental classes also employed this grouping convention in the beginning of the study. But it was expected that students in the experimental condition who were engaged in knowledge building would be able to go beyond group collaboration and demonstrate more idea-centered characteristics of collaboration towards the end of this study.

As for the learning environment, the control class represented a conventional one with focus on structured group-based collaborative learning. Specifically, it was implemented by means of selecting a learning task (i.e., studying sounds), defining the whole content of the task to be learned (e.g., a chapter in the textbook), dividing the whole task into sub-topical components, then having each of the six groups adopt and master one sub-topic (e.g., how sounds travel), and finally teaching other groups by making a presentation in class. Namely, they shared their piece of knowledge with the other five groups like working on a puzzle.

In contrast, while the experimental class also starts with six pre-determined groups, they were guided to work in Knowledge Forum (KF). In brief, KF is an online platform that runs on a multimedia database. It allows users to simultaneously create and post their ideas in the form of note into the database, read postings, reply to other users' notes, search and retrieve records, and organize notes into more complex conceptual representations.

There were in total twelve laptops available for use at all time in the science classroom. The experimental class mainly used computers for work in Knowledge Forum, whereas students in the control group mainly used them for group project work, for example, online search, word processing, and preparing presentation slides. It is important to note that that although the participating teacher was an experienced science and computer teacher for ten years, he had no prior knowledge about knowledge building pedagogy or experience of using Knowledge Forum. So, regular professional development sessions were provided on a weekly basis, with around 30 minutes each time, to help the teacher be familiar with knowledge building pedagogy and technology.

Data source and analysis. The main data sources included (1) students' knowledge building activities recorded in a Knowledge Forum database, and (2) group interview. First, as knowledge building is ideas-driven, with ideas recorded in the form of a note in a database, we looked into online knowledge building activity [18]. In addition, we performed social network analysis [19] to explore the online social dynamic in the experimental class.

Second, to explore students' view on collaboration, we conducted group interview [20]. There were a few reasons for using groups, rather than individuals, for interview. First, as mentioned above, it is because there is a convention in the present class to divide students into fixed groups for science instruction; as such, all class learning and instructional activities were also based on groups. We therefore decided to capitalize on this convention while conducting our interview so that students could feel more comfortable being interviewed as it resembles their routine group discussion in class. Also, the data collected will be based on their authentic group experiences. Second, it is because the main interest of this interview was to explore students' views on collaboration, using group as unit would help us elicit students' view that comes directly from their immediately belonged group interaction. The interviews were administered twice, one in the beginning and a second time at the end of the study. As each class has six pre-defined groups, the total number of groups is twelve, with each group constituted by four or five students. For this particular study, we assigned each group a group ID (i.e., G1-G12). The interview was semi-structured, focusing on the following two main dimensions: whether and how scientists collaborate. An interview protocol is shown Table 1. To conduct interview, the researcher asked questions to the group first and then facilitated each student to express his or her view by taking turns. All interview processes were video-taped. The time for each group interview was about 20 minutes. All videotapes were transcribed verbatim, and then content-analyzed using students' utterances as unit of analysis [21]. Inter-rater reliability (=.91) was calculated by determining the extent to which both raters assigned the same utterances to the same theme, with differences resolved by discussion. Table 2 shows the coding scheme developed from an open-coding process. To analyze, total number of utterances in accordance with a main theme were calculated. As our total group samples (n=12) is few, nonparametric tests (Mann-Whitney U test and Wilcoxon signed ranks test) were employed to measure pre-post change in students' views of collaboration and to test if there were any differences between the control and experimental classes.

Table 1: Interview protocol

Dimension	Sample questions (Translated from Chinese)
Whether scientists collaborate	How do scientists usually work? Do they work alone in the science lab, or do they work with others? How does scientific knowledge in textbook come from (e.g. from individual genius or group work)?
How scientists collaborate	Do scientists interact with other scientists? Why and how? Do scientists need to learn about what other scientists are doing? Why? How do scientists usually collaborate (if they collaborate)?

Table 2: Coding scheme

Category	Theme
Whether scientists collaborate	Yes
	Not necessary/no need
How scientists collaborate Group-based	1. Division of labor 2. Content of task 3. Personality
Idea-centered	4. Idea generation 5. Idea diversification 6. Idea improvement

3. Results and discussion

To answer the two main research questions, we report our findings based on the following two subheadings: (1) online activity in Knowledge Forum; and (2) change in students' views of collaboration. We elaborate each below.

3.1 Online activities in Knowledge Forum

Overall performance. To understand the general online activities and performance in Knowledge Forum, we first analyzed students' online behaviors in terms of the following three aspects: (1) individual contributions to the community; (2) community awareness of contributions made by other peers; and (3) complementary contributions as indicated by the effort to build on and connect to others' work and ideas. In terms of individual contribution, each student contributed a mean number of 21.9 notes (SD=6.79). In terms of community awareness, each student on average read a mean number of 52.4 notes (SD=39.7) in the database. In terms of complementary contribution, each student on average had 5.7 notes that were built on others' notes (i.e., 26% of the total notes contributed), and 8 notes that were collectively created with at least one co-author (i.e., 37% of the total notes contributed). Overall, the frequency of online activities was substantive as compared with previous studies also using Knowledge Forum and ten-to-eleven-years-old participants [22][18]. Nevertheless, while these behavioral measures gave a general picture of how participants worked online in this database, they tell little about how participants actually interacted with one another. To better understand the social dynamics in the community, a social network analysis (SNA) was conducted.

Interaction patterns. To further understand interaction patterns in the class, SNA was conducted using the automatic assessment tools available within the Knowledge Forum platform. Table 3 shows the interactive patterns in the experimental class over 18 weeks, using two indicators: “note-reading” and “note-linking”. In this particular analysis, one connection is defined as a link between two students (i.e., reading or building-on a note), and density is defined as the proportion of connections in a network relative to the total number possible. For example, in a network of three persons, the total possible connections will be three. If the actual connections are two, the network density will be 66.6% (i.e., two connections divided by three connections). The higher the number of the density is, the stronger the social dynamics of a community is implied. An intention of adopting a knowledge-building environment in this class was to help students move beyond fixed group collaboration and be able to engage in more emergent, idea-centered collaborative learning. As Table 3 further shows about detailed results of students’ interactions in phases 1 and 2, the high density of note reading and linking suggests that students’ collaboration was no longer limited to small groups. They were able to exchange ideas by extensively reading a great deal of peers’ notes and working to improve ideas by building on each other’s notes within, not group, but the whole class community. All these quantitative online behavioral and interactive measures indicate that students were able to start to work beyond group limitations. Next we further look into whether qualitatively students also changed their views on collaboration.

Table 3. Social network analysis (SNA) in this community (N=27)

Interactivity	Phase 1 (inquiry of light)	Phase 2 (inquiry of sounds)
Note reading		
Network connections	220	248
Network density	62.67%	70.65%
Note linking		
Network connections	114	121
Network density	32.47%	34.47%

3.2 Students’ views on collaboration: Whether and how scientists collaborate

Table 4 shows pre-post changes in students’ view on whether scientists collaborate. First, as baseline comparison, a statistics test using only pre-assessment data was conducted and it showed there was no significant difference (Mann-Whitney U=17, p>.05) between the control group and the experimental group. Second, Wilcoxon signed rank tests were conducted to measure changes from pre-assessment to post-assessment within the control and experimental classes, respectively; significant increases were found for both the control group (p<.05) and the experimental group (p<.05). Finally, an additional comparison between the control and the experimental classes in terms of the extent of their pre-post change was conducted and it was found there was no significant different between the two classes (Mann-Whitney U=10.5, p>.05). This suggests that conventional group-based instruction and knowledge building instruction were both effective in helping students see the importance of collaboration in scientists’ knowledge work. Arguably, this may be because both groups (1) were practicing collaboration in class (although different kinds); and (2) students were explicitly instructed to play the role of scientists and work collaboratively.

Table 4. Pre-post changes in students' view about collaboration (N=12)

	Control group		Experimental group	
	pre-assessment	post-assessment	pre-assessment	post-assessment
Whether scientists collaborate	1.00	5.17	0.67	6.17
Types of collaboration				
1. Group-based collaboration	6.83	6.50	7.83	7.50
2. Idea-centered collaboration	4.17	4.33	2.67	9.83

In terms of how scientists collaborate, two major views (themes) developed from the coding process were: group-based and idea-centered collaboration.

Group-based collaboration. To understand whether the two types of instruction (conventional vs. knowledge building) influenced students' view on group-based collaboration, nonparametric tests were conducted. Table 5 also shows pre-post changes in students' view on group-based collaboration. First, as baseline comparison (only pre-assessment data was used), it showed there was no significant difference between the control group and the experimental group (Mann-Whitney U=17.5, p>.05). Further comparison between the control and the experimental classes in terms of the extent of their pre-post change was conducted and it was found there was also no significant difference between the two classes (Mann-Whitney U=15, p>.05). The findings suggests that neither conventional nor knowledge building instruction had impacts on students' prior view on group-based collaboration. In other words, engaging students in knowledge building had no effect on their prior view of group-based collaboration.

A more in-depth analysis further suggests that the reasons why scientists perform group-based collaboration may include: division of labor, nature of task, and personality issue. First, there is a great emphasis on division of labor (i.e., who does what). For instance, when asked to give an example of collaboration, a student said, "…in digging up dinosaur fossil, scientists may do some division of labor, they may make someone dig dinosaur fossils, someone paint plaster, someone call the helicopter, and someone moves it up to the helicopter" (G3) Second, it is highly task-driven, with the content or the difficulty level of a task well-specified. For example, when discussing how to divide labor, one student said, "they can do it alone if it's a simple project. But once the project is complex, team work will be needed." (G1). Third, personality plays an important role in division of labor. For example, a student said, "Some scientists prefer to do research alone because they are shy or afraid to interrupt others" (G5).

Idea-centered collaboration. To understand whether the two types of instruction (conventional vs. knowledge building instruction) also have impacts on students' view of idea-centered collaboration, additional analysis was conducted. Table 5 also shows pre-post changes in students' view on idea-based collaboration. As baseline comparison, a nonparametric test using only pre-assessment data showed there was no significant difference between the control group and the experimental group (Mann-Whitney U=8.5, p>.05). Further comparison between the control and the experimental classes, in terms of the extent of their pre-post change, however, showed a significant difference between the two conditions (Mann-Whitney U=2, p<.01), with the experimental class showing a significant pre-post change in students' view on collaboration. The findings suggest that knowledge building pedagogy, as compared with conventional instruction, is more likely to help students develop a more idea-centered view of collaboration.

To elaborate further, a more in-depth examination suggests that students mentioned three main reasons in support of scientists performing idea-centered collaboration: idea generation, idea-diversification and idea-improvement [11]. In terms of idea generation, for example, one student said, "[scientists] discuss together for brainstorming ideas and then research together" (G10). In terms of ways for idea exchange and diversification, a student proposed, "Scientists may put their ideas on Internet to get more ideas from other scientists and they use these ideas to make further inference" (G10). Finally, in terms of idea improvement, when discussing how knowledge is advanced, a student said, "They [scientists] may start to work on previous scientists' idea and then continue working on that idea" (G4). Overall, it is posited that providing students with Knowledge Forum in which students are able to work with ideas as basic knowledge unit may be a key to broaden students' view on collaboration, thus helping them see that group-based teamwork is only one way to collaborate and it may be complimented by collaboration around ideas.

4. Conclusion

Arguably, depending on one's instructional goal, both types of collaborative learning discussed above can be useful, and with careful design, they can be used to complement individual learning. Unfortunately, to a large degree, most science learning in schools still highly focuses on individual learning, rather than collaborative learning. Specifically in the Taiwan context, as noted by [23], most students believe that science learning is all about memorizing textbook knowledge, preparing for tests, practicing tutorial problems in order to get good grades. Namely, science learning is still more concerned about individual knowledge growth, rather than collaborative knowledge work. And if there is any collaborative learning in science classes, the kind of collaborative activities are also quite inclined to the kind of group-based collaboration, highlighting division of labor and mastery of certain content knowledge, thus, neglecting the kind of more creative and idea-centered collaboration. As a result of such learning tradition, students' view on collaboration also appears to be quite limited.

Our study provided an initial look at the impact of engaging students in knowledge building on their practice and views of collaboration. We suggest the following areas for future research: First, we conjecture that there may be a relationship between types of collaboration and students' view on nature of science. Working collaboratively with knowledge around ideas, by brainstorming ideas and collectively improving ideas, in order to solve real-life knowledge problems, implies not only facilitating among students an idea-centered view of collaboration, but also engaging them in an idea-centered education [14]. As such, it may be possible to help students develop a more constructivist-oriented epistemological perspective that sees knowledge as tentative and subject to changes (i.e., understanding that ideas are improvable) [24]. Moreover, we also speculate that long-term exposure to idea-centered collaboration may also have a positive influence on the development of students' problem-solving capacity. It would be interesting to further investigate how students would solve real-life science problems after engaging students in knowledge building for a longer period of time.

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References

[1] Slavin, R.E. (1983). When does cooperative learning increase student achievement? *Psychological Bulletin, 94*, 429-445.

[2] Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: LEA.

[3] Evans, P., & Wolf, B. (2005). Collaboration rules. *Harvard Business Review, 83*(7), 96-104.

[4] Gloor, P. A. (2006). *Swarm creativity*. New York: Oxford University Press.

[5] Latour, B., & Woolgar, S. (1986). *Laboratory Life*. Princeton, NJ: Princeton University Press.

[6] Merton, R. K. (1973). *The sociology of science*. Chicago: Univ. of Chicago Press.

[7] Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science, 5*(1), 14-37.

[8] Nonaka, I., & Takeuchi, H. (1995). *The knowledge-creating company*. New York: Oxford University Press.

[9] Rycroft, R. (2003). *Self-organizing innovation networks: Implications for globalization*. Washington, DC: George Washington Center for the Study of Globalization.

[10] Hong, H.-Y., & Sullivan, F. R. (2009). Towards an idea-centered, principle-based design approach to support learning as knowledge creation. *Educational Technology Research & Development, 57*(5), 613-627.

[11] Hong, H.-Y., Scardamalia, M., & Zhang, J. (in press). Knowledge Society Network: Toward a dynamic, sustained network for building knowledge. *Canadian Journal of Learning and Technology.*

[12] Zhang, J. (2009). Towards a creative social Web for learners and teachers. *Educational Researcher*, 38, 274-279.

[13] Scardamalia, M., & Bereiter, C. (2003). Knowledge building. In *Encyclopedia of Education* (pp. 1370-1373). New York: Macmillan Reference, USA.

[14] Scardamalia, M. (2002). Collective cognitive responsibility for the advancement of knowledge. In B. Smith (Ed.), *Liberal education in a knowledge society* (pp. 67-98). Chicago: Open Court.

[15] Scardamalia, M., Bereiter, C., & Lamon, M. (1994). The CSILE project: Trying to bring the classroom into World 3. In K. McGilley (Eds.), *Classroom lessons* (pp. 201-228). Cambridge, MA: MIT Press.

[16] Zhang, J., Scardamalia, M., Lamon, M., Messina, R., & Reeve, R. (2007). Socio-cognitive dynamics of knowledge building in the work of 9- and 10-year-olds. *ETR&D, 55*(2), 117-145.

[17] Zhang, J., Hong, H.-Y., Scardamalia, M., Teo, C. L. & Morley, E. A. (accepted). Sustaining knowledge building as a principle-based innovation at an elementary school. *Journal of the Learning Sciences*.

[18] Zhang, J., Scardamalia, M., Reeve, R., & Messina, R. (2009). Designs for collective cognitive responsibility in knowledge building communities. *Journal of the Learning Sciences, 18*(1), 7-44.

[19] Wasserman, S., & Faust, K. (1994). *Social network analysis*. Cambridge, UK: Cambridge Univ. Press.

[20] Frey, J. H., & Fontana, A. (1991). The group interview in social research. *Social Science Journal, 28*(2), 175-187.

[21] Strauss, A. L., & Corbin, J. (1990). *Basics of qualitative research*. Newbury Park, CA: Sage.

[22] Hong, H.-Y. & Scardamalia, M. (March, 2008). *Using key terms to assess community knowledge.* Paper presented at the annual conference of American Educational Research Association (AERA), New York.

[23] Tsai, C.-C. (1998). An analysis of scientific epistemological beliefs and learning orientations of Taiwanese eighth graders. *Science Education, 82*(4), 473-789.

[24] Hong, H.-Y. & Lin, S. P. (2010). Teacher-education students' epistemological belief change through collaborative knowledge building. *Asia-Pacific Education Researcher (19)*1, 99-110.

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Constructing a Digital Authentic Learning Playground by a Mixed Reality Platform and a Robot

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Abstract: In this paper, we introduce a learning playground in classroom implementation. Learning Playground is an interactive stage that learning content can be developed into an authentic, task-oriented scenario. Students can acquire knowledge by experiential learning in Learning Playground. Within current technical supports, we apply mixed reality to create a contextual learning platform and place a physical character, a robot, to connect learners and the virtual world. Referring to the experiment, we see learners' motivations, involvement, pleasure and learning effectiveness increase, and they show their strong preference interacting with a robot with social emotions in the learning process.

Keywords: authentic learning, robot, mixed reality, experiential learning, digital learning playground

1. Introduction

Learning can be meaningful and applied in real use in an authentic context [7]. In accordance with Dewey's experiential learning, true learning only occurs in relevant experience [5]. There have been a number of educators who devoted effort to create an atmosphere in which experiences are reflected upon by the learners [6]. Cavazza [3] introduced a real-time interactive storytelling system which is a four-side CAVE-like (CAVE Automatic Virtual Environment) display operated by a PC-cluster [4]. The user can apply multimodal interactions supported by real-time stereoscopic visualization. This system distinctly aims for full immersion in learning. However, creating certain authentic learning environment in classrooms is chiefly concerned with sophisticated equipments and spatial convenience.

Due to the issue mentioned above, is it possible to provide authentic learning with various contexts in classrooms? A simulative setting with virtual objects can yield simulative performance that correlated with real-world tasks from learners [1]. Thanks for current technical supports; we can offer students authentic learning experience by employing mixed reality (MR). In educational MR applications, *Plant System,* developed in Singapore [11], was for students to experience the concepts of seed germination, photosynthesis etc. In this case, this MR module with a wearable display, head-mounted display (HMD), intended a self-operative task without contextual scenario. HITlab designed MagicBook, an MR interface that transports users between reality and virtuality. MagicBook created an immersive environment within a virtual character represented the user and supported multi-scale collaboration. However, the scale of interaction was still limited in terms of mobility of virtual characters and users' sense of collaboration [2].

Perhaps actively engaging learners in authentic settings is also an issue to be improved. Recently, many studies show that physical characters bring more users' enjoyment and engagement than virtual characters [13]. For example, iRobi [8] can display learning contents in built-in screen and encourage users through audio sound and simple facial expressions. LEGO Mindstorms is a programmable teaching tool for users to design their own robot and create hands-on learning [9]. Mitnik proposed another classic example that reinforces students' kinematic concepts by constructing graphs and illustrating the robots' movements [12]. These educational robots are generally functioned either as an informative presenter or an instructional kit. There is a potential for more engagement and interaction between learners and the robot.

With respect to the strengths and the concerns of the technology showed above, we propose some issues in educational application:

1. How do we construct an immersive environment in classrooms?
2. How do we present encountered scenario with aims of experiential learning?
3. What can a robot do in learning process to engage students more in an authentic environment?

We introduce Learning Playground, a theatrical stage with a robot companion in classroom settings. We adopted MR and created a contextual learning platform for teachers and students to explore knowledge through immersion. The physical character, a robot companion, of the system is aiming to connect learners and the virtual world presented on the stage. Furthermore, the robot was infused with different emotional feedbacks that cater for a higher engagement and involvement, and in result of a better learning effectiveness.

2. System Implementation

Three aspects concerning Learning Playground will be elaborated on this section: constructing Learning Playground, experiential learning in Learning Playground, and the role of robot companion in Learning Playground.

2.1 Constructing Learning Playground

The origin idea of Learning Playground is a theatrical stage: a performance space includes a scene and a stage. Applying this concept to classroom settings, learning content in Learning Playground is designed with a situated scenario; teachers and students can join contextual learning activities with pleasure in the stage.

Figure 1. Learning Playground with students and teacher

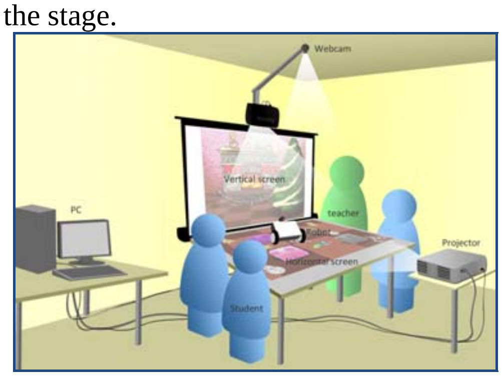

Figure 2. Device setting of Learning Playground

A two-screen theatrical stage with two projections, vertical and horizontal, is a main framework of Learning Playground. As Figure 1 shows, the vertical screen presents a situated scene and content-related information such as a background story, tasked events, and, target learning; the horizontal screen is an extension of vertical scene that provides a stage for learning performance. In this system, the teacher can present learning content within designed situations into the Responsive Stage (the two-screen theatrical stage), and students can immerse task-embedded learning events on the stage with the teacher's assistance.

The main idea of mixed reality supports us to build an authentic learning environment. We add a robot to substitute students to perform tasks on the horizontal screen. The purpose of adding a physical character not only creates involvement and pleasure through the learning process but also avoids a potential great expense of a full immersion (four-side) in classroom settings.

The main device setting consists of two-screen display, two projectors, a PC, a set of tracking equipment, and a robot. The humanoid robot is assembled with LEGO® MINDSTORMS® NXT 2.0 and other LEGO® elements and sensors. In the aspect of tracking control, an infrared ray transmitter is attached to the robot and a webcam on Figure 2 is set to track the infrared ray; and we develop a tracking module to send coordinates of the robot's locations to responsive stage module (Figure 4).

2.2 Experiential learning in Learning Playground

To design meaningful learning activities, we adopt Kolb's experiential learning modal [10] as our core system rationale. The highlights of experiential learning are learner's direct experience and reflections on doing. The developing learning process is four-stage cycle of learning- Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC) and Active Experimentation (AE).

We choose English learning materials and pick "preposition of space" and "color" out of the course units for elementary level. Considering students' context, Hide-and-seek, a well-known children's game, is our situated scenario for students to utilize prepositions and colors in Learning Playground.

At beginning, the teacher plays a short clip of the background story, a Naughty Monkey, Kiwi, on the stage and introduces the task and the learning partner, the robot. Later on, the students are divided into "hiding the monkey" and "seeking the monkey" respectively. Four colored boxes (pink, purple, brown, and gray) are placed in the scene for the hiding group to hide all eight monkeys in; and there are three locations in each box for monkeys to hide in (in, beside, and behind).

During the task, the hiding group gives verbal commands to the platform, for example, saying "two monkeys in the purple box." Then the seeking group is going to find all the monkeys with the robot within certain time span. The group gives verbal commands to the robot such as "go to the brown box." Once the robot reaches the assigned spot, the vertical screen will show the assigned box and three prepositions in it. When the students come up with a decision, apt animation will be played. As we can see, the target knowledge has been transformed into a tool for students to achieve tasks. The students utilize target language in the process (CE) and they gain feedbacks from the vertical screen (RO). For instance, when students say "behind the brown box," and there are monkeys hiding there, the vertical screen will show the animation of a monkey jumping up from back of the box. In the process of task completion, the decision-making from the hiding and seeking group varied with different situations (AC). In order to achieve the task, competing with the other team, students actively find better strategies (AC). Taking turns experiencing hiding and seeking experiences is regarded as a complete set of the learning process in the system. It is thus that students' role in learning process becomes active and dominated in this system.

Figure 3 shows the interactive relationship between the main device and users. The teacher is an editor to blend learning materials into the system and also a coach to ensure smooth running of the activity. The students are task-takers to solve tasks under the robot's help; the robot serves as the bridge between users and the responsive stage. The robot is also a learning companion to receive missions from students and carry out the missions. The responsive stage is a content agent in charge of presenting related information such as learning knowledge, background story, and descriptions of tasked events. Besides, the stage will also respond to students' decisions to reflect students' comprehension (comprehension checker) by showing apt animation.

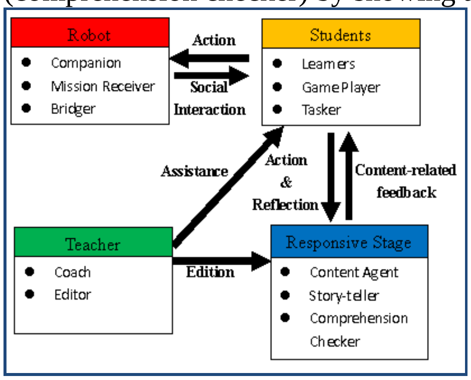

Figure 2. Graph of Learning Relationship

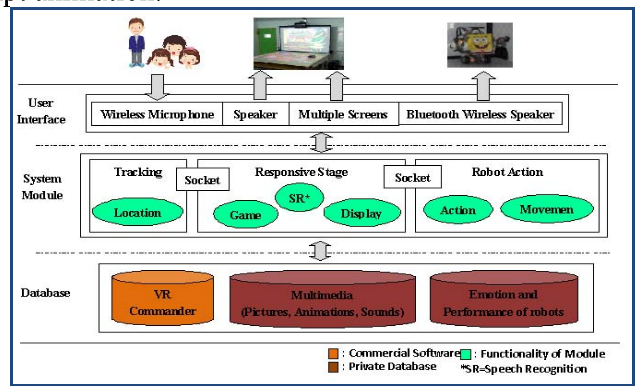

Figure 3. System Architecture

With respect to system architecture, the implementation is composed of three modules, Responsive Stage, Tracking, and Robot Action, as shown in Figure 4. Responsive Stage Module (RSM) demonstrates corresponsive sound, background and visual effects that determined by signal receiving from Tracking Module and meanwhile event signals are sent to Robot Action Module (RAM) for the robot's motions and actions. In terms of amounts of verbal commands, we employ VR Commander as a speech recognition tool in RSM. The results of voice input go to either RAM for mobility or RSM for corresponsive information. Since VR Commander sometimes couldn't recognize the group responses, artificial speech recognition is served as a supportive assistance to ensure a smooth learning process.

2.3 Role of Robot Companion in Learning Playground

For the purpose of eliciting more production, the role of robot, a learning partner, is so as to motivate students conveying and receiving authentic messages. Therefore, social emotions and actions are programmed to develop empathy between users and the robot. The robot can give proper responses with sound effects and simple movements to students. For instance, being idle for certain period, the robot would snore to impel students to give enthusiastic act response. We presume that joining a humanoid robot can enhance motivation, engagement, and involvement, and bring pleasure in the process of learning. The design of robot performance, shown as Table 1, is categorized in three streams: social interactions, emotional behaviors, and learning state:

Table 1. Robot Performance

Act Performance	Expressions	Sound effects and robot behavior
Social Interactions	greeting, praise, and encouragement	Let's get all the monkeys. Excellent! Oops, try again. Turning wrist(behavior)
Emotional Behaviors	happy, hungry, satisfied, and frustrated	Wow, you are awesome. I'm full (hiccup) Circling (behavior)
Learning State	Receiving unclear command, late response, and lack of enthusiasm.	What did you say? I'm lost, please help me. Louder, please. Boring, you ignore me (Snore)

3. Experiment and Discussion

The experiment was held in a classroom with requiring devices. The purpose of the study was to observe learners' behavioral impacts and learning effectiveness through the immersive stage with a robot partner. Questionnaires, progress scores and formative feedback were the means of evaluation data collecting.

3.1 Researching design and hypothesis

We hypothesized that learners could actively acquire and implement target language by using Learning Playground- an responsive two-screen theatre with a robot. The hypotheses through this research were:

1. Utilizing the two-screen responsive theatre with meaningful contexts can enhance immersive experience.
2. Adding a robot companion in learning can facilitate learning motivation, engagement, involvement, and pleasure.
3. Utilizing Learning Playground can fortify learning effectiveness.

To assess the assumptions, learners' behavioral impacts and perspectives through the system were the emphases in this research. Observational data was collected by video-tape recording and user's experiential data was administered by the questionnaires and interview. The objective data related to learning effectiveness was measured by gain scores of the post-test.

3.2 Procedure

This experiment took place in Hua-duo Science & Language Cram School, an after-school academic-enhancing institute, located in Taoyuan, Taiwan. The students are from second to sixth grades. The experiment lasted for three weeks. The main experimental period was about 40 minutes. Each participant needed to take a pre-test and post-test before and after the main activity. The pretest was conducted to understand prerequisite conditions of the students. After completing the pre-test, the participants were randomly assigned to either an experimental or a control group. The number of the control and the experimental group is equally 30. The control group took one English lesson with a teacher. The teacher integrated the target knowledge (color and preposition of space) with the children story, "A color of his own." The experimental group learned target knowledge by immersing in Learning Playground.

3.3 Results and Findings

Users' perceptions and learning behavioral impacts was assembled in two parts: a first section concentrating in the experience toward the Responsive Stage and a second part focusing on the robot with social emotions that was designed for facilitating motivation, engagement, involvement, and pleasure in learning process. We adapt five-point Likert Scale for rating in the questionnaire.

With relation to an overall learning performance within the whole system experience, learning effectiveness was measured by the gain scores of the post-test.

3.3.1 Immersive experience in a contextualized stage in the classroom

The beginning phase was considering whether the interactive contextual cues were relevant to the users. 96.64% of the users perceived the cues from the display and around 83.33% positively stated that they were capable of giving responses. Above 80% expressed they could relate this experience to new daily cases. Approximately 66.7% strongly felt they were playing hide-and-seek with the monkeys. The result demonstrated that the users were highly engaging in the task that was constructed in the immersive setting.

Table 2. Use perceptions and behavioral impacts toward the Responsive Stage (N=30)

No.	Statement	Degree (%)				
		CD	D	Un	A	SA
1	During the course, when I found the monkey with the word "in," I saw the monkey jumping out of the box thus getting the significance of "in the box."	0	0	3.3	33.3	63.3
2	I constantly use the words "in", "beside", and "behind" to accomplish the missions of hiding and seeking for monkeys.	0	0	0	16.7	83.3
3	Due to the constant use of "in, beside, and behind," I've learned, for instance, how to express a ball in the box.	0	0	6.7	13.3	80
4	During the course, monkeys jumping out of the boxes seemed like playing with the animals rather than ordinary English lessons.	0	0	10	23.3	66.7

CD :Completely Disagree; D=:Disagree; UN: Undecided; A: Agree; SA: Strongly Agree

3.3.2 The robot as a collaborative partner in learning

A second part was assessed the effect of a robot with social emotions on motivation, engagement, involvement, and pleasure in learning. Firstly, the awareness of the interaction between the robot and the users reached to 76.7%. 90% showed their preference learning with a robot over sitting in the classroom. 90 % felt having accomplished the mission with the robot partner (engagement) while 86.7% were agreeable they were concentrating in task completion with the robot together (involvement). As to adding pleasure in learning, 76.7% were strongly agreeable that learning with the robot is pleasing.

Table 3. Users' learning behaviors and intentions regarding the robot partner (N=30)

No.	Statement	Degree (%)				
		CD	D	Un	A	SA
1	I perceived the robot had emotions, such as getting tired, feeling helpless, feeling hungry, etc.	0	3.3	6.7	13.3	76.7

2	I get my interaction with the robot. For instance, the robot greets me and encourages me while I let it have candy canes.	0	0	0	23.3	76.7
3	I prefer learning with the robot over sitting in the class.	0	0	10	20	70
4	I look forward to attending courses with robots.	0	0	3.3	23.3	73.3
5	Learning with the responsive scene system, I feel as if actually playing with the monkeys in the settings.	0	3.3	6.7	23.3	66.7
6	I feel having accomplished the mission with the robot.	0	3.3	10	6.7	80
7	As far as I'm concerned, learning with the robot is pleasing.	0	0	0	23.3	76.7
CD :Completely Disagree; D=:Disagree; UN: Undecided; A: Agree; SA: Strongly Agree						

3.4 *Results from Objective statistic Related to Learning Effectiveness*

For assessing how much the users learned through the device, comparing to the ordinary teaching, the post-test was administered to know their progress. The statistical results were summarized in Table 4.

In order to minimize the influence of the students' prerequisites of the target learning on the experiment, the research treated the pretest as a control variable. An independent two-sample t-test was to analyze the significant difference between both groups. The data (p= 0.675, *p*>o.o5) referred to be non-significant. It indicated that the prerequisites of two groups were similar. The purpose of omitting the variable was met.

Table 4. T-test of pre-test and gain score with control and experimental group.

Test	Groups	N	Mean	Std. Dev.	two-tail t-test *F*	*t*	*df*	*Sig.(p)*
Pre-test	Control	30	36	25.41	0.646	0.421	58	0.675
	Experimental	30	38.67	23.60				
Gain Score Post-test	Control	30	68	20.81	0.558	2.249	58	0.028
	Experimental	30	80.83	23.33				

We analyzed the gain scores of the post-test in two groups. Applying an independent two-sample t-test to the gain scores, the result can be seen significant differences (p=0.028, *p*<0.05). The result highlighted the experimental group learning with the device gained more scores than the control group.

3.5 *Discussion*

Overall, we can see that Learning Playground successfully conveyed information under an authentic context to the audience and elicited feedbacks from learners.

Through the observation of the experiment, we found the robot played an essential role engaging students. The students showed their strong preference interacting with a robot with social emotions. Particularly when the robot was snoring, the students urged their teammates to make decisions in order to motivate the robot. In one of our experimental days, the robot couldn't function effectively, including lack of responses, and mobility and then the students were upset and impatient through the process.

From the interview about future implementation, some students expected more diversity in Learning Playground which meant to explore different kinds of tasks. Moreover, some students expressed their desire to have more robots for competing with other classmates. Last but not least, the students regarded the device as a learning supplement that positively installed in classrooms.

3.5.1 Limitations

There are some concerns about technical support and future implementation. At first, we assumed natural language would be elicited under an authentic learning. However, the device of the speech recognition couldn't exactly pinpoint students' articulation which met the teacher's expectation or task requirements. The limitation of the speech recognition affected the mobility of the robot and the smooth flow of the learning process. One other issue is that classroom implementation of Learning Playground is still an unknown quantity since Learning Playground is still in a pioneering stage. However, there is a positive potential for future implementation with respect to an uncomplicated interface and common device, such as PCs, projectors, and a webcam.

4. Conclusion

We have seen Learning Playground provides an authentic learning theatre in classrooms for students and the teacher to join in. Learning Playground simulates a microworld for students to acquire knowledge within the elements of challenge, delightfulness, and competitions.

In future research and implementation, we hope for more meaningful exposures that can be performed in Learning Playground. With well-designed themes plus teachers' cooperation, our system can positively be applied to many subjects, i.e. math, geography, social studies, etc.

Acknowledgements

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References

[1] Azuma, R. (1997). A survey of augmented reality. *Presence-Teleoperators and Virtual Environments, 6*(4), 355-385.

[2] Billinghurst, M., Kato, H., & Poupyrev, I. (2001). The MagicBook: a transitional AR interface. *Computers & Graphics, 25*(5), 745-753.

[3] Cavazza, M., Lugrin, J., Pizzi, D., & Charles, F. (2007). Madame bovary on the holodeck: immersive interactive storytelling. *ACM Multimedia 2007*, 651-660.

[4] Cruz-Neira, C., Sandin, D., & DeFanti, T. (1993). *Surround-screen projection-based virtual reality: the design and implementation of the CAVE.*

[5] Dewey, J. (1938). *Experience and education*. New York: Collier Macmillan.

[6] Enfield, R., Schmitt-McQuitty, L., & Smith, M. (2007). The Development and Evaluation of Experiential Learning Workshops for 4-H Volunteers. *Journal of Extension, 45*(1).

[7] Gagne, R., Wager, W., Golas, K., Keller, J., & Russell, J. (2007). Principles of instructional design. *Performance Improvement, 44*(2), 44-46.

[8] Han, J., Jo, M., Park, S., & Kim, S. (2005). The educational use of home robots for children. *Proceeding of IEEE International Workshop on Robots and Human Interactive Communication, Aug. 2005*, Nashiville, 378-383.

[9] Klassner, F., & Anderson, S. (2003). Lego MindStorms: Not just for K-12 anymore. *IEEE Robotics & Automation Magazine, 10*(2), 12-18.

[10] Kolb, D. (1984). *Experiential learning: Experience as the source of learning and development.* Prentice-Hall Englewood Cliffs, NJ.

[11] Liu, W., Cheok, A., Mei-Ling, C., & Theng, Y. (2007). Mixed reality classroom: learning from entertainment. Proceedings of the 2nd international conference on Digital interactive media in entertainment and arts, 65-72.

[12] Mitnik, R., Recabarren, M., Nussbaum, M., & Soto, A. (2009). Collaborative robotic instruction: A graph teaching experience. *Computers & Education, 53*(2), 330-342.

[13] Yen-Chieh, W., Chi-Hung, C., Chih-Wei, C., & Gwo-Dong, C. (2009). The Comparison of Motivation and Interaction between Virtual characters and Robots in Mixed Reality. *The 17th International Conference on Computers in Education, ICCE 2009.*

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Comprehensive Computational Support for Collaborative Learning from Writing

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Abstract: Learning about subject matter and about writing by collaboratively authoring an electronic document is an important variant of computer-supported collaborative learning. Collaborative writing is particularly often practiced in Higher Education. Our research has the goal to develop comprehensive software support tools for collaborative discipline-based writing, and to study how the team writing process is affected by the use of these tools. This paper describes initial tool developments that integrate computational document analysis methods with process mining methods into a comprehensive writing environment and reports first experiences gained in a undergraduate engineering course.

Keywords: CSCL, writing, text mining, process mining, formative feedback.

Introduction

Writing can be an important form of learning, both of writing itself and of subject matter [1, 2]. We are particularly interested in collaborative forms of writing (for the purpose of learning), which fall into two main categories: *Peer reviewing* where the outcome is an individual document that has been composed by one student and has been reviewed by at least one other student (once or repeatedly), and *collaborative writing* where the outcome is a collaboratively composed and revised document. Collaborative writing (CW), defined by Lowry *et al.* [3] as "..an iterative and social process that involves a team focused on a common objective that negotiates, coordinates, and communicates during the creation of a common document" is a cognitively and organizationally demanding process. As a specialized form of group work it involves a broad range of group activities, multiple roles, and subtasks. When performed by groups that communicate (partially or only) through communication media, the process typically involves, in addition, multiple tools (e.g. phone, mail, instant messaging, document management systems) with different use characteristics.

In CSCL, writing has been seen as a means to deepen students' engagement with ideas and the literature and for knowledge building [4] by jointly developing a text or hypertext. In addition to knowledge building in asynchronous collaboration, synchronous collaborative development of argumentative structures and texts has received much attention [e.g. 5].

The availability of the Internet has made both peer and collaborative writing very easy to implement in schools and universities, and has led to genuinely new forms of writing, such as blogging and wiki writing [6]. In recent years, the rise of so-called 'cloud computing' tools such as Google Documents has led to the availability of almost desktop-quality online writing environments with very little costs to the user. The widespread availability of high-quality technical CS tools does not mean, however, that writing is now performed better. As the use of word processors has not led to better individual writing, so does the availability of wikis engines and Cloud tools not lead by itself to better documents and cooperation, deeper learning, or more satisfaction with the writing process.

Because of the complexity of the CW process, explicit and scaffolded support needs to be provided, in particular for novice writers. Such support generally falls into one of three classes: specialized writing and document management tools, document analysis software, and team process support. Our research focuses on the latter two, the first is provided by commercial vendors (e.g. Google) who provide the writing tools and store the documents written by students. We conjecture that in order to support students in Higher Education effectively in writing together and learning together from the writing process, computational support that has so far been separated should be combined: Namely tools that provide feedback on the *product* of the writing process (drafts) should be combined with tools that can provide visualisations of and feedback on the *team process*.

Accordingly, we combine two computational techniques: semantic analysis, which focuses on extracting knowledge from documents about what the student wrote (or edited) and process mining, which focuses on extracting process-related knowledge from event logs recorded by an information system. In this paper, we describe the architecture of our comprehensive writing environment (CWE) and provide examples for first experiences with an initial implementation.

1. Architecture of the Comprehensive Writing Environment

The CWE framework (see Figure 1) integrates a front-end writing tool that supports collaborative writing activities (manages access writes etc.) and stores all revisions of documents created, shared and edited by groups of writers. with tools for document and process analysis. (Two additional components, a writing assignment management tool for large courses and a automatic question generation tool also exist in first implementations, but are not described here, see [7].) In order to perform analysis of the writing process for particular documents, each revision of a particular document must contain information such as edited text, timestamp of committing change, and identification of the writer. Based on the information such as timestamp and writers' identification of all revisions and event logs of reviewing activities, a process mining tool is used to discover sequence patterns of writing activities (WriteProc). The process analysis provides a way to extract knowledge about writers' interaction and cooperation. The analysis can identify interactions' patterns that lead to a positive outcome and indicate patterns that may lead to problems. In addition, text mining techniques are applied to analyze text-based changes of all revisions of documents (Glosser). The text-based analyses can provide semantic meaning of changes in order to gain insight into how writers develop ideas and concepts during the writing process.

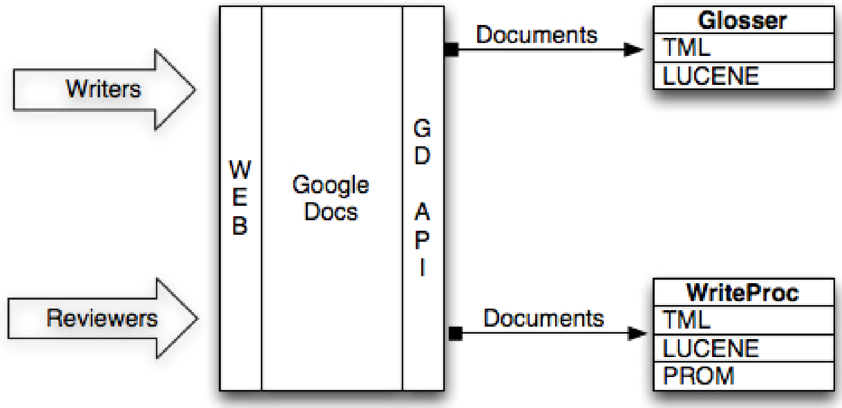

Figure 1: Architecture of WriteProc, a framework for collaborative writing support.

As already mentioned, the front-end writing tool in CWE is Google Docs, a web-based utility with most functionalities for word processing that allows users to share their documents with other team members and to write (almost) synchronously. The Google Document Lists Data API (GDAPI) is used to integrate Google docs into the WriteProc system as shown in Figure 1. The API allows CWE to retrieve and track all versions of documents created, shared and edited among group members. Every time a writer makes changes and edits a particular document, the identification of the writer, the edited content of the document, the timestamp of committing changes and the version number of the edited document are retrieved and stored in CWE's central relational database by using the API. This information extraction is executed seamlessly in the background so that the writers are not interrupted. Using these records, CWE performs document analysis in order to provide feedback on certain aspects of a document (Glosser) and performs process analysis to provide information on the collaboration process (WriteProc).

Glosser is a web-based tools that uses some grammatical but mainly statistical techniques to analyse a document (each version) with respect to parameters such as topics included, relationship between the topics, coherence between paragraphs [8]. The feedback provided by Glosser helps a student to review a document by highlighting the features a document communicates, such as the keywords and topics it includes, and the flow of paragraphs. For the case of collaborative writing, by analysing the content and author of each document revision, it is possible to determine which author contributed which sentence or paragraph and how these contribute to the overall topics of the document. These collaborative features of Glosser can help a team understand how each member is participating in the writing process. The user interface of the Topics feedback tool in Glosser is displayed in Figure 2. The trigger questions at the top of each page are provided to help the reader focus their evaluation on different features of the document. Below the questions is the supportive content called ‘gloss’, to help the reader answer those questions. The ‘gloss’ is the important feature that Glosser has highlighted in the document for reflection. A rollover window on each sentence indicates who wrote it.

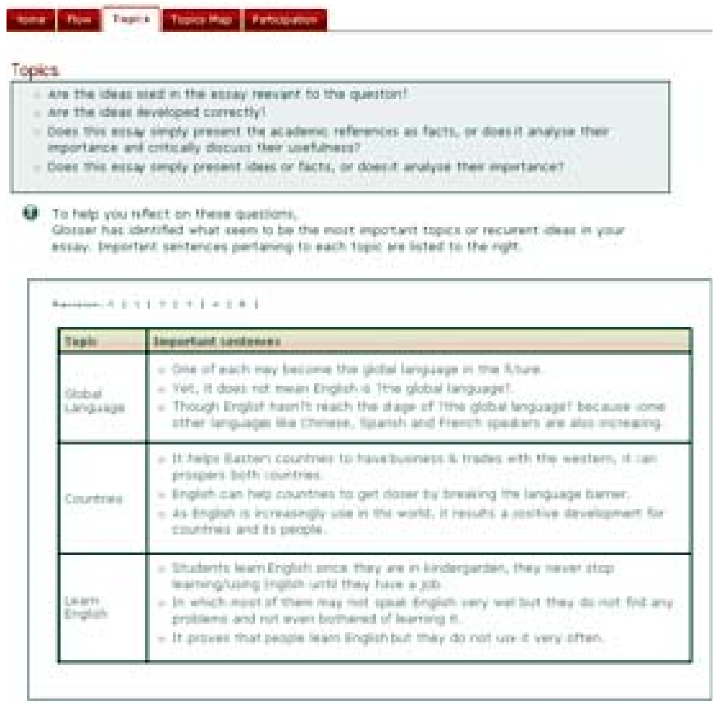

Figure 2: Glosser screen displaying information on topics found in a document. The upper box shows reflection prompts, the lower table is part of the output from Glosser with main topics found in the text displayed in order of their importance.

WriteProc uses a combination of text statistical techniques and process mining techniques to extract information about the mining process from document changes as well as event logs capturing user behavior. WriteProc is currently under development and will eventually comprise a process mining component plus a module that will provide process visualizations for students. The (web-based) visualization module is not developed yet. For the analytical part of WriteProc we currently use PROM [9]; in its final form, WriteProc will use algorithms as contained in PROM, for instance, but made available as web services, independent of the PROM user interface. We describe WriteProc in the context of two case studies in more detail below.

Both Glosser and WriteProc use TML, a multipurpose text mining library (http://sourceforge.net/projects/tml-java/) that implements the natural language processing (NLP) and machine learning techniques that analyse the actual content of the document revisions. TML provides a comprehensive set of text mining algorithms and scaffolds every stage of the text mining process. TML integrates the open source Apache Lucene search engine, the Stanford NLP parser and the Weka machine learning libraries, and is itself open source. TML provides functionalities for the pre-processing of documents, tokenising, stemming and stop-word removal.

2. Sequence and Process Analysis of Collaborative Writing

With sequence and process analysis methods one can uncover regularities ("patterns") contained in information pertaining to temporal order and duration of events. From a learning perspective, it is particularly interesting to find out if there are sequence-dependent regularities in data that correlate with measures such as learning gains or motivational aspects, such satisfaction with group work. In order to demonstrate how such forms of analysis can be integrated into an online writing environment, we illustrate the use with two case studies.

2.1 Analysis of Glosser Logs

The data come from 58 engineering students enrolled in a course on e-business. In pairs of two they had to write a Project Specification Documents (PSD) for their proposed e-business projects. Each pair had to submit one PSD of between 1,500 and 2,000 words. Students were required to write their PSD on Google Docs and share the documents with the course instructor. They were asked to submit their PSD using Glosser. Two other students who were members of different groups reviewed the submitted PSD. Students had one week to review each other's documents and submit their feedback. After getting feedback on their documents from their peers, students could revise and improve their writing if necessary before submitting the final version one week later. Before the submission of the final version they also used Glosser. The total event log file of the system consisted of usage data of Google Docs and Glosser for three weeks. In addition to this log file, the marks of the final submissions of the PSD together with a very good understanding of the quality of each pair through the semester was used to correlate behaviour patterns to outcomes.

The event data type analysed by us were the choice of review tools in Glosser, each of which corresponds to a tab in the interface that can be opened--and the underlying analysis activated--by clicking on the respective tab (see Figure 3 for descriptions). The question was if there is any systematic relation between patterns of use of these review tools and the resulting quality of the document (expressed by grading).

Tool	Description
Home Tool (HOT)	showing basic statistics such as numbers of words and revisions.
Topic Tool (TOT)	checking if content provides evidence to support its topic sentences.
Flow Tool (FLT)	reviewing coherence and checking how paragraphs and sentences follow from previous ones.
Keyword Tool - HTML (KTH)	showing semantic flow.
Keyword Tool - Graph (KTG)	depicting the visualization of semantic flow.
Group Tool (GRT)	showing participation of authors for different versions.

Figure 3: Review tools available in Glosser

The event corpus analysed comprises 4,677 events logged on students' work on 29 documents. The development of each of these documents was treated as a process case, and we distinguished eight event types: use of each the six review tools displayed in Figure 3, opening the Google document (ROD), and accessing the review tool (TOR).

From the event log of our case study data, we extracted the process model shown in Figure 4, which represents the process common to all the groups; we used the PROM Fuzzy Miner (see [10] for more details on this algorithm and an application to group decision making). Groups began with events of opening a particular document (ROD). Then, the reviewing tool was requested (TOR). After that, different reviewing activities were performed, in no particular order. The process reiterated until users logged off or closed their browsers.

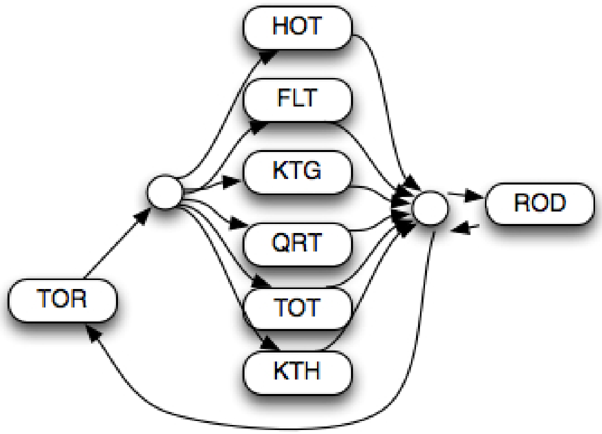

Figure 4: Process model for the use of reviewing tools across all pairs.

We were interested in finding out more about differences between groups and relations to success criteria. ProM provides a Performance Sequence Analysis plug-in to find the most frequent paths in an event log. (This algorithm also uses performance data, in particular duration of events, but we do not elaborate on this due to lack of space.) Figure 5 shows the most frequent pattern in terms of transitions between event types for Group 1 (received a mark of 8/10) at the top and Group 29 (10/10) at the bottom. As one sees, there are no dramatic differences between these two groups. In general, in these case study data there were no substantial differences between groups' behavior that were correlated with success criteria. Such differences were also not found when looking at frequency data. For more details, see [11].

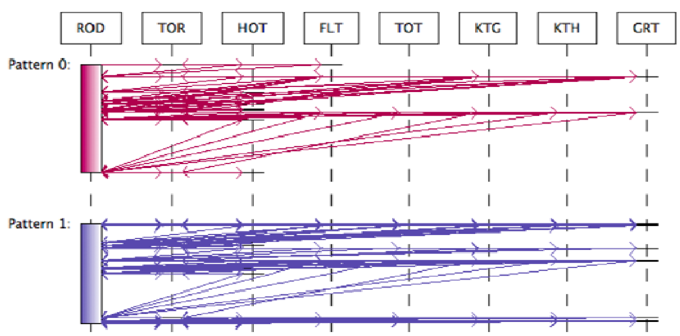

Figure 5: Performance Sequence diagram for Pair 1 (top) and Pair 29 (below)

2.2 Analysis of Google Logs in Terms of Team Writing Activities

While mining for sequence patterns in log file data may be informative for the researcher, the question remains to what extent this kind of information is also informative for the student (and teachers/lecturers, for that matter). We would contend that event-based log file visualizations are by and large not very useful as *feedback* to learners unless the visualized information pertains directly to pedagogically relevant processes. For the visualization described above, no pedagogical (prescriptive) model exists that would suggest any specific sequencing of reviewing activities, and hence the information as visualised has limited feedback value. We do, however, have prescriptive models for the larger process of group writing, for instance based on the taxonomy suggested in [3]: (Writing) teachers often formulate at least partial orders on sequences of Brainstorming, Outlining, Drafting, Revising, and Editing. Hence, process visualizations on this level would constitute potentially valuable feedback as students can compare their group's sequence with, for instance, an ideal writing sequence. In any case, describing behavior in such event categories that encompass the *semantics* of collaborative writing activities is inevitably more informative than a description of behavior sequences in terms of activities in the software interface (Glosser for instance).

Here we illustrate this point and demonstrate how the records stemming from writers' activities in Google Docs can be semantically interpreted. Data from the same students and course as in Section 2.1 were used, but this time we build on the database of records of activities in Google Docs. The analysis proceeded in multiple steps: First, after initial data cleaning the Google Docs data log (time-stamped versions of a document along with information which user performed the changes) was interpreted in terms of *individual* Writing Activities and their effects on a document (e.g. topic shifts, change of coherence, see the top row in Figure 6). For this, text-statistical methods were employed, using the TML library (see section 1) and methods of latent semantic indexing (we build in particular on work described in [12]). In a second step, these individual Writing Activities and document changes were related to *collaborative* writing activities (the Lowry taxonomy, see first column in Figure 6) by means of heuristics. The heuristics were implemented computationally, so that the heuristic mapping could be performed automatically [see 13 for details].

Writing activities	Surface change	Reorganization of information	Consolidation of information	Distribution of information	Addition of information	Deletion of information	Alteration of form (Macro-structure change)	Micro-structure change	Structure	S vs P	Ratio of Number of Words (F1)
	C1	C2	C3	C4	C5	C6	C7	C8	S1	S2	F1
Brainstorming	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	List	S = P	Change
Outlining	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Structured list	S = P	Change
Drafting	No	No	No	No	Yes	Yes	No**	Yes	Sections and paragraphs	S > P	Change
Revising	No	Yes	Yes	Yes	No*	No*	Yes	No*	Sections and paragraphs	S > P	Change
Editing	Yes	No	No	No	No	No	No	No	Sections and paragraphs	S > P	Constant

Figure 6: Heuristics that lead from changes in documents (columns) to identification of group writing phases

After this extensive pre-processing, we are left with an event sequence that we can interpret pedagogically, in the context of collaborative writing: for each document produced (by a pair of students in our case) we have a sequence of events in terms of the Lowry taxonomy, which we then can subject to sequence and process analysis, as sketched in Section 2.1.

3. Conclusions

Collaborative online writing provides CSCL researchers with rich data and at the same times comprises an important element of academic work and 'knowledge work' in general. We have demonstrated how building on a globally available 'cloud' writing tool (Google Docs) one can add analytical services that have the potential to support learning from writing. We have also demonstrated how one can move from log file visualizations to visualizations of process that capture the semantics of writing. On this level the notion of a holistic 'process' as different from a 'sequence of steps' becomes meaningful: teachers typically provide students with a sense of how the overall team writing process should proceed, linking all the elements of the taxonomy into a coherent whole, a students will, if things go well, strive to realize this process in their team work. (For more on the distinction between sequence and process in temporal data see [14]). How students react to these new affordances for learning will be the focus of our future studies.

Acknowledgements

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References

[1] Bereiter, C. and M. Scardamalia, *The psychology of written composition*. 1987, Mahwah, NJ: Lawrence Erlbaum Publishers.

[2] Galbraith, D., *Writing as a knowledge-constituting process*, in *Knowing what to write: conceptual processes in text production*, T. Torrance and D. Galbraith, Editors. 1999, Amsterdam University Press: Amsterdam. p. 139-150.

[3] Lowry, P.B., A. Curtis, and M.R. Lowry, *Building a taxonomy and nomenclature of collaborative writing to improve interdisciplinary research and practice.* Journal of Business Communication, 2004. **41**(1): p. 66-99.

[4] Scardamalia, M. and C. Bereiter, *Knowledge building: Theory, pedagogy, and technology*, in *The Cambridge Handbook of the Learning Sciences*, R.K. Sawyer, Editor. 2006, Cambride University Press: New York. p. 97-115.

[5] Amalesvoort van, M., J. Andriessen, and G. Kanselaar, *Representational tools in computer-supported colloborative argumentation-based learning: How dyads work with constructed and inspected argumentative diagrams.* Journal of the Learning Sciences, 2007. **16**(4): p. 485-521.

[6] Stern, S., *Producing Sites, Exploring Identities: Youth Online Authorship*, in *Youth, Identity, and Digital Media*, D. Buckingham, Editor. 2008, The MIT Press: Cambridge, MA. p. 95-117.

[7] Calvo, R.A., et al., *Collaborative writing support tools on the cloud*. manuscript under review.

[8] Villalon, J., et al., *Glosser: Enhanced feedback for student writing tasks*, in *8th IEEE International Conference on Advance Learning Technologies (ICALT) (Santadar, Spain, July 1-5, 2008; accepted March 2008)*. 2008: Santadar, Spain.

[9] Aalst, W.M.P.v.d., et al., *PROM4.0: Comprehensive support for real process analysis*, in *Petri nets and other models of concurrency (Proceedings 28th International Conference on Applications and Theory of Petri Nets and Other Models of Concurrency, ICATPN 2007, Siedcle, Poland, June 25-29, 2007)*, J. Kleijn and A. Yakovlev, Editors. 2007, Springer: Berlin. p. 484-494.

[10] Reimann, P., J. Frerejean, and K. Thompson, *Using process mining to identify models of group decision making processes in chat data*, in *Computer-supported collaborative learning practives: CSCL2009 conference proceedings*, C. O'Malley, et al., Editors. 2009, International Society for the Learning Sciences: Rhodes, Greece. p. 98-107.

[11] Southavilay, V., K. Yacef, and R.A. Calvo, *WriteProc: A framework for exploring collabortive writing processes*, in *Australian Document Computing Symposium*. 2009: Sydney, Australia.

[12] Villalon, J. and R.A. Calvo, *Single document semantic spaces*, in *The Australian Data Mining Conference*. 2009.

[13] Southavilay, V., K. Yacef, and R.A. Calvo, *Process mining to support students' collaborative writing*, in *Educational Data Mining Conference*. 2010: Pittsburgh, PA.

[14] Reimann, P., *Time is precious: Variable- and event-centred approaches to process analysis in CSCL research.* International Journal of Computer-supported Collaborative Learning, 2009. **4**: p. 239-257.

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Presentation Based Learning Support System to Facilitate Meta-Learning Communications

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Abstract: As described in this paper, we propose a presentation-based meta-learning scheme. First, we introduce the design rationale of our meta-learning scheme by introducing our conceptualization, which clarifies the kind of support to facilitate meta-learning that is embedded into our learning scheme. Secondly, we present support functions that we embed into the system. Thirdly, we conduct experiments to verify the meaningfulness of our learning scheme, which suggests the system can stimulate learners' reflection on their learning processes. Furthermore, it can stimulate learners' meta-learning communications. Results show that users tightened their criteria to evaluate their own learning processes and understanding states. It is useful for learners to facilitate change in their learning processes.

Keywords: meta-learning, meta-learning communication, presentation-based learning

Introduction

Many researchers working in the educational psychology field have described the importance of meta-cognition to enhance transfer to other learning domains [2] [3]. Research into computer-supported systems to enhance meta-cognitive skill are also investigated by many researchers based on shared recognition [7] [8] [9]. Results show, particularly in the educational psychology field, that an emphasis on meta-cognition must accompany domain-specific instruction in each of the disciplines, but not generic instruction in a general context, because the type of monitoring that is required will vary [1]. In a history course, for example, a student might be asking herself in an internal self-conversation, "who wrote this document, and how does that knowledge affect the interpretation of events," whereas in a physics course, the student might be monitoring her understanding of the underlying physical principle at work [1]. In the software development field, in addition to learning program design methods at the theoretical level, it is important to combine concrete examples with theoretical issues for constructing deep understanding. Our research goal is the enhancement of meta-learning through stimulation of learners' reflections on their own learning processes. To achieve this goal, we assign a task to make a presentation material on a specific pre-learned topic for other learners whose academic abilities are similar to those of the learner [6].

Collaborative learners with no regulation, however, might stray in undesired directions: in the case of our presentation-based learning, for instance, they tend to discuss illustrations of the slides, the impact of the presentation, and so on. These topics are important in the business scene, but are not necessarily important for learning the lesson at hand.

We therefore propose a support system that facilitates meta-learning communication by providing learners with viewpoints to discuss their learning methods.

1. Design Rationale of the System

Meta-learning is the learning of learning processes: it requires learners to perform meta-cognitive monitoring and control of their own learning processes. However, it is not always performed spontaneously.

We encourage learners' awareness of meta-learning by setting a presentation task whereby the learners must be conscious of teaching methods to plan audiences' learning processes. Through the task, we aim (1) to facilitate learners' acquisition of domain-specific significant learning activities and (2) to tighten their criteria to evaluate their own learning processes and understanding states by reflecting on their own learning processes.

We herein explain the design rationale of our meta-learning scheme by introducing our conceptualizations: SHIFT, LIFT, REIFICATION, TRANSLATE, OBJECTIVIZATION.

- **SHIFT**: Stagger the time of developing learning skills after performing problem-solving processes. The learner cannot allocate sufficient cognitive capacity to perform meta-cognitive activities if the learner must perform both learning and production of presentation materials. By setting pre-learned subjects, we shift the time of meta-cognitive learning after domain-specific learning.
- **LIFT**: Make the learner aware of learning skill acquisition. In preparing presentation materials, the learner monitors prior personal learning processes and asks herself queries to validate them. This stimulation corresponds to LIFT.
- **REIFICATION**: Give appropriate language for the learner's self-conversation to acquire learning skills. It provides terms for representing learning processes and plays an important role in realizing appropriate LIFT and OBJECTIVIZATION.
- **TRANSLATE**: Translate the learning skill acquisition task (LSAT) to a problem-solving task that includes the same task structure of LSAT. The targets of meta-cognitive activities in learning are *learning* activities performed in her head, whereas, in our learning scheme, these are *teaching* activities performed in the outside world by translating learning skill acquisition task to presentation task.
- **OBJECTIVIZATION**: Objectify a learner's self-conversation processes by externalizing them for learning communications with other learners.

The difference between REIFICATION and OBJECTIVIZATION is that REIFICATION is giving a term to facilitate learner's internal self-conversation by eliminating a difficulty of segmentation of process, while OBJECTIVIZATION is objectifying effects of designed teaching processes through interaction with other learners to verify them.

These conceptualizations clarify what kind of support to facilitate meta-learning we embed into our learning scheme.

By setting the presentation task in which learners explain pre-learned topic to others, the support concepts of SHIFT and TRANSLATE are embedded into our meta-learning scheme.

Support concepts of LIFT, REIFICATION, and OBJECTIVIZATION are embedded into our design principle for developing our learning support system described in the next sub-section: Our system provides terms for describing teaching plans and visualization environment according to the REIFICATION concept. It also provides guidance information to stimulate a learner's internal self-conversation processes according to the LIFT concept. Furthermore, it provides a CSCL environment according to OBJECTIVIZATION concept.

2. Embedding Support Functions to Facilitate Meta-learning Communication

In our research, we developed a presentation-based meta-learning scheme whereby learners can specifically examine learning on their own learning processes. Learners in our learning scheme perform learning by following three steps.

i. Learning specific domain contents through self-study or attending lectures until they think they have understood them
ii. Making comprehensive presentation materials to teach other learners who have the same academic level
iii. Collaborative learning using presentation materials

In the following, we explain support functions embedded into the system at (ii) and (iii) phases to facilitate meta-learning, although phase (i) is beyond our support.

2.1 Intention Structure Reflecting Learning Contexts

To encourage meaningful meta-communication among learning partners, each learner must (A) become aware of performing meta-learning and (B) share individual learning contexts. In our learning system, providing a representation to describe their intention of the presentation (intention structure), intention structures and guidance function according to them play roles of enhancing their awareness at the presentation design phase.

At the presentation design phase, we make learners construct intention structures to be aware of learning skill acquisition. Giving appropriate instructions according to learners' learning contexts is significant to facilitate their learning skill acquisition processes.
In our task setting of making truly comprehensive presentation materials for use by those who have the same academic level with the presenter, we adopt an assumption that intention structures of presentation reflect learners' learning contexts in their learning.

In the intention structure (Fig. 1. (iii)), each node represents an educational goal. Educational goals connected vertically to each other represent that the learner intends to achieve upper goals by performing lower ones, e.g., the learning goal of "Make the learner understand the significance of building DP" is detailed as its sub-learning goals that "Make the learner understand considerable viewpoint of software design" and "Make the learner understand the meaningfulness of that each DP has its own name." Terms are provided from the system to represent the learners' educational goals.

2.2 Guidance Function to Enhance Meta-Cognitive Awareness

Guidance information to facilitate the learner's reflection on personal learning processes is provided when the learner intends to move to the subsequent collaborative learning phase. It represents queries on domain-specific learning activity based on the learner's intention structure. The teacher giving a presentation subjects also constructs an intention structures and indicates required learning (teaching) activities on them that should be embedded into learners' intention structures. The system cannot understand the contents of learners' presentation written in natural language. However, it can process intention structures by referring learning skill ontology. Therefore, if learners did not embed them, then the system provides queries by referring domain-specific learning skill ontology and the teacher's intention structure as follows:

(1) "Do the following learning activities need to be included in your presentation to achieve the learning goal "make the learners understand DP using Abstract Factory pattern as an example?" Choose "embed into presentation" by right-mouse clicking if you think you need to do so.

(2) "Do you have sufficient understanding of these teaching activities? Check the items you had already understood."

□ Make the learner understand the meaningfulness of the fact that each DP has its own name.

□ Make the learner understand the advantages of object-oriented programming by combining its general theories with concrete examples in the Design Patterns.

□ … (Required learning activities defined in learning skill ontology are listed)

The learner is required to examine the importance of each learning activity for constructing comprehensive presentation materials: the learner judges whether the learner's presentation is valid or not and whether each learning activity should be included in the learner's presentation. This guidance is a stimulation to facilitate the learner's reflection on personal learning processes.

The fact that the learner did not embed listed learning activities is interpreted as follows: (a) the learner has no learning activities as domain-specific learning operators in his own consciousness, (therefore the learner cannot perform them) or (b) the learner does not understand the importance of the learning activities even if they have and they had performed their learning processes. The learner's checking activity in query (2) is interpreted as a declaration of whether the learner has them as learning operators.

For (a), the learner must perform the learning activities spontaneously or must be taught from the learning partners at the collaborative learning phase. For (b), the learner must encourage internal self-conversation to consider the importance of each learning activity.

The guidance function is embedded based on the LIFT concept. It plays a role of building a foundation to encourage meta-learning communications among learning partners by stimulating their awareness in meta-learning before starting collaborative learning.

2.3 Viewpoint Function to Stimulate Meaningful Learning Communications

Figure 1 portrays a screen image at the collaborative learning phase. The window comprises six panes: the presentation pane (Fig. 1 (i)), interaction history pane (Fig. 1 (ii)), intention structure pane (Fig. 1 (iii)), video chatting pane (Fig. 1 (iv)), text chatting pane (Fig. 1(v)) and discussion viewpoint pane (Fig. 1 (vi)). The system is implemented in Visual Basic (Microsoft Corp.) and Java, functioning cooperatively with Power Point (Microsoft Corp.).

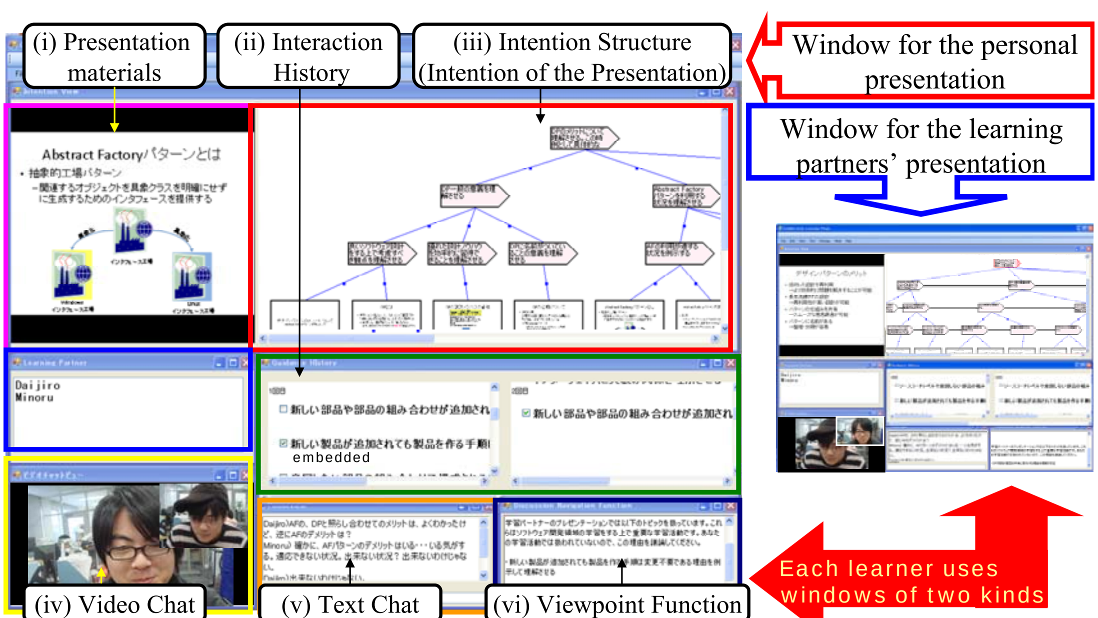

Figure 1. CSCL Environment to Facilitate Meta-Learning Communication.

The system in the collaborative learning phase provides support of two kinds to facilitate learners' learning skill acquisitions (acquiring learning operators and tightening evaluation criteria) as follows.

(1) Support to share learning (teaching) contexts of learning partners by referring to presentation materials with intention structures.
(2) Facilitate meaningful discussions to encourage their reflections on their own learning processes by providing discussion viewpoints.

As described in this paper, we particularly examine the topics on the viewpoint function. Thinking processes related to one's own learning processes are quite tacit. Therefore it is not easy to externalize and to discuss learners' thinking processes (while teaching processes reflecting their learning processes are externalized as intention structure). Ordinary learners with no support tend to discuss the appearance of illustrations, animations, and so on.

To eliminate the problem, our system provides viewpoints to discuss their teaching and learning methods based on the interaction history between the learner and the system at the presentation design phase. As shown in Fig. 1 (vi), the system provides each learner with respective viewpoints to discuss as follows: "You judged the learning activity "Make the learner understand the significance of the fact that an interface specifies the name of each method by taking an example." as important. It is an important learning activity in the software development domain and you embedded it into your presentation. On the other hand, your learning partner judged it as not important. Explain why you think this learning activity is important."

Collaborative learners can discuss their domain-specific teaching methods by referring to the viewpoints for meta-learning communication.

3. Experimentation

3.1 Objectives and Methods

We conducted an experiment to verify the meaningfulness of our learning scheme and usefulness of support functions embedded into the system. We specifically examine the issues of whether the system can encourage meta-learning communications. The outline of the experimentation is described below.

- **Subjects:** 16 graduate students participated. They had completed software engineering (UML) and object-oriented (Java) programming courses when they were undergraduate students. They were divided into two groups at random: eight students were in the experimental group (ExpG) using the system; eight were in the control group (CtlG).
- **Presentation topic:** Make presentation materials explaining the merits of building design patterns by taking the abstract factory pattern as an example.
- **Flow of the experiments:** Continuous 7 days lecture (90 min lecture each day) without weekend:
  - ✓ **1st – 2nd day:** Self-study of software design patterns until they think they have understood them. (Questionnaire administered at the end.)
  - ✓ **3rd – 5th day:** Making presentation materials. Participants in ExpG used our system; those of CtlG used only Power Point (Microsoft Corp.). The system provides 109 domain-specific learning activities (including 16 required learning activities) to describe their intention structures. (Questionnaire administered at the end.)
  - ✓ **6th day:** Collaborative learning for meta-learning. Each participant in CtlG had provided guidance information before coming to collaborative learning. Four pairs in each group are constructed for collaborative learning. Participants in ExpG referred discussion viewpoint if they thought it is meaningful. In this experiment, we did not use chatting function but did adopt face-to-face communication specifically to

examine the evaluation of usefulness of viewpoint provides function. They performed CSCL by sitting next to each other. (Questionnaire administered at the end.)

- ✓ **7th day:** Examination to take a credit of the course. (Questionnaire administered at the end.)

- **Evaluation methods:** Administered four questionnaires (5-scale, 52 items for ExpG in total, 30 items for CtlG in total) and performed protocol analysis.

One of the authors conducted the experiment in his course: he explained the meaningfulness of meta-learning—what it is and the intentions of performing the presentation based learning for all students—at the beginning of the first day's lecture. He also explained that the learning goal of the lecture is to acquire software development domain-specific learning methods.

3.2 Experimental Results And Analysis

3.2.1 Time Ratio Analysis of Learners' Communication Topic

Table 1 presents a time-based ratio of their communications as a part of the protocol analysis. The average time ratio of meta-learning communication of four pairs in ExpG is drastically more than the ones in CtlG although the teacher had instructed to all participants to perform meta-learning communications for getting them be aware of meta-learning. Therefore, it suggests that the system was able to encourage learner's meta-learning communications. The average time ratios of communication for confirming their understanding of fundamental domain-concepts and for trivial things (how to depict the class diagram, illustration and animation of the slides, and so on) in CtlG are significantly higher than those in ExpG. These results also support the meaningfulness of the system.

Table 1. Time Ratio of Communication Topics in Collaborative Learning Phase

Topics	ExpG	CtlG
Percentage of meta-learning communication	31.75%	11.75%
Percentage of discussion on domain knowledge	1.5%	12.5%
Percentage of discussion on appearance of slides	0.5%	20.25%

3.2.2 Questionnaire Analysis

Table 2 presents results of questionnaires after their collaborative learning. Questionnaire items 1 and 6–10 are for participants in both ExpG and CtlG: item 1 is related to the usefulness of the presentation-based learning scheme and 6–7 are related to learning effects from the viewpoint of meta-learning. Items 2–5 only for participants in ExpG are on usefulness of support functions embedded into the system.

Regarding item 1, participants in both ExpG and CtlG gave quite high marks, which suggests the presentation based meta-learning stimulates learners' reflection on their learning processes. Regarding item 2, participants in ExpG gave high marks, which mean that descriptions of intention structures are useful to share their learning contexts. Regarding items 3–5, participants in ExpG almost all gave high marks, suggesting that embedded support according to the LIFT concept is useful to encourage learners' reflections on their learning processes and their meta-learning. Especially, we were able to verify the viewpoint providing function can trigger their meta-learning communications.

It is expected that learners will execute better learning processes using the acquired domain-specific learning activities and tightened evaluation criteria if the learners' meta-learning processes are performed successfully. Items 6–10 inquired the about learners' consciousness of them. Both groups gave high marks to each item. However, CtlG gave higher marks than ExpG for the acquisition of domain-specific learning activities (items 7

Table 2. Results of Questionnaire after the Collaborative Learning Phase

Questionnaire Items		ExpG		CtlG	
		Mean	SD	Mean	SD
1	Do you think the collaborative learning after making your presentation materials enhanced your reflection on your own learning processes?	4.375	0.267	4.375	1.982
2	Do you think the intention structures facilitated your analysis on your learning partner's presentation structures (his teaching methods to construct audience's understanding)?	3.375	0.553		
3	Do you think the viewpoint providing function enhanced your consciousness of your learning methods?	3.625	0.839		
4	Do you think the viewpoint providing function facilitates your analysis of your learning processes?	3.625	0.839		
5	Do you think the viewpoint providing function facilitated your discussion?	4	1.142		
6	Do you think collaborative learning changed your criteria to evaluate your understanding of DP?	2.875	1.553	3.375	1.982
7	Do you think you could acquire learning methods using collaborative learning?	3.375	0.839	3.625	1.41
8	Do you think your learning processes for other DPs will change after performing this presentation-based learning?	3.75	1.071	3.5	1.428
9	Do you think you could acquire learning methods by performing this presentation-based learning?	3.625	0.553	4.125	0.982
10	Do you think your consciousness of learning will change by performing this presentation-based learning?	4.1	0.238	3.875	0.982

and 9), whereas ExpG gave higher marks than CtlG for items related to the consciousness of changes of their own future learning processes (items 8 and 10). Those responses seem to be mutually contradictory. However, they are not so by the following interpretation: learners in ExpG had tightened their learning criteria to evaluate their learning processes and understanding states; thereby, they also strictly evaluated their meta-learning processes. The results of the average time ratio of meta-learning communication support this. However, the fact that participants in ExpG gave low marks related to item 6 suggests that they were unable to perform all meta-learning processes by themselves even though they were able to understand the importance of meta-learning. They might be conscious of the functions. Actually, we do not embed the functions that support performance of learning activities acquired by meta-learning processes even when the system triggers learning activities. On the other hand, participants in CtlG spent less time for meta-learning communications, suggesting that the learners' evaluation criteria had not been tightened through their communications. Consequently, their evaluation results for these items were more tolerant.

4. Related Works

Through interaction with computer agents, Betty's Brain supports learners as they acquire domain knowledge and self-regulated skills [8]. Learners in their system and our system perform teaching activities. Betty's Brain supports learners' teaching processes on domain knowledge by externalizing the changes of Betty's understanding. It realizes SHIFT, LIFT, and TRANSLATE concepts. In contrast, we embed support functions to stimulate their judgment of the importance of domain-specific learning activities and facilitate their communication on them.

Learning support systems for self-directed exploratory learning embed a function to lighten a learner's cognitive loads of performing meta-cognition [7]. This embedding of functions does not always include the SHIFT principle. Furthermore, self-setting of learning goals and acquisition of experience of self-exploratory are important points in this approach. This emphasis differs from our goal because we fix the target domain knowledge for domain-specific meta-learning and seek to encourage learning skill acquisition by the production of presentation materials.

An interaction analysis system for collaborative learning was proposed by Inaba et al. [4]. The teacher can characterize learning interactions among learners using systemized concepts; then the system can understand the situation of the learners' interaction. Therefore, the system can show information related to each learner's state as well as the situation of the group discussion. Consequently, the teacher can instruct the group discussion based on that information. We also would like to develop an interaction analysis system for our presentation-based meta-learning scheme. It is also helpful for both learners and teachers to analyze their interactions.

Azevedo et al. [9] classified monitoring processes into 8 categories used by learners during self-regulated learning (SRL) with hypermedia and analyzed learners SRL processes in detail. We also would like to classify meta-learning processes by analyzing learners' learning communications.

5. Concluding Remarks

As described in this paper, we present discussion of a presentation-based meta-learning scheme. We introduced the design rationale of our meta-learning scheme by introducing our conceptualization. It clarifies what kinds of support to facilitate meta-learning are embedded into our learning scheme. Furthermore, we conducted an experiment to verify the meaningfulness of our learning scheme and usefulness of support functions embedded into the system, which suggests that the system was able to stimulate learners' reflection on their learning processes. It stimulates learners' meta-learning communications. Consequently, they tightened their criteria to evaluate their own learning processes and understanding states. It is meaningful for the learner to change their learning processes. We also evaluated their learning outcomes of domain dependent knowledge: it suggests participants in ExpG could get higher mark than ones in CtlG. We will carefully address the issues of this in future works.

References

[1] Bransford, J., Brown, A., & Cocking, R. (2000). Brain, Mind, Experience, and School, In *How People Learn*. Washington, DC: National Academy Press.

[2] Brown, A. L., Bransford, J. D., Ferrara, R. A., & Campione, J.C. (1983). Learning, Remembering, and Understanding', In: E. M. Markman & J. H. Flavell. (Eds), *Handbook of Child Psychology* (4th ed.) Cognitive Development, Vol. 3. (pp. 515–529) New York, NY: Wiley.

[3] Flavell, J. H. (1976). Metacognitive aspects of problem solving, In L. Resnick (Ed): *The Nature of Intelligence*. (pp. 231-235) Hillsdale, NJ: Lawrence Erlbaum Associates.

[4] Inaba, A., Ohkubo, R., Ikeda, M., & Mizoguchi, R. (2003). An Interaction Analysis Support System for CSCL, *Proc. Transactions of Information Processing Society of Japan*, *44*(11), 2617-2627 (in Japanese).

[5] Kayashima, M., Inaba, A., & Mizoguchi, R. (2005). What Do You Mean by to Help Learning of Metacognition?, *Proc. 12th Artificial Intelligence in Education* (*AIED2005*), pp. 346-353, Amsterdam, The Netherlands.

[6] Maeno, H., Seta, K., & Ikeda, M. (2010). Development of Meta-Learning Support System based on Model based Approach. *Proc. 10th IASTED International Conference on Artificial Intelligence and Applications* (*AIA2010*), (pp.442-449).

[7] Nakano, A., Hirashima, T., & Takeuchi, A. (2006). Developing and evaluation of a computer-based problem posing in the case of arithmetical word problems. *Proc. Fourth International Conference on Computer Applications*, (*ICCA2006*).

[8] Schwartz, D. L. et al. (2009). Interactive Metacognition: Monitoring and Regulating aTeachable Agent, In D. J. Hacker, J. Dunlosky, A. C. Graesser (Eds) *Handbook of Metacognition in Education*. (pp.340-358) Routledge.

[9] Azevedo, R. and Witherspoon, M. A: Self-Regulated Learning with Hypermedia, In D. J. Hacker, J. Dunlosky, A. C. Graesser (Eds) *Handbook of Metacognition in Education*. (pp.319-339) Routledge.

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A Tripartite Model of Co-designing for an iMVT Integrated Science Curriculum

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Abstract: Curricula that substantiate innovative pedagogies are crucial for sustaining and scaling up education reform efforts. However, when researcher-designed curricula are enacted by teachers, the results might not be what researchers expected. Both researchers and teachers need to understand national curriculum policies in order to align their selection, design, and enactment of certain curricula. A co-design strategy, thus, is ideal in order to address the challenges. In this paper, first we describe a tripartite model of curriculum co-design process for a secondary chemistry unit through collaboration among a Singapore MOE chemistry curriculum specialist, researchers, and teachers when developing an iMVT integrated curriculum. This was also intended as a means for teacher professional development to build teacher competence in adopting, sustaining, and scaling up our innovation. Secondly, we intend to find out a mechanism behind this tripartite collaboration to theorize a co-design model by analyzing the interactions among the three parties over about six months of time following a design research tradition. The study contributes to the literature by proposing and evaluating a tripartite model for curriculum development and teacher professional development.

Keywords: Co-design, a tripartite model, curriculum development, iMVT innovation, technology, secondary chemistry

Introduction

It is well-known that teachers tend to teach to the text and plan for students learning according to curriculum materials. Therefore, the curricula are crucial in schools for teachers to adopt an education innovation. Researchers in the learning sciences tend to develop curriculum materials that engage students in inquiry, make use of technology, and enhance students' learning experience in a context of design-based research [1]. However, the ideas may not be well understood by school teachers because usually the designers and enactors of a curriculum are different people with different expertise and emphasis [2]. One way to bridge the gap is to involve the teachers in the process of curriculum development to advance their understanding of the innovation [3]. In 2009, Singapore National Institute of Education (NIE) has advocated an 'enhanced partnership model' within the Teacher Education Programme to strengthen the tripartite relationship between the key stakeholders that determine the quality and excellence of teacher education – Ministry of Education (MOE), schools , and NIE [4]. In our project, we make use of this strategic relationship between the three parties to develop a model for co-designing and sustaining our pedagogical innovation called iMVT (Modeling and Visualization Technology integrated inquiry-based learning) [5]. We engage a chemistry curriculum specialist from MOE, the teachers from four collaborating schools, and researchers from NIE with support from international collaborators into a co-design process in order to design and enact iMVT integrated curriculum materials and research. Besides addressing student learning difficulties in chemistry topics, this tripartite model of curriculum co-design is also considered a means to address teacher learning of the innovation. We eventually built a community of practitioners with teachers' participation in order to sustain and scale up the educational innovation. The following research questions guide the research:

- What does the tripartite curriculum co-design process look like?
- How do the interactions among different parties lead to quality curriculum materials?

In this paper, we first briefly state the theoretical underpinning of the iMVT innovation and the co-design process, then provide the context of the study, our data and data analysis. The result section answers our research questions in details. We concluded that this study contributes to the literature by providing a model for building a community of practice in order for teachers' adopting, sustaining, and even scaling up an ICT –based innovation.

1. Theoretical underpinning

Although the inquiry process provides students a more authentic experience during science learning, there are many challenges to the successful design and implementation of inquiry-based curriculum [6]. Adapting scientific models and visualization tools in education has become a hot topic of recent science education research not only with physical models [7] but also computer models. Modeling-based inquiry [8] is a specific pedagogical approach that focuses on computer modeling to investigate phenomena that might be difficult to do without technology. Although learning sciences through the i, M, V, T as described above have not been uncommon, putting them together to form an iMVT framework can be a new paradigm to reshape the science learning pedagogy when using technology. iMVT can be an innovative pedagogy that applies to chemistry, biology, physics, and perhaps other subjects. It is a collaborative inquiry-based pedagogy to address student science learning difficulties [5] and it has.shown to be an effective way to facilitate students' understanding in several Singapore secondary schools using different learning sciences research designs [9-10].

In recent years, a collaborative approach to develop innovations has been explored by researchers in the learning sciences. Penuel et al. [11] defined the co-design process and described seven characteristic features of co-design as a method. Besides as a way aiming to develop curriculum materials and assessment tools [3] [11-12], co-design process is also perceived as way to build community and common language among researchers and teachers, as well as a form of teacher professional development [11]. There are many reasons to involve teacher into the co-design as co-designer rather than transmitters [13], but at the same time, there are hurdles impeding teachers in becoming participators in the co-design, such as the unfamiliarity with the changed roles and few materials to support their participatory relationship with curriculum materials [14].Some key tensions revealed from the previous studies of co-design process, such as teachers' limited time committed to the project [11] co-design process, but little was done to specially describe how the tensions were resolved.

2. Context

The current research study is a part of a larger designed-based research project (MVTII) [15] aiming to sustain and scale up the iMVT innovative pedagogy from the MVT [16]. We argue that this innovative pedagogy applies to all the science subjects and we work with more than twenty teachers in four collaborating schools in Singapore to develop curriculum materials in chemistry, physics and biology. In this paper, we focus on the first cycle of our chemistry design work that has finished in March 2010 with one teacher Mr. Woo (all names are pseudonyms) in one collaborating school. He has eight years' teaching experience and is currently holding the duties of the head of department for Science in his school. Besides normal teaching, he also has administrative commitments in the school. For chemistry, we were fortunate to collaborate with one of the few chemistry curriculum specialists from CPDD (Curriculum Planning & Development Division), MOE in Singapore. The curriculum specialist, Ms. Ai, has been working on curriculum policy and preparing teachers for curriculum enactment at CPDD for ten years. She was an ex-teacher and she knows the Singapore education system and teacher needs very well. The topic is *Particulate Nature of Matter* for secondary one student, which is commonly regarded as a challenging topic for secondary students because there are many abstract concepts and hence difficult for students to understand. The design of this topic started from October 2009 and went through several iterative revision and refinement process among the tripartite parties until it was enacted in February 2010. The curriculum development is mainly led by a researcher and the project principal investigator with chemistry education background. Two international collaborators also gave valuable comments and feedback on some drafts of the curriculum. The implementation lasted about 7.5 periods (one hour for each period) including the pre-test and post-test of content understanding and pre-survey and post-survey of students' understanding of models and modeling. Researchers and MOE collaborator followed through the classroom implementation to provide on-site support during the lesson and also gave quick feedback to the teacher after the lesson.

3. Data and data analysis

During the process of co-design, every party in this tripartite relationship communicated with each other through various modes including mobile phone SMS messages, phone calls, emails, and face-to-face communication, such as teacher-researcher working sessions. All these communication records were collected, transcribed and analyzed to examine the frequency and content of communication, and the synergy among different modes, hence revealing how the tensions have been resolved. Teacher interviews before and after the implementation were also transcribed to examine how the interactions worked for teacher learning and knowledge and belief change.

4. Results

Past research has revealed different kinds of tensions in the co-design process due to the relatively complex collaborating system. Our co-design process was iterative in nature. Table 1 presents a summary of continuous phases we have gone through and the tensions revealed in different phases of the first cycle of co-design, from which we can also infer about different roles that the three parties played out. To initiate the curriculum design process, researchers came up with a general template of iMVT integrated curriculum package (the student workbook as the main product). It was circulated and finalized by the research team, then shared with MOE collaborator and teacher. When choosing the suitable software, teachers were more concerned about students' capabilities to learn through such a software rather than teaching strategies, while researchers from an analytical stance considered more about the software's usability in modeling process. The depth of the content is determined based on the school's scope and discussed within three parties after several rounds of communication. After settling down the scope and sequence, researchers initiated the first draft of workbook and engaged in several cycles of revision with the teacher and MOE collaborator before its implementation. After the final revision, the teacher conducted the lessons while researchers and MOE collaborator observed the process and provided on-site support. One more round of revision and refinement has been done after observing students' reactions to the activities, their performance in the test and teacher's feedback on the practical issues, and a similar unit has been developed based on this topic and readily be enacted by another collaborating school.

Table 1. Major tasks and participants in different phases and tension revealed

Time	Major Tasks	Participants	Tension
Sep.'09 -Nov.'09	Develop a general template for all the three science subjects	Researcher, MOE collaborator	Different views on types and organization of students activities
Oct.'09 -Dec.'09	Search for the suitable simulation utilized in curriculum	Researcher, teacher	Different focuses when integrating the technology
Nov.'09 -Jan.'10	Continuously co-design and revise the workbook	Researcher, MOE collaborator, teacher	Teacher's time constraint between co-design and normal teaching schedule
Feb.'10	Implement the curriculum	Teacher, Researcher, MOE collaborator	Different interpretation of the iMVT pedagogy between teacher and researcher
Feb.'10 -Apr.'10	Further revision and refinement of the workbook	Teacher, Researcher, MOE collaborator	Teacher's time constraint and different perspectives of refinement among the three parties

'Teachers never have enough time' has been reported as one tension revealed in the co-design process [11], and this is especially true for our collaborating teacher. Besides the teaching, he has other administrative and research commitments in school. What's more, in the tripartite relationship, we had to coordinate the busy time schedule among three parties. In order to resolve this tension, alternative ways of communication other than face-to-face working sessions were taken to facilitate the conversations among the three parties. As shown in Figure 1 and 2, intensive communication among the three parties existed before and during the iMVT implementation. Emails were used to exchange the ideas on curriculum feedback, acquire students' information as well as updates for project progress, and the teacher always responded promptly and sometimes even initiated the discussions. SMS messages were more used for the logistic matters, such as arrangement of classes and reminder of meetings. Different modes were utilized synchronously to improve the efficiency and effect of the interaction. Researchers interacted with the other two parties through multiple modes, while teachers and MOE collaborator mainly through face-to-face working sessions. Four working sessions were held before the implementation period and each of the working session lasted 1.5-2 hours, where all the three parties exchanged the ideas and discussed about the details of curriculum. During the implementation, researchers went to school and provided on-site support to teacher and exchanged ideas of improvement of curriculum after each lesson.

Another key tension that affected the productivity and success of the co-design was the different expertise that different parties brought in. With different professional background, three parties tend to give feedback from different perspectives to improve the productivity of the co-design. There are in total 11 ongoing versions of workbook with track changes from different parties, 3 of them came from MOE collaborator and 3 were contributed by teacher. All the comments and track changes (not including grammatical revisions) were looked into and analyzed to examine the different expertise that the three parties bring in. Our analysis found that three parties demonstrated different expertise and focus of the curriculum. Researchers were more concerned about the overall framework of the innovation and the scientific accuracy of instructions and questions. The MOE collaborator provided insight about the process of students' knowledge development, for example, in one document, she reminded the researcher to go over the science syllabus requirement on this topic to get an idea of how the ideas should be connected to students' previous knowledge in primary school and proceed to the next level. It is worth mentioning that after reading the literature papers that researchers have recommended to her, MOE collaborator gave valuable advices on how to make this innovative pedagogy more practical in the Singapore context. After the framework was shaped up, the teacher was then pulled in to revise the workbook. He cared more about more practical and detailed issues such as the formatting of the questions to be in line with O' level syllabus. During the process, he also contributed the resources he has used from his previous lessons to make the package more comprehensive.

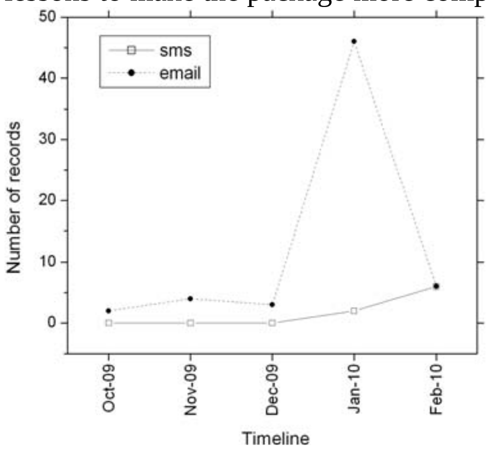

Figure 1. Communication records between researchers and the teacher

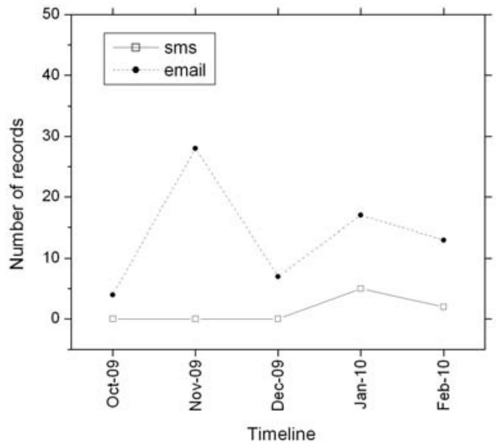

Figure 2. Communication records between researchers and the MOE collaborator

Teachers often see researchers' solutions as too theoretical and not practical enough for real classrooms, while researchers often view teachers' limited content knowledge as a barrier to their contributing effectively to design efforts [17]. Whereas, MOE collaborator at a middle stance knows the situation of schools and teachers' practical concerns, at the same time she is more ready and able to take in the innovative ideas. The MOE collaborator was invited to the workshops, the working sessions where we interacted with teachers, and the researcher's group meeting. She knows the Singapore school system well and is aware of teacher's concerns and constraints, at the same time she also understands the goals and principles of the research. As a mediator, MOE collaborator bridged the gap between the researchers and teacher by translating researcher's ideas using her interpretation and considering the teaching practical issues from teacher's point of view in the working sessions. Hence, the teacher got access to more authentic understanding of the innovation in real context from various channels rather than only from researchers. Further more, he was in a sense encouraged to implement the innovation with the support from people from government level. At the outset of the collaboration, teacher might have doubted about the feasibility and advantages of the innovation, but MOE collaborator convinced the teachers using her own understanding and experience with other school teachers. The teacher thought people have talked about 'inquiry' all the time and everywhere, and wondered whether it's worthwhile to try the iMVT out. The MOE collaborator stated, "*you said many schools are conducting (inquiry) because of our curriculum framework… the way we reach inquiry, I think the problem ah, is still time, no time to do this no time to do that, even down to actually bringing our students down to concepts", "I suppose I must deal that this way of doing inquiry, there's something special, it's our modeling… so far I haven't seen someone actually use computer, plus modeling to do inquiry*". She also played the role of facilitating the bonding of researchers and teacher such as she found a way to initiate the conversation between researcher and teacher as shown in following excerpt from transcript of one of the working sessions. "*You know, so my concern is when I look at the workbook, all of us must have good ground work and background knowledge before we go to design. It is very difficult, maybe on the part of X (one researcher's name), to try to understand what she is going to provide in the* *worksheets and what sec. 1 students know. …so where is the starting of the whole science curriculum, maybe you can share with us so that she can understand better*”.

The involvement in the co-design provided teacher a platform to think through systematically the relation between pedagogy and content and chances to talk with researcher to promote their understanding. The technologies may have their own propensities, affordances and constraints, which present challenges to teachers who are willing to integrate more technology in their teaching [18]. The teacher also pointed out ‘*the downside of technology*’ that teacher needs to ‘*have a lot of time, in a way wasted, to help students to manage*’ the technical issues. In order to tackle the problem, researchers and teachers exchanged ideas and discussed about how to optimize the technology to be utilized for students. With the criteria for searching software provided by the researchers, the teacher also searched and recommended the possible simulations, and contributed his ideas on teaching strategies. He showed improved understanding of the pedagogy framework and expressed enhanced understanding of technology in education after co-design process. When talking about the understanding of iMVT, he put emphasis only on power of technology but kind of ignored the strength of its integration with pedagogy in the pre-survey as saying that “*it allows the users/learners to explore information and data in a meaningful and authentic way to gain greater understanding and insights regarding the scientific data/information… for example, the use of MVT to teach electrolysis will enable students to discover for themselves without using actual laboratory equipment……*”, but after several working sessions and co-design experiences, he stated the iMVT innovation more comprehensively and expressed explicitly its advantage in pedagogical usage in the mid-survey that “*the use of modeling and visualization tools for the learning of sciences is not new, however, to incorporate them onto a common platform for students to collaborate… there could be greater interactions (peer teaching) taking place and hopefully with the combination of self-discovery coupled with collaborative learning, students would be able to achieve deep learning*”, “*The visual and interactive nature (such as manipulation) of the objects in the tools would also bring in a higher degree of authentic learning”*. After carrying out the iMVT lessons, the teacher appreciated the pedagogy “*a worthwhile approach*” though some practical issues existing, and he expressed his willingness to continue using this materials with other classes and revise based on the responses from students.

With the processes as described above, we concluded the interactions of three parties in the tripartite relationship as shown in Figure 3.

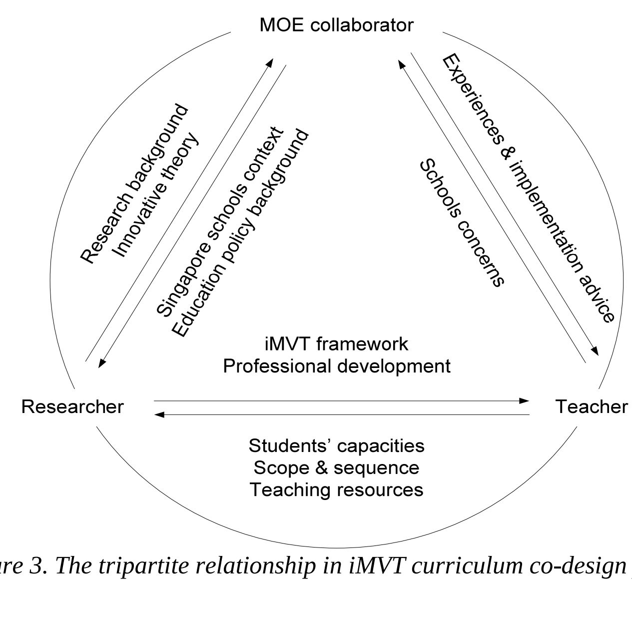

Figure 3. The tripartite relationship in iMVT curriculum co-design process

5. Conclusion and Discussions

Multiple tensions existed between teachers, and researchers due to their backgrounds and emphases. Our study revealed that the key tensions persist along the collaboration journey, but we resolved the tensions by the tripartite relationship model where each party demonstrated the agency [19], especially the MOE collaborator's role to bridge the gap between researchers and teachers. It is definitely challenging to introduce a new party in the collaborating cycle resulting in a more complex system. However, it is necessary that every party's strengths are optimized and brought out into this collaboration to make the system work smoothly and successfully. The model provides a new way of collaboration and work out a way to effectively address the long-standing tension between researcher and teacher [11, 14]. The tripartite model generated here might be adoption-limited in a way that it's a model formed in a very unique set-up of education ecosystem, where the three parties from research, practice and policy level worked closely to achieve the desired outcomes of education. Although not every research team has the luxury to invite an MOE curriculum specialist or people of such caliber to be a collaborator, we believe that different parties in this tripartite model can be replaced by the ones that function equally when researchers in other context want to adopt the model. A party who holds administrative responsibilities in supporting teachers' understanding and enacting national or state curriculum, and has experiences of teacher training could substitute the role of the MOE collaborator in our project. What's more, professional development has always been viewed as an important approach to the sustainability of an innovation and consistency between designed curriculum and enacted curriculum [20]. In our project, we have proposed the tripartite model of co-design where teachers were engaged in the design process of innovative curriculum and shown the evidence of teacher's development of capacity. This contributes to the literature of professional development. The interaction in the co-design was definitely not only uni-directional. It's not only about the benefits researchers or MOE collaborator bringing to the teacher, but also the influences each party bring to another one.

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References

[1] Singer, J., et al., *Constructing Extended Inquiry Projects: Curriculum Materials for Science Education.* Educational Psychologist, 2000. **35**(3): p. 165.

[2] Remillard, J.T., *Examining Key Concepts in Research on Teachers' Use of Mathematics Curricula.* Review of Educational Research, 2005. **75**(2): p. 211-246.

[3] Edelson, D.C., *Design research: What we learn when we engage in design.* The Journal of the Learning Sciences, 2002. **11**(1): p. 105-121.

[4] NIE, *A Teacher Education Model for the 21st Century*. 2009, National Institute of Education: Singapore.

[5] Zhang, B.H., et al., *Developing an iMVT Pedagogy for Science Learning*, in *9th International Conference of the Learning Sciences*. 2010: Chicago.

[6] Edelson, D.C., D.N. Gordin, and R.D. Pea, *Addressing the Challenges of Inquiry-Based Learning through Technology and Curriculum Design.* Journal of the Learning Sciences, 1999. **8**(3): p. 391-450.

[7] Lehrer, R. and L. Schauble, *The development of model-based reasoning.* Journal of Applied Developmental Psychology, 2000. **21**(1): p. 39-48.

[8] Hay, K.E., B. Kim, and T.C. Roy. *Virtual reality modeling-based inquiry: Conceptual coherence and alternative theories trials.* in *Annual Meeting of the American Educational Research Association*. 2004 San Diego, CA.

[9] Zhang, B.H., et al., *Exploring the representational affordances of two types of modeling tools*, in *Annual meeting of the American Education Research Association*. 2008.

[10] Zhang, B.H., et al., *Exploring modeling and visualization technology (MVT) enhanced biology teaching and learning in Singapore*, in *The International Conference for the Learning Sciences (ICLS)*. 2008: Utrecht, the Netherlands.

[11] Penuel, W.R., J. Roschelle, and N. Shechtman, *Designing Formative Assessment Software with Teachers: An Analysis of the Co-design Process.* Research and Practice in Technology Enhanced Learning, 2007. **2**(1): p. 51-74.

[12] Maldonado, H. and R.D. Pea, *LET's GO! to the Creek: Co-design of Water Quality Inquiry Using Mobile Science Collaboratories* in *6th IEEE International Conference on Wireless, Mobile, and Ubiquitous Technologies in Education*. 2010. p. 81-87.

[13] Connelly, F.M. and M. Ben-Peretz, *Teachers, research, and curriulum development*, in *The curriculum studies reader*, D.J. Flinders and S.J. Thornton, Editors. 1997, Routledge: New York. p. 178-197.

[14] Gunckel, K.L. and F.M. Moore. *Including Students and Teachers in the Co-Design of the Enacted Curriculum*. in *NARST Annual Meeting*. 2005. Dallas, Texas.

[15] Zhang, B. and S. Foong, *Sustaining and Scaling up Modeling and Visualization Technologies Enhanced Inquiry-based Science Learning (MVT II)*. 2009, Office of Educational Research, National Institute of Education: Singapore.

[16] Zhang, B.H., M.J. Jacobson, and B. Kim, *Enhancing Inquiry-based Science Learning through Modeling and Visualization Technologies (MVT)* 2007, National Institute of Education, Nanyang Technology University, Singapore.

[17] Shrader, G., et al. *Participatory design of science curricula: The case for research for practice*. in *Annual Meeting of the American Educational Research Association*. 2001. Seattle,WA.

[18] Koehler, M.J. and P. Mishra, *What is technological pedagogical content knowledge?* Contemporary Issues in Technology and Teacher Education, 2009. **9**(1): p. 60-70.

[19] Sewell, J., William H., *A Theory of Structure: Duality, Agency, and Transformation.* American Journal of Sociology, 1992. **98**(1): p. 1.

[20] Kubitskey, B. and B.J. Fishman, *A role for professional development in sustainability: linking the written curriculum to enactment*, in *7th International Conference of the Learning Sciences*, S.A. Barab, K.E. Hay, and D.T. Hickey, Editors. 2006: Bloomington IN. p. 363-369.

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Exploring Interactive Patterns among Students in Competitive Games by a Mixed Approach

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Abstract: Recently, many researchers are interested in the game-based learning environment. However, few empirical studies investigated the issues of surrounding influence between real classroom context and virtual environment context. Hence, this study examines the interactions among students in the situation of competitive games. We implemented a game-based learning environment, entitled My-Pet-My-Quest, and a study was conducted in an elementary after-school club for 29 students over a four-month period. This study employed a mixed approach for data collection and analysis that contains collecting system records data, observation comments, and questionnaires, as well as adopting social network analysis and regression analyses. The results showed that 1) the students' self-reported friendship states predict the extent to which they interact with their friend in on-line environment; 2) the interactive patterns of schoolboy and schoolgirl differ regarding their genders in game-based learning environment; and 3) an elementary school student in the competitive game not only competed with others, but also enhanced the social interaction and emotional communication. Some suggestions about the results were also discussed. Firstly, researchers could use mixed methods to explore the patterns of interaction on game-based learning environments; secondly, researchers could adopt social network analysis for the design of game-based learning environments; finally, researchers could comprehend the interactive patterns of real classrooms and virtual competitive games.

Keywords: game-based learning environment; competitive game; social network analysis

1. Introduction

Many researchers are interested in the studies relevant to game-based learning environments in recent years, for example, River City [10] for science inquiry learning, exploring embedded guidance and self-efficacy in educational multi-user virtual environments, and Whyville.net [6] for online learning, focusing on a connective ethnography of peer knowledge sharing and diffusion in a tween virtual world. The above-mentioned studies mainly focused on the discussion of happenings in virtual learning environment. In contrast, few empirical studies explored some of the issues surrounding influence between real classroom context and virtual environment context.

Hence, the study explores the interactions among students in situation of virtual competitive games with real classrooms. The study implemented a My-Pet-My-Quest [3, 2] for math learning in an elementary after-school club during the 120-day period. The study would be discussed a part of the entire implementation; we focus on reporting the findings of **"interactive patterns of students"** on competitive games.

2. Method

2.1 Participants and Context

The participants were 29 third-grade students (14 schoolboys and 15 schoolgirls) from an elementary school in Taiwan. Each participant had a small portable laptop computer with wireless capability as “small notebook”. Each participant used the notebook to practice the math problems about basic computation in a game-based learning environment.

2.2 Game-based Learning Environment

Previous study developed the game-based learning environment on arithmetic practice, entitled My-Pet-My-Quest (MPMQ) [3, 2]. The MPMQ is a web-based system, a pet-keeping environment where the virtual characters represent learners’ open learner models [1], supporting the learning tasks, seeing figure 1. Additionally, the MPMQ contains many pet-keeping tasks and learning tasks, while students would play the role of pet-keeper who can interact with virtual pets and solve a series of small quests that sustain students’ motivation and engage them in a game-based learning environment.

Figure 1. Snapshot of the My-Pet-My-Quest environment.

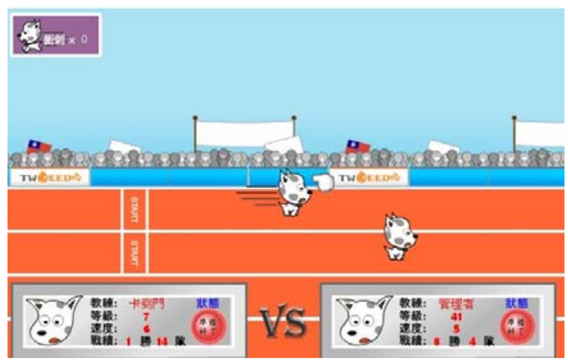


Figure 2. Snapshot of the competitive game.

Students will also play the role of coach who can interact with My-Pet that sustains his/her motivation and engages him/her in learning tasks and competition activities [9]. The coach needs to train My-Pet and to complete the learning task in Quest Island, and the coach has to control the pet to compete against other coach in a competitive game, seeing figure 2. Students can free select the competitor’ pet in each competitive game according to the identification of competitor’ pet in MPMQ. Students could decide to compete with who have relationship of friendship or according to present identification. In other words, the students can find their competitor by themselves while the students also need to learn to pick good strategies for negotiating with other classmates.

2.3 Procedure

The study utilized a ‘‘game-based learning’’ activity in an elementary after-school club. The process was divided into two phases. First phase: the period of after-school club was from 9/01 to 12/31 in 2009, and students could nurture one virtual pet, practice the math problems about math basic computation, and compete with other pets in the MPMQ environment. In each day, the students used the small notebook for approximately thirty or forty-minute sessions. During the period, graduate students were as teacher assistants to observe the students' usage and feedbacks. Second phase: when the students finished the term activities, the questionnaire with relationship was carried out.

2.4 Data Collection and Analysis

This study employed a mixed approach for data collection and analysis. [4] proposed a suggestion that "the quantitative data and results provide a general picture of the research problem; more analysis, specifically through qualitative data collection, is needed to refine, extend, or explain the general picture" [4, p.515]. Data mainly came from students' behaviors recorded in a game-based learning environment, and the relationship among students about real classroom and the questionnaire of competitive game impression collected in end of semester. There were two types data collected. In addition, students' behaviors generated from daily solving a variety of learning task and competitive game activities, each student was also observed to keep the observation comments [11].

Regarding data analysis, first, for the quantitative data, a descriptive analysis and a social network analysis (SNA [5]) were applied to explore students' online behaviors and patterns of social dynamics between friendship in real classrooms and interaction in virtual competitive games. Then, a regression analysis was followed to look specifically into students' relation between a real context and a virtual context. Finally, in order to further explore whether and how students actually deepen their impression of the competitive games, analysis of quantitative data and qualitative data were employed in the study to achieve triangulation verification.

3. Findings

The following four subsections described both quantitative and qualitative results. Firstly, we started with the statistical distribution of students' participations in a virtual competitive game. Secondly, we reported the basis for interpretation of the SNA graphical representation. Thirdly, we further examined and predicted the relationship between the friendship in a real classroom and interaction in a virtual competitive game. Finally, we reported the investigation of a questionnaire about students' opinion and competitive game impression.

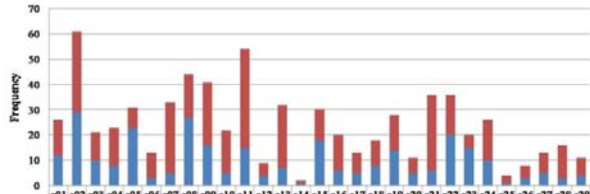
3.1 Distribution of Students' Participations in Virtual Competitive Game

Table 1 shows the period of on-line game-based learning activities, and 702 times competition game was generated among 14 schoolboys (453 times) and 15 schoolgirls (249 times). On average, each student participated 24.21 times and the standard deviation was 14.28; each schoolboy participated 28.31 times and the standard deviation was 16.14; each schoolgirl participated 19.15 times and the standard deviation was 10.01.

As we can see in table 1, schoolboys participated more times in general than schoolgirls. There were four schoolboys (#a02, #a11, #a08, and #a09) and two schoolgirls (#a21 and #a22) who were very active and engaged more than 35 times in game-based learning environment. From this distribution, we noticed that two schoolboys (#a12 and #a14) and two schoolgirls (#a25 and #a26) participated fewer times.

In order to explore how these interactions intertwined among students, we need further examination with SNA to uncover the interactive structure of the students as a competitive game.

Table 1. Distribution of Students' Participation in Virtual Competitive Game.



	a01	a02	a03	a04	a05	a06	a07	a08	a09	a10	a11	a12	a13	a14	a15	a16	a17	a18	a19	a20	a21	a22	a23	a24	a25	a26	a27	a28	a29
Lose	14	32	11	15	8	10	28	17	25	17	39	5	25	1	12	14	8	10	14	6	30	16	5	16	3	5	8	13	7
Win	12	29	10	8	23	3	5	27	16	5	15	4	7	1	18	6	5	8	14	5	6	20	15	10	1	3	5	3	4

3.2 The Dynamics of Relationship among Students between Real classroom and Virtual Competitive Game

This initial analysis in table I was very helpful in interpreting the results of SNA in Figures 3 and 4. In Figure 3, the graph shows the entire social network of 29 students on the competitive game. Up triangle with blue represents schoolboy while circle with red represents schoolgirl. Black lines between students indicate that they jointly participated to the same competitive game. Red lines represent that they not only jointly participated to the same competitive game but also its own friendship in real classroom. There were strong ties of interaction between the different nodes indicate roughly which students were more closely linked to others.

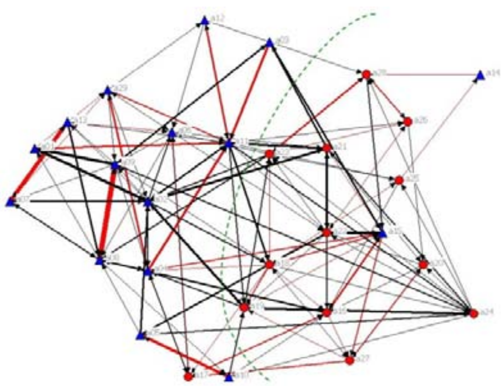


Figure 3. Graphical representation of students' interaction patterns with firendship on virtual competitive game.

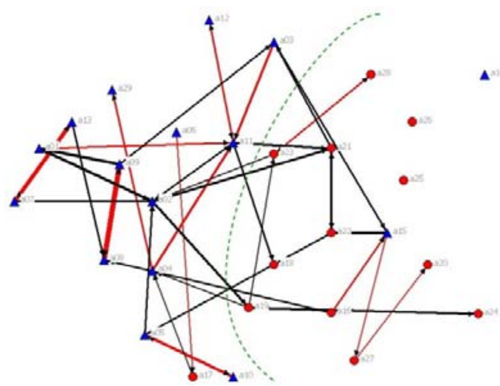


Figure 4. Reduced graphical representation of students' interaction patterns with firendship on virtual competitive game.

From this figure 3 we found two points. Firstly, two subgroups in terms of the roles: one cluster at the left part of the graph is composed mainly of schoolboys, with the exception of one schoolgirl, a17; and the other at the right part is composed mostly of schoolgirls, with the two schoolboys, a14 and a15, appearing about the periphery and one at the center (a15) surrounded by all the schoolgirls. Secondly, mostly of black links based on red links mean that competitive game possible enhanced interpersonal relationship in game-based learning environment. It's very interesting to explore further what happened in this social network.

The graph in figure 4 is identical to figure 3 but shows only co-participation competitive games greater than 5. By comparing all interactions in figure 3 with the strong co- participation in figure 4, we can more easily find better which stronger interactions exist. In this reduced graph, the two subgroups introduced earlier become clearer, seeing figure 4. The smaller one consists mainly of mostly schoolgirls and one schoolboy, while the other bigger one consists of mostly schoolboys.

The insights provided by this reduced graph imply two things. Firstly, the mostly students in the two subgroups either schoolboy play together, or schoolgirl play together. Secondly, the members that bridge two subgroups of social networks are a04, a11, and a15 for the schoolboys and a17, a18, a19, and a21 for the schoolgirls. The SNA shows that their interests cross the boundary between the same genders. Altogether, it is clear that times of co-participation are generated in a mixed fashion by both schoolboys and schoolgirls. This competitive game has successfully interwoven and enhances students into communal relationships of co-participation.

In order to analyze how these interactions of gender among students, we adapt further examined with regression analyses to understand the interactive structure between real context and virtual context.

3.3 The Interactive Structure of Gender among Students

The entities, means, and standard deviations of each variable are presented in table 2. According to the research questions, we investigated whether students' friendship would predict co-participation on competitive game. To examine this, we first carried out a regression analysis in which students' co-participation in virtual competitive game was predicted by students' friendship in real classroom. The results are presented in table 3. The R squares (R^2) for each equation was also calculated and is given in table 3.

Table 2. Descriptive Statistics of Competitive Game.

Competitive Game	E	M	SD
Boy-Boy	196	1.69	4.53
Girl-Girl	225	.85	2.14
Boy-Girl	210	.40	1.71
Girl-Boy	210	.42	1.74
Total	841	0.83	2.78

Schoolboy (n = 14), Schoolgirl (n= 15)

The results showed that students' friendship emerged as a significant predictor (R^2 = .17, $F_{(1, 839)}$ = 174.72, P < .001) of co-participation on competitive game. An analogous analysis was carried out for students' friendship among genders, seeing table 3. These results showed that the friendship about boy-boy (R^2 = .42, $F_{(1, 194)}$ = 140.14, P < .001), girl-girl (R^2 = .11, $F_{(1, 223)}$ = 26.78, P < .001), and boy-girl (R^2 = .05, $F_{(1, 208)}$ = 11.22, P < .001) predicted students' co-participation on the competitive game. There was not significant about the relation of Girl-Boy (R^2 = .00, $F_{(1, 208)}$ = 0.92, P > .001).

3.4 The Opinion and Competitive Game Impression

Table 4 presents the statistical results of the 5-scaled questionnaire regarding student opinions. Opinions of "strongly agreed" and "agreed" are regarded as positive responses. The questionnaire indicated 29 (100%) students had the experience on playing computer games. In terms of students' interest and motivation, 28 (96.55%) students showed that MPMQ raised their attraction to the learning subjects, and 21 (72.41%) students expressed that My-Pet-My-Quest enhanced their willingness to practice in learning activities. For the relationships among classmates, 26 (89.66%) students indicated that they like constant compete with others.

Table 3. Regression Analyses for Friendship and Virtual Competitive Game (N = 29).

	r	B	SE	β	T
Boy-Boy	.65**	10.13	.86	.65	11.84
Girl-Girl	.33**	1.93	.37	.33	5.18
Boy-Girl	.23**	5.62	1.68	.23	3.35
Girl-Boy	.07	.84	.88	.07	.96
Total	.42**	4.55	.34	.42	13.22

Students' interviews were conducted to collect further detailed information about students' affective experience. Most students like to play the pet-racing game while different students have different reasons, such as, to become a winner (e.g., "*I like to go dog racing, because I can beat someone's dog*", #a02), to obtain reward (e. g., "*I like to play with others , because I can get gold medal*", #a16), to know who is winner (e. g., "*I want to know who get first prize or second prize*", #a11), and to be exciting or for fun (e. g., "*I feel game is very fun*", #a8). Few students don't like to play the pet-racing game because they are afraid to become a loser (e. g., "*I do not like I very much, because I will lose it*", #a23) and the fear of being laughed at (e. g., "*Because my dog run very slowly, I am afraid of being laughed*", #a14).

Table 4. Questionnaire and statistics regarding student opinions

Item	# of S.A.	# of A.	# of N.	# of D.	# of S.D.	Avg. score
Do you have played computer games?	**29** (100%)	0	0	0	0	5
Do you like to learn math with game-based learning environment?	**13** (44.83%)	**8** (27.59%)	5	2	1	4.03
Am I more willingness to learn math with game-based learning environment?	**17** (58.62%)	**11** (37.93%)	0	1	0	4.55
Do you like to compete with others in game-based learning environment?	**15** (51.72%)	**11** (37.93%)	0	2	1	4.28

(Strongly agreed=5, Agreed=4, Neutral=3, Disagreed=2, Strongly disagreed=1)

4. Discussions & Conclusion

This is the first study of a game-based learning environment to incorporate students' behavior data with real classroom and virtual competitive game. The study focus on reporting the findings of interactive patterns of students in competitive game by using mixed approach that applied the system records data, observation comments, and questionnaires, and adopted social network analysis and regression analyses. First, the findings indicated that the students' self-reported friendship states would predict the extent to which they interact with their friend in on-line environment. Second, the findings indicated that the interactive patterns of schoolboy and schoolgirl differ regarding their genders in game-based learning environment. Final, the findings indicated the competitive game for an elementary school student not only mans that to compete with others, but also enhance the social interaction and emotional communication. Next, we discuss the academic and practical development of game-based learning, such as *methodology, research and design, and interactive environment.*

4.1 Using Mixed Methods to Explore the Patterns of Interaction on Game-based Learning Environments

In the research field of computer-supported collaborative learning (CSCL), many studies attempted to develop the mixed methods that explored the co-constructive knowledge of interaction in on-line discussion forums or learning communities [5], because the SNA could process interaction data to present different data representations and to unpack different types of interactions. The SNA allows the relationships between different participants to be illustrated in order to develop new insights or visualizations.

Hence, this study followed the above ideas and adopted mixed methods to investigate the interactive patterns. By the mixed methods of social network analysis with others, it is possible for us to understand deeply the interactions and behaviors among students in a game-based learning environment with a real classroom. In the future, the diversification and plenty of game-based learning environments for learning activity possibly emerged from technology enhanced learning (TEL) or computer assisted learning (CAL) fields, and so on. Therefore, there are enormous potential opportunities how this method could be integrated with existing game-based learning systems while this kind of method also could enhance students' social interaction in game-based learning environments.

4.2 The Design of Game-based Learning Environments

Competition might provide the dimensions of fame, fortune, and power while it makes a great impact on students. This study considered these influences and designs three strategies on game-based learning environment. For reputation strategy, when students' pets won the competitive game, the learning environment gave the title of differ levels for students; for interest strategy, when students solved a series of learning tasks, the learning environment gave the reward (e.g., coins) for students. Students could use coins to buy food for feeding pets, and to buy the racing ticket for competition; for authority strategy, when student completed three learning tasks, the learning environment gave the racing ticket to students and then the students could join in a competitive game.

The findings indicated that the most students had positive affections about competitive games with learning. Previous studies have shown that schoolgirls were more affected by the social comparison than schoolboys in the relationship between learning goal and students' academic task values [12]. The results verified that schoolboys participated more actively than schoolgirls in terms of comparing with others not only in real classrooms [12], but also in virtual environments [7, 8]. Hence, we should develop a wider range of forms in game-based learning for students, even for schoolgirls.

4.3 The Interaction Patterns of Real Classrooms and Virtual Competitive Games

The findings indicated that the students' friendship emerged as a significant predictor of co-participation on competitive games. The results of regression analysis predicated students' co-participation among genders on competitive game except the correlation of Girl-Boy. Therefore, it would reflect that on-line social interaction is based on relationship of real classroom. The students' interaction relationship with others in a virtual environment was closer to a real classroom.

Additionally, we also found that students stayed with the same genders in on-line competitive game less than in real classroom. In situation of a competitive game emerge more students crossing two subgroups of social networks. In other words, competitive game will provide more interactive opportunities and channels among genders, because the students, no matter boys or girls, need to negotiate and communicate with others. The game-based learning environment should be encouraged to develop interactive elements that will play a leading role in the future.

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References

[1] Bull, S., & Kay, J. (2007). Student Models that Invite the Learner In: The SMILI:() Open Learner Modelling Framework. *International Journal of Artificial Intelligence in Education*, 17(2), 89-120.

[2] Chen, Z. H., Liao, C. C. Y., & Chan, T. W. (2010). Quest Island: Developing Quest-Driven Learning Model by Blending Learning Tasks with Game Quests in a Virtual World. *The 3rd IEEE International Conference on Digital Game and Intelligent Toy Enhanced Learning* (pp.93-100), Kaohsiung, Taiwan.

[3] Chen, Z. H., Tseng, Y. F., Liao, C. C. Y., Wang, J. H., & Chan, T. W. (2009). My-Pet-My-Quest: Utilizing Game Quests to Scaffold Students' Goal Setting for Learning. In S. C. Kong, H. Ogata, H. C. Arnseth, C. K. K. Chan, T. Hirashima, F. Klett, et al. (Eds.), *Proceedings of The 17th International Conference on Computers in Education* (pp.733-737). Hong Kong: Asia-Pacific Society for Computers in Education.

[4] Creswell, J. W. (2005). *Educational research: planning, conducting, and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Pearson.

[5] de Laat, M., Lally, V., Lipponen, L., & Simons, R. (2007). Investigating patterns of interaction in networked learning and computer-supported collaborative learning: A role for Social Network Analysis. *International Journal of Computer-Supported Collaborative Learning*, *2*(1), 87-103. doi: 10.1007/s11412-007-9006-4

[6] Fields, D., & Kafai, Y. (2009). A connective ethnography of peer knowledge sharing and diffusion in a tween virtual world. *International Journal of Computer-Supported Collaborative Learning*, *4*(1), 47-68.

[7] Kafai, Y. (1999). Video game designs by girls and boys: Variability and consistency of gender differences. In M. Kinder (Ed.), *Kids' media culture* (pp. 293–315). Durham, NC: Duke University Press.

[8] Ke, F. (2008). Alternative goal structures for computer game-based learning. *International Journal of Computer-Supported Collaborative Learning*, *3*(4), 429-445. doi: 10.1007/s11412-008-9048-2

[9] Liao, C. C. Y., Chen, Z. H., & Chan, T. W. (2009). Designing the game-based environment to facilitate learners' interaction in performance-based learning by virtual pets. In *Proceedings of the 9th international conference on Computer supported collaborative learning - Volume 1* (pp. 429-433). Rhodes, Greece: International Society of the Learning Sciences.

[10] Nelson, B., & Ketelhut, D. (2008). Exploring embedded guidance and self-efficacy in educational multi-user virtual environments. *International Journal of Computer-Supported Collaborative Learning*, *3*(4), 413-427.

[11] Taylor, S. J., & Bogdan, R. (1998). "Participant Observation：In the Field." in *Introduction to qualitative research methods*. pp. 44-86. New York, NY: John Wiley & Sons, Inc.

[12] Townsend, M., & Hicks, L. (1995). Classroom goal structures, social satisfaction and the perceived value of academic tasks. Paper presented at the Annual Meeting and Exhibit of the American Educational Research Association, San Francisco, CA.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Changing the Reading Attitude of Young Children through Facebook

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Abstract: It is widely recognized that positive reading attitude affects reading performances [1]. As such, the aim of this study is to examine the effect of a reading program that leverage on social networking tool Facebook on reading attitude. Reading attitude is affected by personal beliefs, social beliefs and reading experiences [2]. In this study, pupils in the treatment group were required to post book reports onto Facebook which provided them with peers support and social purpose for reading and sharing their reading experiences with peers. Pre- and post- test were administered using Elementary Reading Attitudes Survey (ERAS) before and after the implementation of Facebook reading program. The result of the study shows that the treatment group developed a more positive attitude towards reading of Chinese story books than control group.

Keywords: Reading attitude, Chinese story books, recreational reading, Facebook

1. Introduction

This study is developed base on McKenna's model [2]. Reading attitude is defined by Mckenna as "a system of feelings related to reading which causes the learner to approach or avoid a reading situation". McKenna also pointed out that as children mature, and as more and more leisure options compete with reading, positive attitudes toward reading will gradually worsen. This is a common situation that many teachers are facing now, as children's attention are frequently diverted to other activities, such as playing computer games than reading.

Base on McKenna's theory, we predicted that socialization and interaction of reading experiences among pupils could have a strong impact on their reading attitude. Therefore, reading program in school which aims to cultivate positive reading attitude could include more social elements to create a greater impact. As more and more pupils are creating social networking site Facebook to communicate online, we see the advantage of using it to promote sharing and interactions. Hence, the functions and impact of online community were further explored to study its suitability to be included in a reading program that aims to improve the reading attitude of pupils.

1.1 The McKenna Model

The McKenna model [2] identifies 3 principal factors influencing attitudinal change: (a) personal beliefs about the outcomes of reading, (b) social beliefs about the expectations of others and (c) reading experiences. McKenna argues that children's perceived reading outcomes are relational; that is children will always weigh the pleasure of reading against other available alternatives, such as watching television or playing games. As a result, children's attitude towards reading changes when they expect more satisfying results from doing other activities. The second factor that affects children's reading attitude is the desire to be accepted by the people they value. These people can be family, teachers or peers whose views have a strong impact on the perceptions of pupils on reading. Third, negative experiences in reading, such as being scolded by teachers for not handing in book reports, may lead to a belief that the inevitable result of reading is frustration. Poor readers who often experience frustration during reading will eventually develop negative attitude towards it. On the opposite side, if a child is immersed in an environment that encourages reading, s/he will develop a more positive attitude towards it.

1.2 Online Community

Many studies were conducted by educators to explore instructional methods or to design reading programs to cultivate a positive attitude in reading [3, 4, 5]. However, not many studies were conducted on the effect of online community on changing reading attitude. Online community has the ability to affect the value and practices of members [6]. It is powerful as it is able to reach out to anyone who has internet connection as there is no constraint in physical boundary. Study has also pointed out that when a person develops a strong sense of belonging to the community, there is a higher tendency that he or she will interact more in the community [7]. When a child interacts with better peers frequently in the same community, learning takes place; the child will begin to appropriate and internalize the value and thought of the better peers [8].

Recently, there is more and more studies conducted on the impact of different online community on learning. These online communities include gaming, discussion forum, wiki and many more. However, these are communities specially nurtured by educators to meet certain learning objectives; pupils are invited to participate for academic purposes. As a result, the ability to sustain participation becomes one of the factors that determines the success or failure of the academic program [9, 10]. In this study, we argue that instead of creating a platform for nurturing online community, the result may be better if we can take advantage of an existing active social network, Facebook, as a communication platform to foster a learning community. As Wenger & Snyder [11] pointed out, community cannot be build, but we can identify and nurture one from existing networks. The key is not to impose a structure but assist the development of the community through providing appropriate assistance.

Facebook is a social networking tool that gains enormous popularity recently. It allows users to search and get connected with people for socialization purpose through setting up a personal website easily and quickly. This function has made Facebook one of the most powerful tools for communication among college students to keep in touch with old friends and meet new friends [12].

2. Research Question

In this study, we wanted to take advantage of the affection pupils have for communicating through Facebook to cultivate a more positive attitude in reading Chinese story books. Instead of the usual practice of monitoring students' reading through writing and handing in book reports to teachers for evaluation, pupils will be encourage to post their book reports onto Facebook to share with their peers. We use the following questions to guide our study:

1. What is the effect of a reading program that leverage on social networking tool Facebook has on lower primary pupils' reading attitude of Chinese story books?

3. Methodology

3.1 Participants

The participants were 2 classes of primary 3 pupils in a neighborhood school in Singapore. Each class consists of about 30 pupils with mix abilities. 26 samples were successfully collected from each class. The treatment class and control class were taught by different Chinese language teachers. Before the pupils in the treatment class embarked on the program, about half of the class already own a Facebook account and all of them have email accounts. Prior to the program, the pupils knew how to access internet and how to key in Chinese text using Chinese phonics, hanyu pinyin.

3.2 Instrument

The instrument that was used to measure reading attitude was modified from Elementary Reading Attitude Survey (ERAS), developed by McKenna and Kear [13]. The instrument is divided into 2 sections; each section consists of 10 items. The first section of the survey measures attitude toward recreational reading and the second section measures attitude toward academic aspects of reading. Our aim in this study is to survey the attitude of recreational reading, so the data collected for academic reading is not included for discussion.

In Singapore, pupils study 2 languages in primary school, English and Chinese. To ensure pupils knew we are surveying their attitude on reading Chinese story books, instead of English book, we modify the wording for some of the items in ERAS to reflect the correct context. The modified ERAS were then administered in a class that was not participating in the study to examine its internal reliability. A cronbach alpha analysis was run after the data was collected. The obtained alpha score is 0.746 for the first half of the survey on recreational reading and 0.808 for the second half of the survey on academic reading. The score indicates that the items for both scales have high internal consistency.

3.3 Procedure

A pre-test was administered in both treatment and control classes before the Facebook supported reading program started. During the pre-test, ERAS forms were issued to the pupils in both classes to complete. The study lasted about 2 months. During this period, the control class proceeded with their standard reading program, while the treatment class embarked on a Facebook supported reading program. At the end of the study, pupils of both control and treatment groups were issued another set of ERAS forms to complete. Both set of data were collected and analysed to determine if there is any changes in reading attitude before and after the Facebook reading program.

3.4 Intervention

At the start of the Facebook supported reading program, consent forms were issued to parents of treatment group to explain the study and seek permission for involving their children in the program. Most parents were supportive of the study. To avoid pupils' posting being commented by uninvited people, a group account, name: BCPS Book Club was set up to restrict participants. During the intervention period, pupils were encouraged to write and post their book reports onto the wall of BCPS book club and comment on one another's view of the same title. For the control group, pupils wrote their book reports base on a template created by their teachers. After that, teacher will marked and returned the book reports to pupils.

4. Result & Discussion

Independent sample t-test was performed on both groups at the beginning of the semester on students' reading attitude and the results showed no difference between the two groups,

$t(50)=.653$, $p=.52$. The academic results for Chinese was also compared for both groups and no significant differences were observed, $t(50)=.69$, $p=.69$. An independent t-test for the reading attitude however revealed significant differences in favour of the treatment group, $t(50)=2.083$, $p=.042$. Furthermore, paired samples *t*-tests indicated that there were significant changes in the recreational reading attitude for both control and treatment group. The treatment group (M=27.39, SD=6.5) achieved a significant gain in recreational reading attitude after attending the Facebook supported reading program (M=30.31, SD=6.7), $t(25)=-2.27$, $p=0.032$. However, the control group (M=28.73, SD=8.3) showed a significant drop in recreational reading attitude (M=26.23, SD=7.4), $t(25)=2.08$, $p=0.049$.

The result supports our argument that reading attitude can be influenced by social factors. As compare to reading alone and writing book reports individually, pupils find a social purpose to read in this program. Sharing their reading experiences with their peers on their favorite online platform may be able to motivate them to read.

The Facebook supported reading program impacted different pupils differently. If we look at the individual scores in the treatment group, the Facebook reading program seems to have a greater impact on pupils who were average and poor readers. The reading attitude for pupils who are stronger in Chinese language academically is less or not affected at all by the program. The social support given to weaker pupils in comprehending text by their peers during the study period could be the main contributing factor to this result. For more able readers, they may not see the meaning of collaboration or enjoy the socialization in reading and sharing in the Facebook reading program as yet. Thus, to examine if online community, such as Facebook has a greater and more generalized impact on the reading attitude of pupils compared to conventional reading program, there is a need to extend the study period and re-examine the structure of the program to ensure pupils enjoy the collaboration and sharing through online community.

In other words, to declare a change in reading attitude, the reading program supported by Facebook should be implemented for a longer period of time. In this study, pupils stopped posting book reports onto Facebook when the study ended. Through the Facebook news feed, we can observe that pupils continue to be active in Facebook, as they commented on one another's online games. Unfortunately, they have not interacted over their reading experiences. That is to say, the newly cultivated interest in reading is not strong enough to combat other leisure options pupils find more attractive and exciting in Facebook. Although there is no evidence to show that they have read less after the study, but to build a stronger sharing culture, there is a need to continue the reading program for a longer period of time to create a more impactful attitudinal change. Perhaps we should also interview the students to find out from their perspective if there are other features in Facebook or other pedagogical arrangements that could enhance their interest.

5. Conclusion

This study examined the effect of a reading program designed for lower primary pupils on the reading attitude of Chinese story books. This reading program used social networking tool Facebook as a communication platform for writing book reports. Evidence shows that the Facebook reading program has a positive impact on pupils' reading attitude. The main reason being Facebook provided a social purpose for reading and sharing reading experiences among pupils. However, to inculcate a more permanent attitudinal change, there is a need to extend the reading program for a longer period of time.

References

[1] Kush, J., Watkins, M., & Brookhart, S. (2005). The temporal-interactive influence of reading achievement and reading attitude. *Educational Research & Evaluation*, *11*(1), 29-44.

[2] McKenna, M., Kear, D., & Ellsworth, R. (1995). Children's attitudes toward reading: A national survey. *Reading Research Quarterly, 30*(4), 934. Retrieved from Academic Search Premier database.

[3] Chua, S. (2008). The effects of the sustained silent reading program on cultivating students' habits and attitudes in reading books for leisure. *Clearing House*, *81*(4), 180-184. Retrieved from Education Research Complete database.

[4] Kim, J., & White, T. (2008). Scaffolding voluntary summer reading for children in grades 3 to 5: An experimental study. *Scientific Studies of Reading*, *12*(1), 1-23.

[5] Reis, S., McCoach, D., Coyne, M., Schreiber, F., Eckert, R., & Gubbins, E. (2007). Using planned enrichment strategies with direct instruction to improve reading fluency, comprehension, and attitude toward reading: An evidence-based study. *Elementary School Journal*, *108*(1), 3-23. Retrieved from Education Research Complete database.

[6] Shen, D., Nuankhieo, P., Huang, X., Amelung, C., & Laffey, J. (2008). Using social networking analysis to understand sense of community in an online learning environment. *Journal of Educational Computing Research, 39*(1), 17-36.

[7] Wenger, E. (2006). Communities of practice. A brief introduction. [Electronic Version]. Retrieved 8 December 2009. from, http://www.ewenger.com/theory/

[8] Vygotsky, LS (1978). *Mind in society*. Cambridge, MA: Harvard University Press. [Electronic version]. Retrieved September 19, 2009, from www.psy.cmu.edu/~siegler/vygotsky78.pdf

[9] Baran, E., & Correia, A. (2009). Student-led facilitation strategies in online discussions. *Distance Education*, *30*(3), 339-361.

[10] Hewitt, J. (2005). Toward an understanding of how threads die in asynchronous computer conferences. *Journal of the Learning Sciences*, *14(4),* 567–589.

[11] Wenger, E. C., & Snyder,W.M. (2000). Communities of practice: The organizational frontier. *Harvard Business Review. 78*(1), 139-145.

[12] Stern, L., & Taylor, K. (2007). Social networking on Facebook. *Journal of the Communication, Speech & Theatre Association of North Dakota*, *20*9-20. Retrieved from Communication & Mass Media Complete database.

[13] McKenna, M., & Kear, D. (1990). Measuring attitude toward reading: A new tool for teachers. *Reading Teacher*, *43*(9), 626-639. Retrieved from Academic Search Premier database.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Scenario-Based MUVEs in the Science Classroom: Pre-service teachers' perspectives

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Abstract: This paper presents the findings of a study on the understanding and attitudes of pre-service teachers in the use of scenario-based multi-user virtual environments in science education. The pre-service teachers involved in this study used a scenario-based multi-user virtual environment as part of a lecture on problem-based learning in science education and were then required to complete an open-ended questionnaire. Data from the questionnaire indicated that gender and current computer game use were both likely to have an effect the future use of virtual worlds in a classroom setting. Behavior management was also seen as a concern to pre-service teachers. The results of the study indicate that teachers are both aware of virtual worlds and have an understanding of both their potential advantages and challenges within a classroom setting.

Keywords: Virtual worlds, problem-based learning, science education, pre-service teachers, ICT

Introduction

There is a growing body of research surrounding the use of scenario-based multi-user virtual environments (MUVEs) in inquiry learning in secondary school science education. A virtual world can be defined as 'an electronic environment that visually mimics complex physical spaces, where people an interact with each other and with virtual objects, and where people are represented by a virtual character' [1]. Scenario-based virtual worlds such as *Quest Atlantis, River City* and *Virtual Singapura* have all shown that the environments are both highly motivating and challenging to students. Research studies to date have shown that the value of these tools in engaging and maintaining student motivation is substantial [2-6].

The role of teachers in facilitating the use of integrated classroom technology (ICT) is pivotal in the successful implementation of the technology in a classroom. Yet many teachers are resistant to using technologies such as MUVES for reasons that include the additional time pressure to learn new skills, the lack of technological support within the school and concern over the pedagogical value of the technology [7, 8].

The purpose of this paper is to present the findings of a study with pre-service science teachers on the use of a scenario-based MUVE to teach inquiry skills in secondary schools. The study investigates pre-service teachers' current knowledge of virtual worlds and their attitudes towards using a virtual world in a classroom setting.

1. Pre-service teachers and ICT

There is only a small body of research on pre-service teacher training and ICT – especially in regards to using MUVEs. A pre-service teacher, in this instance, refers to an undergraduate or post-graduate student that is majoring in education that has not yet commenced classroom teaching. The limited and inadequate amount of training that pre-service teachers often receive before entering a classroom means that pre-service teachers, in many cases, do not feel that they have the technical support, the skills, or a pedagogical rationale for implementing ICT in the classroom [9, 10]. Many pre-service teachers are also surprised that technology that is ubiquitous outside of the classroom is not ubiquitous in schools [11].

Henriques [7] suggests that to overcome the negative attitudes to using ICT in the classroom, pre-service teachers need to see the use of technology in the context of science education, and to see the relationships that exist between the two. Moreover, ICT should be presented as both accessible and worthwhile to pre-service teachers, rather than just as a box ticking activity. Pre-service teachers entering the school system that are interested in using technology in the classroom should be encouraged to explore this domain [11]. In this context, virtual worlds such as *Virtual Singapura* can bridge the gap between science education and technology by presenting teachers with a rich medium to present inquiry learning and science based problems that are free (in the case of *Quest Atlantis* and *Virtual Singapura*), easy to use, and provide students with an opportunity to interact with a motivating and engaging learning experience.

However, as Dede [8] notes, in order for ICT to be seen as worthwhile and to address the negativity surrounding ICT implementation in schools, factors such as pedagogy, curriculum, assessment and school organizations need to be addressed simultaneously rather than in a piecemeal fashion. Another factor that needs to be considered is pre-service teachers' views on teaching as many pre-service teachers tend to maintain an ideological underpinning for their teaching such as facilitating a student-centered classroom, yet when they enter the classroom they tend to use teacher-centered approaches, hence at this early stage in their teaching career their attitudes and values towards teaching have not yet solidified [12]. Changing the attitude of pre-service teachers needs to be supported in school and access to training and technologies such as virtual worlds needs to be maintained both in higher education settings and in the classroom.

2. Research Design

2.1 Participants

This research study involved 28 participants from a pre-service science education course at Sydney University. There were 13 female participants, 13 male participants and two participants did not identify their gender. The participants had all completed at least one in school practicum and were from either a Bachelor of Education (18 participants) or Master of Teaching (10 participants) program. None of the participants had ever undertaken work as a teacher within a secondary school.

2.2 Data Collection

The data collection took place during the normal lecture time for the group. Participants were provided with an overview of the scenario and were then allowed 40 minutes to explore the problem space. Participants were randomly assigned to teams of three. After the participants finished their in-world explorations they were asked to complete a fifteen-question open-ended questionnaire.

2.3 Data Analysis

The data presented in this paper was analyzed into two areas. Area 1 covered current knowledge of virtual worlds, game use and understanding of the technology. Area 2 covered the use of virtual worlds in education from the perspective of a teacher.

3. Results

3.1 Area 1 - Current Knowledge of Virtual Worlds and Games Use

Area 1 related to the participants current understanding of virtual worlds. The responses to the first question indicate that the participants all had a basic understanding of what a virtual world was. Responses included:

A made-up computer game based on the real world
A world that exists with a technology – it is not real, but simulates a real world
A world designed and accessible by computer technology
A simulation which allows interaction between a played character and the elements of the world

These responses were coded in relation to their similarity to the definition of a virtual world provided by Bainbridge [1] in the introduction. The level of understanding of a virtual world was not linked to current computer game use – people who used computer games more frequently did not show a more in-depth or detailed understanding of the technology. However, the responses indicated that a virtual world was a creation or made-up technology.

An important factor in the intent to use virtual worlds in education is linked to gender and game use (see Table 1). The results of these questions indicate that females are both less likely to play games as they are to use them in an educational setting, these findings are consistent with the review undertaken by Becta [13].

Table 1: Comparison of gender and game play and the use of virtual worlds in a classroom

		Gender				
		Female	Male		Female	Male
Computer game use	Infrequent or non user	91.6%	36.4%	Use virtual worlds in class	84.6%	100%
	Frequent user	8.4%	63.6%	Not use virtual worlds in class	15.4%	0%
	n	12	11	*n*	13	13

3.2 Area 2 - Virtual Worlds in Education

The perceived advantages and disadvantages of virtual worlds in education were consistent with other studies on ICT (e.g. Becta 2004, Webb and Cox 2004). The results of the survey on Area 2 are presented in Table 2. The results indicated that there are clearly perceived advantages and disadvantages of using a virtual world in a classroom setting. The advantages being the ability visualize information that would not be possible from a text or normal classroom setting. The disadvantage was that students would be off-task and that it would be difficult to make sure that students were completing the activities when the teacher could not monitor student progress.

Table 2: Pre-service teachers views on the potential advantages, benefits, problems and issues of using virtual worlds in a classroom setting

Perceived Benefits		Perceived Problems	
Characteristic	%	Characteristic	%

Visualization Motivating Interactive, learner centered Engaging Risk free Team work	41.7% 20.8% 16.7% 8.3% 8.3% 4.2%	Off-task Lack of resources Not liking computers Too complicated Too expensive Repetitive	53.3% 20% 10% 6.7% 6.7% 3.3%
n	24	*n*	30

In regards to whether or not a pre-service teacher would consider using a virtual world in the classroom, overwhelmingly, 71.4% (20) of the respondents indicated that they would use the technology. All of the frequent computer game users indicated that they would use the technology in their classrooms. 21.4% (6) of the respondents indicated that they might possibly use the technology, but it depended on several conditions, such as smaller, groups, technical support, sufficient time and class behavior. Only 7.1% (2) participants indicated that they would not use the technology in their classrooms. The two participants that indicated that they would not use the technology were infrequent or non users of game technology.

It seems contradictory, or perhaps it is the result of greater awareness, but the participants that were most critical of the use of the technology in the classroom were the frequent users. For example, comments such as:

> *I don't see why you need to use ICT to do this role-play. It can be conducted in a classroom with different bits of information spread like Singapore* and
> *Yes, but probably only with a smaller class. I would do a 'test' lesson with a class and then stop if they wasted too much time off task*

indicate that the participants were thinking about how they would actually use the technology in a classroom setting.

4. Discussion

The use of virtual worlds in science education affords teachers with opportunities to enhance students' ability to visualize and engage with complex problems. The pre-service teachers in this study were aware of the potential learning affordances of a virtual space such as *Virtual Singapura*; yet, their main concern was in regards to behavior management and keeping the students on task.

The results of this study suggest that pre-service teachers perceive the issues relating to behavior as more influential on their chosen method of delivery than the technical or potential learning benefits of the virtual world. This shows that while pre-service teachers may be willing to use a tool such as *Virtual Singapura*, they would weigh this up against factors such as class size, class temperament, access to technology and skill requirements. This focus on behavior management is perhaps a result of their inexperience as classroom teachers. Experienced classroom teachers who participated in a similar study as part of this project were more concerned about time constraints and technical problems than behavioral issues, which is also consistent with Urhane [14] and Becta [13].

This study also indicates that the greater familiarity that a pre-service teacher has with computer games and virtual worlds the more likely they are to consider using this technology in their classroom. Correspondingly, as a greater proportion of male pre-service teachers in this study use computer games more frequently than females, more male pre-service teachers would be likely to use virtual worlds in their science classes, again this corresponds with the findings of Becta [13]. The results of this study indicate that there is a potential divide in the use of ICT in science education depending on both gender and technical literacy.

5. Concluding Remarks

This study sought to gain an understanding of how pre-service teachers perceived the use of virtual worlds in science education as a result of using a scenario-based MUVE. The results of the study suggest that a one-off encounter with a virtual world may seed the desire to use ICT in a classroom setting; however, as pre-service views on education have not yet crystallized ongoing support in the use of ICT in a positive ICT environment is necessary to develop an enduring belief in the value of ICT in education.

Acknowledgements

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References

[1} Bainbridge, W. S. (2007). The Scientific Research Potential of Virtual Worlds. Science, 317(5837), 472-476.

[2] Bailenson, J. N., Yee, N., Blascovich, J., Beall, A. C., Lundblad, N., & Jin, M. (2008). The Use of Immersive Virtual Reality in the Learning Sciences: Digital Transformations of Teachers, Students, and Social Context. Journal of the Learning Sciences, 17(1), 102 - 141.

[3] Dede, C., Clarke, J., Ketelhut, D. J., Nelson, B., & Bowman, C. (2005). Fostering Motivation, Learning and Transfer in Multi-User Virtual Environments. Paper presented at the American Educational Research Association.

[4] Jacobson, M. J., June Lee, B. K., Hong Lim, S., & Hua Low, S. (2008). An Intelligent Agent Augmented Multi-User Virtual Environment for Learning Science Inquiry: Preliminary Research Findings. Paper presented at the 2008 American Educational Association Conference.

[5] Shaffer, D. W., & Gee, J. P. (Eds.). (2007). Epistemic Games as education for innovation. Leicester: British Journal of Educational Psychology.

[6] Squire, K. D., Barnett, M., Grant, J. M., & Higginbottom, T. (2004). Electromagentism Supercharged! Learning Physics with digital simulation games. Paper presented at the International Conference of the Learning Sciences.

[7] Henriques, L. (2002). Preparing tomorrow's science teachers to use technology: An example from the field. Contemporary Issues in Technology and Teacher Education [online serial], 2(1).

[8] Dede, C. (1997). Rethinking: How to invest in technology. Educational Leadership, 55(3), 12 - 16.

[9] Angeli, C. (2004). The effects of case-based learning on early childhood pre-service teachers' beliefs about the pedagogical uses of ICT. Journal of Educational Media, 29(2), 139 -151.

[10] Lee, D. (1997). Factors influencing the success of computer skills learning among in-service teachers. British Journal of Educational Technology, 28(2), 139-141.

[11] de Winter, J., Winterbottom, M., & Wilson, E. (2010). Developing a user guide to integrating new technologies in science teaching and learning: teachers' and pupils' perceptions of their affordances. Technology, Pedagogy and Education, 19(2), 261-267.

[12] Simmons, P. E., Emory, A., Carter, T., Coker, T., Finnegan, B., Crockett, D., et al. (1999). Beginning Teachers: Beliefs and Classroom Actions. Journal of Research in Science Teaching, 36(8), 930-954.

[13] Becta. (2004). A review of the research on barriers to the uptake of ICT by teachers.

[14] Urhahne, D., Schanze, S., Bell, T., Mansfield, A., & Holmes, J. (2010). Role of the Teacher in Computer-supported Collaborative Inquiry Learning. International Journal of Science Education, 32(2), 221 - 243.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Programming Learning Support System 'CAPTAIN' with Motivational Study Model

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Abstract: ARCS model is known as a learning model aiming at stimulating and sustain the learner's motivation to learn. In this paper, the ARCS model is applied for a motivational learning model for programming language learning environment. Features to realize the motivational learning model are proposed, and implemented in the programming training system CAPTAIN currently under development. The proposed system is applied in an actual programming course. Finally, the effectiveness of the proposed features designed to realize the motivational learning model is discussed, and future works are pointed out.

Keywords: E-learning, Programming, Motivational study model, ARCS model

Introduction

Recently, the field of study of students choosing to take courses in computer and information sciences has broadened, to include not only science fields but also the arts fields including Web design, game, and multi-media. In such learning environments where students with different backgrounds take the same course, one method is to divide the course into classes depending on the initial skill or experience of the students. Even in such cases, depending on the teaching staff resources, each classroom may have as many as 50 students. In larger classes, it becomes more difficult to care for each individual student, and slower students fall behind, while advanced students become dissatisfied with the slow speed of progress. In either case, the student's motivation to study deteriorates. This has lead to the increased interest in improving the motivational aspects of learning in computer related courses.

Research on motivational learning methods for programming education based on the ARCS model[1] has been reported[2]. But there have been no reports on implementation of a motivational learning model in an actual e-learning system, and evaluation of the motivational learning model for programming training. In this paper, features designed to realize the ARCS model are proposed, and implementation in a programming training system are explained. Finally, the effectiveness of the proposed features and future works are discussed.

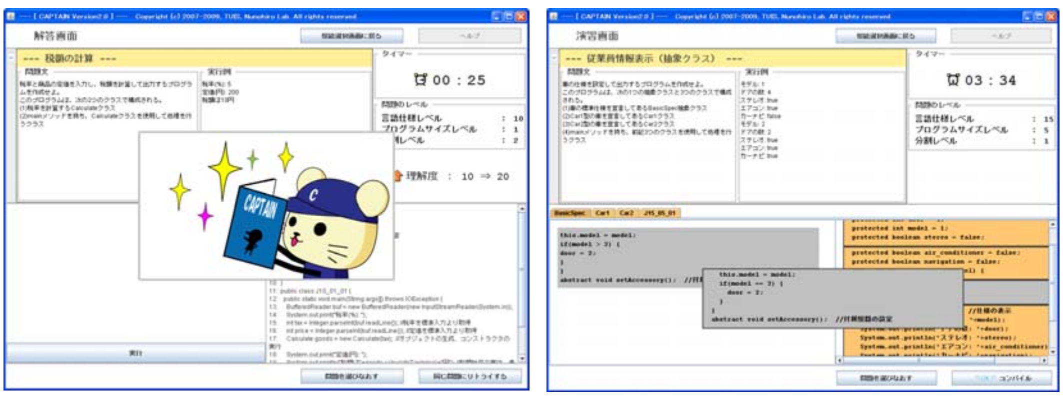
1. Programming study model

The authors have previously reported on CAPTAIN[3][4][5], a puzzle-based programming training system, in which learners create programs similarly to solving a puzzle game. In this paper, a learning model to stimulate and sustain motivation of the learner is considered, and implementation of the model in CAPTAIN is reported. ARCS model is selected as the motivational learning model. The programming training support components based on the ARCS model was categorized as below.

(1) Attention
Animation and illustrations are inserted in the learning process to stimulate and keep the attention of the learner.
(2) Relevance
The training problems match the contents of the lecture and training goals.
(3) Confidence
The learner and trainer can monitor the learner's progress and comprehension in real-time.
(4) Satisfaction
The training problems are provided step-by-step, and the learner can review the contents of the training.

2. Features of the programming training support system (CAPTAIN)

Using the previously developed CAPTAIN as the basic system, for this research, programming training components based on the ARCS model was implemented to develop CAPTAIN ver. 2 (CAPTAIN2). Screen shots of CAPTAIN2 are shown in Fig.1.



(a) Animation for correct answer (b) Programming training screenshot

Fig.1 CAPTAIN2 screenshots

In CAPTAIN2, the major components designed around the ARCS model are the following features for Attention and Relevance

(1) Attention: User interface for programming training similar to a gaming experience
(2) Relevance: Automatic programming problem creation matching the learner's progress

2.1 User interface

A Display feature to visually show the learner's progress and the learner's relative level compared to other learners in the same group was implemented, in order to stimulate the learner's attention and motivation. Furthermore, animation features to visually stimulate the learner during the training were implemented (Fig.1 (a)).

2.2 Automatically generation of programming problems

CAPTAIN already has functionality to automatically create puzzle pieces from the problem source code according to the progress and comprehension level of the learner, by selecting appropriate piece sizes and piece division, as well as the actual problem solving function in which the learner tries to reorder the program pieces in the correct order. In CAPTAIN2, a new navigation feature to guide the learner according to a training schedule, as well as functions to automatically insert incorrect and unnecessary puzzle pieces (Fig.1 (b)) were added.

3. Application and evaluation of CAPTAIN2 system

3.1 Application

CAPTAIN2 was applied in a Java programming course for 2nd year students in the Department of Information Systems, Tokyo University of Information Sciences. In this course, the students were divided into 3 classes, advanced, intermediate, and introductory, according to the results of a preliminary test. CAPTAIN2 was applied in the introductory class. The applied programming course is a full year course. The general flow of each lecture is shown in Fig. 2. The contents of the lecture and teaching material such as slides and programming problems used are the same for all 3 classes, and the programming education experience of the teachers are also similar.

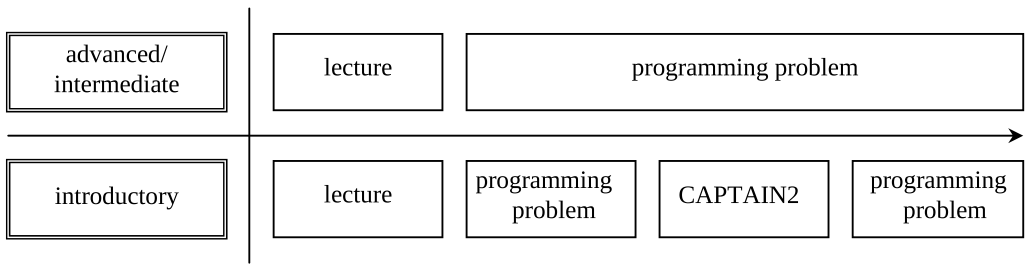


Fig.2 Flow of each lecture

3.2 Evaluation

In order to evaluate the effect on motivation and ease of use of CAPTAIN2, a questionnaire was taken from the 130 students in the introductory level. The same progress evaluation test was taken by 25 students in the advanced level, 25 students in the intermediate level, and 130 students in the introductory level classes, in order to evaluate the learning effect.

(1) Questionnaire

An anonymous questionnaire was taken from 130 students in the introductory level classes. The questions were chosen to evaluate each component of the ARCS model, and student selected from 1 to 5 for each question where 5 was the highest positive reply.

a. Attention
   Do you want to continue using CAPTAIN2?
b. Relevance
   Did you find the contents of CAPTAIN2 to be relevant to the associated lecture?
c. Confidence
   Did you feel that you improved your programming skills by using CAPTAIN2?
d. Satisfaction
   Did you feel CAPTAIN2 helped you do better in the test?

The results of the questionnaire are shown in Fig.3-6. For the question regarding ‘Attention’, the same question was taken 3 separate occasions in order to evaluate temporal change. It can be seen from Fig.3 that there is a large number of students who want to continue using CAPTAIN2 from the beginning, and that this ratio continues to increase as the students use training system. It can be deduced that the students’ motivation and interest in programming training increased by using CAPTAIN2. From Fig.4 it can be seen that the training schedule of the system succeeded in matching the pace of the lecture. However, from Fig.5 and Fig.6

a strong relationship between test results and system use could not be seen. This may have been because the problem style of CAPTAIN2 did not match the test problem style.

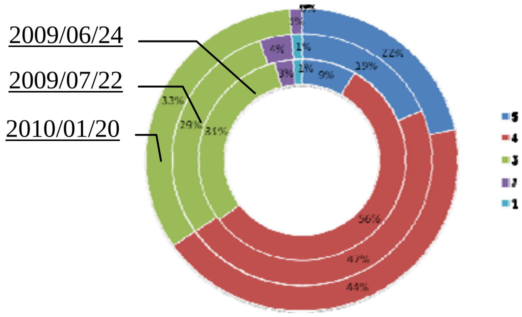


Fig.3 Attention:Continual use

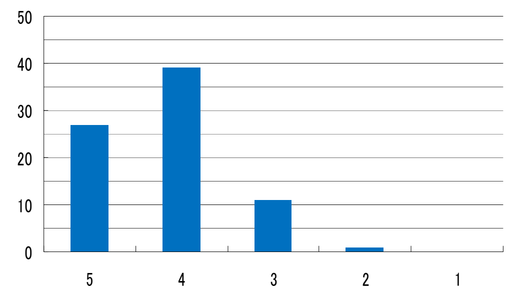


Fig.4 Relevance:Relevance to lecture

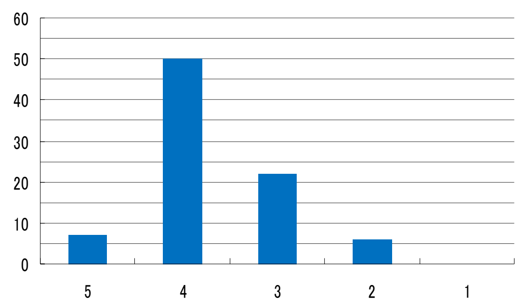


Fig.5 Confidence:Improvement in programming

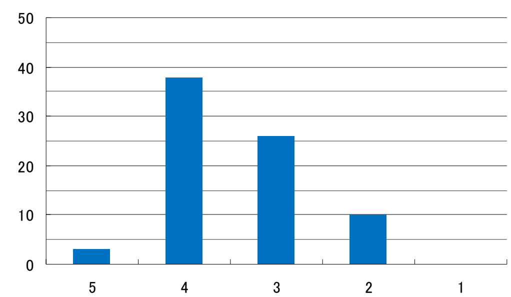


Fig.6 Satisfaction:Improvement in test

(2) Comprehension evaluation test

In order to evaluate the effectiveness of learning with CAPTAIN2, a comprehension evaluation test was carried out. Basic problems to test the understanding of each lecture were chosen. Table 1 shows the comparison of test results, and statistical t-test results between the advanced class and introductory class. Table 2 shows the same comparison between the intermediate and introductory class. The results showed no statistical evidence that the introductory class using CAPTAIN2 was able to narrow the skill difference between the more advanced 2 classes.

Table 1. Comparison of advanced and introductory classes

Class		6/3	7/22
advanced class (CAPTAIN2 not used)	Avg.[pts]	31.7	31.3
	Std. Dev.	2.57	3.35
introductory class (CAPTAIN2 used)	Avg.[pts]	18.6	13.1
	Std. Dev.	6.18	7.11
t-test between classes	*t* value	13.27	15.24
	significance	$p < 0.05$	YES

Table 2. Comparison of intermediate and introductory classes

Class		6/3	7/22
intermediate class (CAPTAIN2 not used)	Avg.[pts]	25.7	22.0
	Std. Dev.	4.34	5.21
introductory class (CAPTAIN2 used)	Avg.[pts]	18.6	13.1
	Std. Dev.	6.18	7.11
t-test between classes	*t* value	5.84	5.55
	significance	$p < 0.05$	YES

4. Conclusion and future works

From the results of the questionnaire and large number of positive comments, it could be concluded that there was partial success in motivational learning by the proposed system. However, the results could not be confirmed as statistical results of test score increase for the comprehension evaluation tests. It is assumed that in the proposed model, Attention and Relevance components of the ARCS model has been successfully implemented, but the added features did not contribute to the learner's confidence or test results. In order to improve these points, it is necessary to strengthen functions related to Confidence and Satisfaction in the ARCS model, including added support for learners and comprehension confirmation features.

For future works, we plan to develop features to monitor the progress and problems of the learners in real-time, and to provide necessary learning support according to the progress level of the learner.

Acknowledgments

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References

[1] Principles of Instructional Design (2005), Robert M. Gagne, Walter W. Wager, Katharine C. Golas, John M. Keller, Wadsworth Pub Co.

[2] Wenyong WANG, Mitsuru IKEDA, Fengrong LI (2007), Proposal and Evaluation of the "Motivation-Oriented" Teaching Method in Programming Education, *Japan Society for Educational Technology, Vol.31, No.3, pp.349-357 (in Japanese)*.

[3] E.Nunohiro, K.J.Mackin, M.Ohshiro, K.Matsushita, K.Yamasaki (2007), Implementation of a GA driven programming training support system, *The 12th International symposium artificial life and robotics, pp.517-522*.

[4] E.Nunohiro, K.Matsushita, K.J.Mackin, M.Ohshiro, K.Yamasaki (2008), Design and development of a puzzle based programming learning support system with genetic algorithm, *Transactions of Japanese society for information and system in education, vol.25, No.2, pp.207-213 (in Japanese)*.

[5] Yuji Yoneyama, Kotaro Matsushita, Kenneth J. Mackin, Masanori Ohshiro, Kazuko Yamasaki, Eiji Nunohiro (2008), Puzzle Based Programming Learning Support System with Learning History Management, *The 16th International Conference on Computers in Education (ICCE2008), pp. 623-627*

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Pattern-Based Knowledge Building in Learning Organizations

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Abstract. Learning organizations strive to encourage knowledge exchange and knowledge building. Through externalization of knowledge into a shared digital artefact, individual knowledge is integrated into organizational knowledge. Through internalization, organizational knowledge is applied individually. Through discussion and collaborative revision of the artefact, organizational knowledge develops and thus again stimulates individual knowledge. Cress and Kimmerle [1] describe this process as co-evolution of individual and organizational knowledge. The current paper adopts the co-evolution model to knowledge-in-use, defined as complex knowledge needed for activities that are performed frequently. Such knowledge is often tacit and therefore difficult to externalize, internalize, or discuss. We propose that patterns facilitate the exchange of knowledge-in-use. The implementation of a pattern-based knowledge exchange tool in a large, decentralized organization is introduced.

Keywords: pattern, knowledge building, lessons learned, knowledge-in-use, learning organization

Introduction

Most of today's organizations may be defined as *learning organizations*. A learning organization "facilitates the learning of all of its members and continuously transforms itself" [2] (p.2). Such an organization integrates learning into daily work practices and provides ongoing "experimentation, using lessons learned to draw a link between learning outcomes and changes in knowledge performance" [3] (p.133). Organizational research literature has mainly addressed the impact of learning at the organizational level [4], but from a Learning Science point of view, the interplay between individual and organizational learning (also referred to as *knowledge building*) is of no less interest.

A learning organization supports the exchange of knowledge within an organization. However, different types of knowledge are not equally easy to exchange. In contrast to declarative knowledge, little is known about the exchange of *knowledge-in-use* [5]. Knowledge-in-use is a combination of declarative, conceptual or procedural knowledge that is necessary to perform a given task, solve a problem or handle a complex situation. Knowledge-in-use is embedded in daily challenges and in most cases implicit, because it is based on experienced work routines, which are often carried out unconsciously [6]. Knowledge-in-use is highly situated [7]: individuals develop an association between a situation that requires certain knowledge and the knowledge itself [5]. This association helps to identify relevant features of a current problem, to build an adequate representation of the problem and to retrieve necessary knowledge to solve a problem.

We thus define knowledge-in-use as knowledge about activities that are performed frequently and that are well established in the action routine of a person. In an organization, such activities are often socially shared. Moreover, these activities are usually tied to a specific context, because different contexts have their own characteristics that require a certain activity [8]. In contrast to declarative or conceptual knowledge, larger parts of knowledge-in-use are tacit, because it consists of implicit knowledge about sequences of action [9]. Thus, the externalization of knowledge-in-use is laborious. In order to externalize, members have to become aware of their work routines, have to draw general conclusions from situated knowledge-in-use, and present it in an abstract form so it can be transferred to other contexts. Internalization is also difficult: Individuals have to adapt information from an abstract level to a very concrete situation. Nevertheless, both externalization and internalization are indispensable components of what constitutes organizational knowledge building.

1. Individual Learning and Organizational Knowledge Building

Based on the *theory of knowledge creation* [10] and on the *concept of knowledge building* [11], the co-evolution model by Cress and Kimmerle [1] emphasizes knowledge creation by externalization, internalization and the use of shared digital artefacts. Going beyond earlier models, the co-evolution model [1] points out that individual learning and collective knowledge building are two parallel and equally important processes which support each other. Based on Luhmann's social systems theory [12], the model regards the exchange of knowledge as interplay between the cognitive system (i.e., the individual, operating through thinking, reasoning and learning) and the social system (i.e. the organization, operating through communication). The cognitive system externalizes knowledge into a shared digital artefact. Thus, the externalized knowledge exists independently. Another cognitive system is then able to gather the information and transfer it into individual knowledge (internalization). The social system operates through communication within the digital artefact. Thus, the shared artefact initiates a dynamic and self-organized process in which ideas are modified, reflected, discussed. Individual learning and knowledge building stimulate each other. Social software is capable of supporting these processes within the social system [13]. Taken together, the co-evolution model offers a framework to interlink the processes of individual learning and knowledge building within a learning organization and regards these processes as co-evolving.
The model has not explicitly focused on knowledge-in-use yet, but we propose that the processes are the same when applied to knowledge-in-use. Knowledge building can also take place in the exchange of how learners handle authentic real-life problems that require knowledge-in-use. Learning organizations should thus facilitate the exchange of different experiences and the collective creation of knowledge-in-use at the organizational level. Lessons learned may be regarded as a digital artefact which is useful for such knowledge-in-use. Members of a learning organization externalize their knowledge-in-use by creating reports on lessons learned. These reports will help other member to detect features of a current problem and retrieve relevant knowledge-in-use: They will be able to adopt and internalize lessons learned in the context of a specific situation (figure 1).

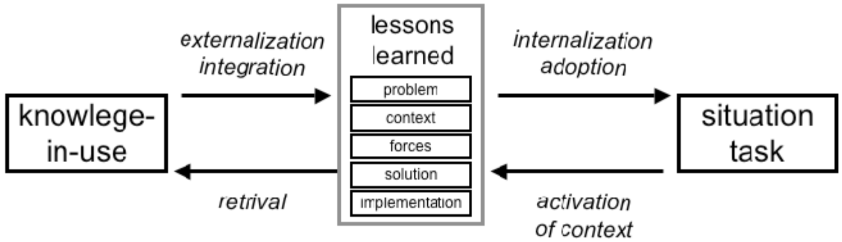

Figure 1: Process of internalization and externalization

Communication on the reported and adopted lessons learned leads to the development of the shared artefact, and thus increases organizational knowledge. In other words, the processes of externalization and internalization not only lead to the development of knowledge-in-use at the individual level, but to a mutual development of individual and organizational knowledge. Such a co-evolution of individual and organizational knowledge-in-use is the key to successful knowledge building in organizations.

In local organizations, knowledge-in-use can be socially transferred by socialization, i.e. learning by observation, imitation and practice. Decentralized organizations with strong local characteristics do not have that possibility and thus depend more strongly on shared digital artefacts. The fact that knowledge-in-use is tacit, however, makes the externalization, internalization and discussion of knowledge-in-use within a shared artefact difficult, but these processes are crucial preconditions for successful organizational knowledge building. We propose that patterns can serve as a means to facilitate the co-evolution of individual and organizational learning.

2. Pattern and Knowledge Building

2.1 The Pattern Idea

Patterns are “concrete problems and solutions, yet phrased in a manner that affords generalisation and application in a broad set of contexts” [14] (p.1079). Formally, a pattern is a structured input format that connects a certain problem to a certain solution and stimulates reflection on the solution. A standard pattern contains the following fields: *name* (short description for the entire pattern), problem (describes the question that could be solved by using the pattern), *context* (describes in which situation one may use the pattern), *forces* (competing requirements) and *solution*. Originally, patterns were used in architecture [15] and software programming [16]. The concept of using patterns to store and transfer knowledge has also become popular in other technical and educational domains, for example, the design of human-computer interaction [17], programming Web 2.0-sites [18], and E-learning [19]. Based on the co-evolution model, we assume that patterns support the mutual development of organizational and individual knowledge-in-use.

Experienced members of a learning organization can use patterns to externalize situated knowledge-in-use, including invariant components of recurring problems and their successful solution within work routines. This way, reflection is stimulated and different situations and experiences are integrated into an abstract pattern that explicates the context as aggregation of different situations (figure 2a). Patterns thus describe lessons learned as successful solutions that may be used as samples for solving problems in similar contexts, and they make it possible to externalize implicit knowledge-in-use by providing structures for the externalization of knowledge.

Experiences of different experts may be integrated into one shared pattern, so knowledge will be reflected and revised in a collective process. This will lead to new, emergent organizational knowledge if different experiences influence each other and stimulate the integration and combination of individual knowledge-in-use (figure 2b).

Moreover, patterns are likely to support the internalization of organizational knowledge-in-use by identifying specific situations where that knowledge is needed. If a specific situation activates a context that is part of the shared pattern, the use and internalization of shared knowledge-in-use will be supported. This way, individuals can integrate organizational knowledge-in-use in the appropriate context. When particular organizational knowledge-in-use has been applied, that knowledge can, again, be reflected with other organizational members in the shared pattern. Taken together, patterns are likely to facilitate the externalization of individual knowledge-in-use, the internalization of shared organizational knowledge-in-use, and enable a co-evolution of individual and organizational knowledge-in-use.

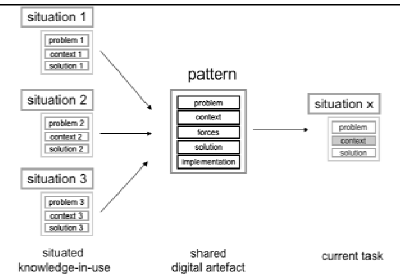

Figure 2a: Externalization of knowledge-in-use.

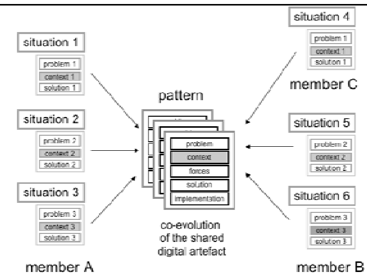

Figure 2b: Co-evolution of a pattern.

3. Implementation of Pattern-based Knowledge Building

3.1 The Patongo Project

The aim of the Research Project PATONGO (Patterns and Tools for Non-Governmental Organizations) is to investigate and optimize the exchange of knowledge-in-use between members of decentralized non-profit organizations. Together with the *Evangelische Kirche in Deutschland* (EKD, Evangelical Church in Germany) and *FernUniversität Hagen* (Distance Teaching University), we are developing and evaluating a knowledge exchange platform for the 250,000 full-time staff members and about one million volunteers of the EKD. These members possess tremendous knowledge-in-use, have a strong need to exchange their knowledge but rarely do so beyond their circle of colleagues and friends.

3.2 The Pattern Platform

The new Internet platform for the employees and volunteers of the EKD consists of three main areas that are named “idea space”, “experience space” and “knowledge space”.
In the *idea space*, users ask questions that concern their everyday working life, discuss current problems, and develop their ideas together. Users may post questions or ideas, and discussions on single topics are threaded. Each topic provides a conclusion field that invites users to write a short summary or present the result of this discussion in the experience or knowledge space. In the *experience space*, users describe specific individual experiences (e.g., a choir project with youngsters in a Berlin suburb) that have stood the test of practice. The lessons learned in this space are tied to a specific context and local characteristics. The pattern structure provides input fields for describing preparation, implementation, material, or costs. The *knowledge space* is more abstract and more collaborative: it establishes a common encyclopedia of the organizational knowledge-in-use (e.g., music projects). All users of the platform may edit the entries in this section as in a wiki. Patterns in this space use the classical problem-context-solution structure. Besides these artifact-focused spaces, the platform also facilitates communication and coordination between the members by providing an opportunity to fill in personal profiles and create groups. In this way, it is possible to find users with similar experiences and interests.
The three spaces of the platform are strongly linked together and technical tools encourage transformations of more concrete to more abstract forms of descriptions. Discussion around a topic in the idea space encourages users to collect ideas and encourages members to write about their own knowledge-in-use. When users search in the knowledge space for patterns

that do not exist yet, the platform advertises appropriate lessons learned from the experience space. At the same time the users are invited to sum up these different experiences into the knowledge space. Strong interlinks between the sections facilitate discussion, reflection and integration of lessens learned. This way, collaboration is supported and optimal conditions are created to stimulate individual learning and organizational knowledge building at the same time.

References

[1] Cress, U., & Kimmerle, J. (2008). A systemic and cognitive view on collaborative knowledge building with wikis. *International Journal of Computer-Supported Collaborative Learning*, *3*(2), 105–122.

[2] Pedler, M., Boydell, T., & Burgoyne, J. (1989). Towards the learning company. *Management Learning*, *20*(1), 1–8.

[3] Marsick, V. J., & Watkins, K. E. (2003). Demonstrating the value of an organization's learning culture: the dimensions of the learning organization questionnaire. *Advances in Developing Human Resources*, *5*(2), 132–151.

[4] Yang, B., Watkins, K. E., & Marsick, V. J. (2004). The construct of the learning organization: dimensions, measurement, and validation. *Human Resource Development Quarterly*, *15*(1), 31–55.

[5] De Jong, T., & Ferguson-Hessler, M. G. M. (1996). Types and qualities of knowledge. *Educational Psychologist*, *31*(2), 105–113.

[6] Smith, E. A. (2001). The role of tacit and explicit knowledge in the workplace. *Journal of Knowledge Management*, *5*(4), 311–321.

[7] Greeno, J. G. (1998). The situativity of knowing, learning, and research. *American Psychologist*, *53*(1), 5–26.

[8] Wodzicki, K., Moskaliuk, J., & Cress, U. (in press) Patterns of social practice: A psychological perspective. In C. Kohls & J. Wedekind (Eds.). Investigations of E-Learning Patterns: context factors, problems and solutions. Hershey, PA: IGI Global.

[9] Polanyi, M. (1966). *The tacit dimension*. Garden City, NY: Doubleday.

[10] Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization science*, *5*(1), 14–37.

[11] Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge-building communities. *The Journal of the Learning Sciences*, *3*(3), 265–283.

[12] Luhmann, N. (1995). *Social systems*. Stanford: Stanford University Press.

[13] Kimmerle, J., Cress, U., & Held, C. (2010). The interplay between individual and collective knowledge: technologies for organisational learning and knowledge building. *Knowledge Management Research & Practice, 8*, 33–44.

[14] Winters, N. & Mor, Y. (2009). Dealing with abstraction: Case study generalization as a method for eliciting design patterns. *Computers in Human Behavior*, *25*(5), 1079–1088.

[15] Alexander, C. (1977). *A pattern language: towns, buildings, construction*. Oxford: Oxford University Press.

[16] Beck, K., & Cunningham, W. (1987). Specification and design for object-oriented programming. Paper presented at OOPSLA'87. Orlando, Florida, USA.

[17] Tidwell, J. (2005). *Designing interfaces*. Sebastopol: O'Reilly Media, Inc.

[18] Mahemoff, M. (2006). *Ajax design patterns. Creating web 2.0 sites with programming and usability patterns.* Sebastopol: O'Reilly Media, Inc.

[19] Schümmer, T., & Lukosch, S. (2007). *Patterns for computer-mediated interaction.* Hoboken, NJ: John Wiley & Sons.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

A Language Learning System with Automatic Feedback: An Application Based on a English-Chinese Parallel Corpus

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Abstract: The learners of English as a second language generally need many practices on writing English, identification of the mistakes in their English, and feedback hints on how to correct their mistakes. A computer-assisted online system is designed to address these issues in a context of learning from a corpus of parallel English-Chinese corpus of New York Times news articles. In the system, students match chunks of English words to chunks of Chinese strings and order chunks of English to produce the original English sentences. Results from an empirical experiment indicated that the students found the tasks challenging and felt that the learning activities were meaningful in improving their knowledge of English. Their score improvement increased when they practiced more.

Keywords: Learning English as a second language, computer-assisted language learning, E-learning

Introduction

In Taiwan, a common method of teaching translation is the translation of knowledge. For learners of English as a second language, using translation can help them understand and memorize the grammar of English, which reduces their frustration and anxiety. Using translation to learn foreign language is a kind of learning strategy for many learners [2]~[13]. According to Catford, translation can be an excellent strategy for learning a foreign language if it is used properly [1].

According to overseas research, designing an effective English learning system with automatic scoring mechanism (e.g. e-rater version 2.0, an automated essay scoring system) and effective grammar feedback (e.g. Critique, a system to provide feedback on test-taker's composition errors) is more helpful for students in learning English grammar. In addition, the system should be able to reduce the burden on individual manual score and let teachers have more time to prepare materials and assist students.

Research results indicate that E-rater scores are significantly more reliable than human scores and that the true-score correlation between human and e-rater scores is close to perfect [14]. The Critique system makes decisions that simulate how teachers grade students' essays. Teachers may make explicit that there is no thesis statement, or that there is only a single main idea with insufficient support. This kind of feedback helps students to develop the discourse structure of their writing [15] [16].

With goals similar to those of e-rater and Critique, we design an online computer-assisted learning system to help students in learning English. Our system does not only grade a student's English sentence and produce a score, but also points out which parts of the sentence are correct and which parts are not. In addition, the system provides feedback hints to help student correct her mistakes.

Our system asks students to do two tasks. In the first task, the Chinese translation of an English sentence is provided. The Chinese sentence is segmented into chunks of words/phrases manually and so is the English sentence. The student's job is to match each English chunk to its translated Chinese chunk. In this task, the English sentence is not given in its original form (with correct ordering of its chunks). In the second task, students are given the correctly matched chunks and are asked to reorder the English chunks to produce the original sentence.

1. System Components

The system of computer-assisted language learning is composed of a front-end user interface and three back-end modules—grading, feedback and record. The user interface includes one used by students and one used by the instructor. Fig. 1 shows the architecture of this system.

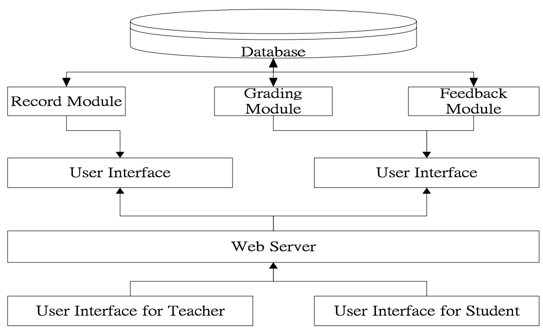

Fig. 1 System architecture

1.1 First task: chunk matching

The interface for the first task is shown in Fig. 2. A student reads the Chinese sentence in region A of the interface. The chunks of the Chinese sentence are listed vertically in region B while the English chunks are listed at random in region C. The student can drag an English chunk to swap with another English chunk within region C. Each swap is recorded by the recording module. When the student wants her answer to be graded, she can submit her answer. The grading module grades her answer and returns a score. Also, in region D of the interface, the feedback module shows which pairs of her answer are correct and which are not. Then the student needs only to revise the incorrect pairs and resubmit her answer. For each sentence, she can submit at most six times.

Fig. 2 First task: match English chunks to Chinese chunks

1.2 Second task: reorder the English chunks to produce the original sentence

The interface for students to do the second task is shown in Fig. 3. Like the first task, the Chinese sentence is shown in text area A of the interface and the Chinese chunks are shown in column B. In column C, each English chunk is displayed to the right of its corresponding Chinese chunk. The student can drag an English chunk to any entry in the table in column C and the entries and their Chinese counterparts in column B will be pushed down one slot but the entries above the chosen slot will not change. After each drag, the English chunks in their top down order will also be displayed horizontally in text area D of the interface, since some people might be more comfortable in reading horizontally. Similarly, the corresponding Chinese chunks, whose ordering will not form a grammatical Chinese sentence in general, will be displayed horizontally in an area below area D.

Every drag will be recorded by the recording module. When a student wants her answer to be graded, she will submit her sentence and the grading module will return a grade. Moreover, the feedback module will indicate in areas E and F which parts of the submitted sentence are correct and which parts are not. In this way, the student can improve her answer and submit again. For each sentence, the student submits answers for at least three times, if full score is not obtained earlier, and at most six times. Whenever she obtains full score, she proceeds to work on the next sentence.

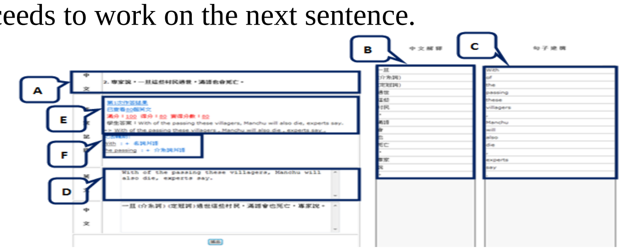

Fig. 3 Second task: reorder the chunks to produce the original English sentence

1.2 Feedback module

First of all, the feedback module must identify which chunks are correctly ordered and which are not. The former is underlined in the feedback region. Consider an example. The target sentence, the student's submitted answer, and the feedback information follow:

Target: *Skills shortages have become a common feature of the global economy, particularly in aging countries.*

Feedback: *Skills shortages have become* *the global economy* *a common feature of* *particularly in aging countires* , .

Hints: *Skills shortages have become* + *<noun phrase>*
the global economy + *<adverbial phrase>*
a common feature of + *<noun phrase>*

The student might use these hints to produce the target sentence.

1.3 Grading module

The grading scheme for chunk ordering is more involved and Table 1 shows the grading formula. $Length(T)$ is the number of elementary chunks (the initial chunks provided by the system) in the target sentence, $Length(S)$ is the number of elementary chunks and $Chunk(S)$

is the number of chunks of correct word strings in the submitted answer. If the student's answer is identical to the target, $Chunk(S)$ is 1.

Table 1 The grading formula for chunk ordering

The second part of Grading formula
$\text{Grade} = \left[1 - \frac{\lvert \text{Length(T)} - \text{Length(S)} \rvert + \text{Chunk(S)} - 1}{\text{Length}(\text{T})}\right] \times 100$

2. Experiment and results

2.1 Participants and Teaching Materials

Twenty-nine students in the experiment were selected from a technological university in Central Taiwan. All of them were juniors and seniors in the college of engineering. Students used the computer-assisted online system to do the two tasks in an English course every week. We collected data for four weeks of the course. The texts used in this study were selected from *New York Times*, translated into Chinese and published in a Chinese-English bilingual form by *United Daily News* in Taiwan.

2.2 Results and Discussion

Students progressed from first construction to the final construction in all eight texts, four for bilingual chunk matching and four for ordering English chunks. Table 2 and Table 3 show students' mean scores at the first and final sentence construction in each text in the word phrase matching and translation.

Table 2 Results of chunk matching

Text	First score	Last score	Progress (P)	Average #submissions (A)	P/A
1	75.3	98.7	23.4	2.8	8.4
2	78.9	99.1	20.2	2.3	8.7
3	76.2	97.4	21.2	2.4	8.8
4	76.1	98.4	22.3	2.5	8.9

Table 3 Results of chunk ordering

Text	Avg. sentence length	First score	Last score	Progress (P)	Avg. #submissions (A)	P/A
1	20.1	50.4	84.4	34.0	3.2	10.6
2	13.2	68.1	92.2	24.1	2.8	8.6
3	21.8	57.0	92.1	35.1	3.3	10.63
4	20.9	55.7	91.6	35.9	3.2	11.2

3. Conclusion

A primary goal of this study is to provide an E-learning environment that detects the errors in each student's answers to tasks related to translation. The first task is to match chunks of English words/phrases to Chinese chunks, which are translated by professionals from the original English sentence, so that the students can learn more English vocabulary. The second task is to order chunks of English words/phrases to produce the original sentence from which the Chinese sentence is translated. The purpose of this task is for the students to apply their knowledge of English grammar and sentence patterns.

An empirical experiment was done with a class of 28 senior students using the system in an English course. Results indicated that they enjoyed using the system, found the tasks challenging, and felt that they became more aware of the difference in sentence structures between English and Chinese. Furthermore, recorded data showed that students were actually using the hints to improve their answers. Quantitative results indicated that their average score improvement increased and the mean score improvement per each submission increased as they practiced more.

Future experiments should test their vocabulary and grammar before and after using the system for a considerable amount of time, such as half a semester. This might provide more evidence on what they actually learn from the computer-assisted online system.

Acknowledgements

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References

[1] Catford, J. (1965). Linguistic theory of translation: An Essay in Applied linguistics. London: Oxford University Press.
[2] Colina, S.(2003). Translation teaching, from research to the classroom: a handbook for teachers. Boston: McGraw-Hill.
[3] Chamot, A. U. & Kupper, L. (1989). Learning strategies in foreign language instruction. *Foreign Language Annals*, 22(10), 13-24.
[4] Chan, T.-h L. (2000). Translation and the foreign language program: Whither are we goin*g?* Paper presented at *the 9th International Symposium on English Teaching*, Taipei, Taiwan, R.O.C.
[5] Chellappan, K. (1991). The role of translation in learning English as a second language. *International Journal of Translation*, 3, 61-72.
[6] Chen, J.-Y. (2000). Junior high school student's English learning strategies. Selected papers from the ninth international symposium on English teaching (pp.198-209). Taipei: Crane Publishing Co.
[7] Danchev, A. (1983). The controversy over translation in foreign language teaching, Translation in the system of foreign language training (pp. 35-43). Paris: Round Table FIT-UNESCO.
[8] Huang, H.-l.(2003). Raising student's awareness of idiomatic English through cross-translation practice. *English Teaching and Learning*, 28(1), 83-100.
[9] Liao, P. (2002). Taiwanese students' beliefs about translation and their use of translation as a strategy to learn English. Unpublished doctoral dissertation, The University of Texas at Austin, Austin.
[10] Marti Viano, M.-D., & Orquin, V. (1982). Identifying our students' strategies for learning English as a foreign language. *Modern English Teacher*, 9(4), 38-41.
[11] O'Malley, J. M. (1987). The effects of training in the use of learning strategies on acquiring English as a second language. In A. Wenden & J. Rubin (Eds.), Learner strategies in language learning (pp. 133-144). Englewood Cliffs, NJ: Prentice-Hall.
[12] Tudor, I. (1987). Using translation in ESP. *ELT Journal*, 41(4), 268-273.
[13] Wong, Wing-Kwong, Yang, Hsi-Hsun, Shen, Wei-Lung, Yin, Sheng-Kai, Hsu, Sheng-Cheng, 2008, Increase the efficiency of English-Chinese sentence alignment: target range restriction and empirical selection of stop words, *WSEAS Transactions on Computers*, vol.7, no.2, pp. 57-64.
[14] Burstein, J., Chodorow, M., Leacock, C., 2004. Automated essay evaluation: the criterion online writing service. AI Magazine 25 (3), 27–36.
[15] Attali, Y., Burstein, J., 2006. Automated essay scoring with e-rater V. 2. The Journal of Technology, Learning, and Assessment 4 (February (3)), 3–30.
[16] Lee, K. J., C. Y. Seok. (2010). "Building an automated English sentence evaluation system for students learning English as a second language ".

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

A Method for Detecting Focusing Utterance through Discussion in Collaborative Learning

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Abstract: In collaborative learning, learners discuss with other learners by exchanging their utterances. In order to represent effective utterances for knowledge acquisition timely, we propose a detection method of focusing utterances which are useful for understanding about their discussion. Focusing utterances are detected according to utterance types and understanding knowledge of learners. Focusing utterances are represented emphatically in the interface so as to distinguish them from normal utterances. Experimental result showed that our method could detect more than 60% of focusing utterances correctly.

Keywords: CSCL, awareness support, focusing utterance, round-table interface

Introduction

As the development of information and communication technologies, learners can easily meet and study with others through the network independently of time and location. To support these learners' activities in the shared virtual space, computer-supported collaborative learning (CSCL) is one of the interesting research fields in recent years [1]. Collaborative learning takes a learning style where learners try to solve their exercise through the discussion with others. However, learners cannot acquire much information about other learners' situations or behaviors because of the restricted communication band and it is still difficult to communicate with other learners through the network.

In order to attain communication among learners in distributed environments, one of the well-known concepts as awareness should be considered. Awareness provides the information: who is around, what activities are occurring, who is talking with whom and so on [2]. Many researchers engaged in CSCL fields have conducted on supporting awareness for learners [3, 4]. In collaborative learning, awareness for conversation is especially required since learners can acquire knowledge by exchanging their utterances. To support communication of learners, text-chat is commonly used in the CSCL system [5]. In text-chat, learners input their utterances carefully. In addition, learners are able to look back their utterances observing the chat logs in comparison with voice-chat. On the other hand, the synchronous collaborative learning using text-chat causes the difficulty to read all utterances and understand who is talking to whom about what. This problem has been known as chat confusion [6]. Therefore, to be aware of the conversation flow and the contents of utterances leads the footholds of their communication.

In this paper, we propose a detection method of the focusing utterances to enhance knowledge acquisition of learners. Focusing utterances which are useful for understanding knowledge are detected timely according to utterance types and understanding knowledge of learners. By observing useful utterances from the interface intuitively, learners can acquire new knowledge about their discussion more effectively.

1. Round-table Interface

In this research, we are focusing on the learners who discuss current topics and acquire new knowledge through the discussion. In order to support the real-time communication among

learners, we have proposed a collaborative learning support system in which focusing intentions for other learners and utterances can be reflected. Figure 1 shows the interface of our collaborative learning support system. Learners progress their learning by exchanging utterances through the text-chat. Round-table window corresponds to each learner's view and changes automatically according to the learners' action such as making utterance [7]. In addition, utterance texts are moved in the interface by inputting their utterance texts with utterance target information (particular learner or all learners) to represent the conversation flow. In order to be aware of the important utterances for leaners, focusing utterances which relate to each learner are estimated and represented in the interface with different manners from other utterances [8]. Figure 2 shows the examples of moving utterance among learners (b1, b2) and displaying focusing utterance (c).
Experimental result about the display method of utterances showed that participants intuitively grasped the flow of utterances by observing the moving utterance texts. However, the precision rate of detected focusing utterances was low, since the method only detects the utterances whose targets are learner himself/herself. The goal of this research is to modify the detection method of focusing utterances from the viewpoint of acquiring the new knowledge.

Figure 1: Interface of our collaborative learning support system

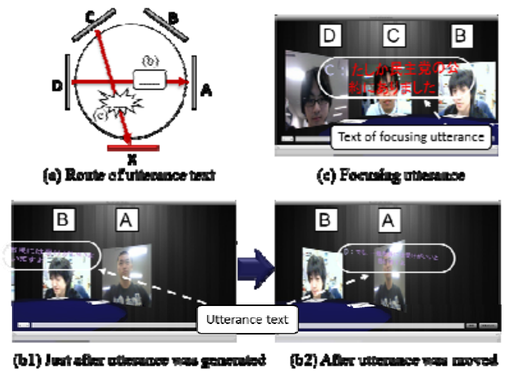

Figure 2: Example of moving utterance among learners and displaying focusing utterance

2. Focusing Utterance of Learners in Discussion

In order to analyze the feature of focusing utterances of learners, we investigated the chat log of the collaborative learning conducted in our laboratory. Two groups which were organized individually by four participants were asked to discuss topics about current Japanese society for 30 minutes. After the discussion, participants were asked to select utterances on which they focused during the experiment from the chat log.
We examined utterance types of selected utterances. Based on the category of the utterance type [9], all utterances were attached either type "Propose", "Explanation", "Agree", "Disagree", "Question", or "Others". In groups 1 and 2, 116 utterances (total 241 utterances) were selected as focusing utterances by participants and more than 80% of focusing utterances were "Explanation". This result indicates that learners focus on the utterances which are useful for understanding knowledge for their discussion. In addition, there was a tendency to select the utterance which includes new keywords at the time. It indicates that a learner may not know/understand the keywords that are not discussed so far. For detecting these focusing utterances timely, keywords and utterance types from each utterance should be extracted. When the utterer makes an "Explanation" utterance, he/she may understand the keywords in the utterance. On the other hand, the utterer may not know the keywords in the case of "Question" utterance. In this manner, understanding degrees for each keyword are different from individual learners according to the utterance types. In order to estimate the focusing utterance for each learner, we introduce the *understanding*

knowledge of learner which is represented as a set of keywords and these understanding degrees. Figure 3 shows the mechanisms for detecting focusing utterances. When an utterance is occurred, its keywords and utterance type are extracted. In addition, the understanding knowledge of the learner is estimated. Based on the utterance information and understanding knowledge of learners, the focusing degree of the utterance for learner is calculated. If the utterance is detected as a focusing utterance, it is represented differently from normal utterances in the round-table window.

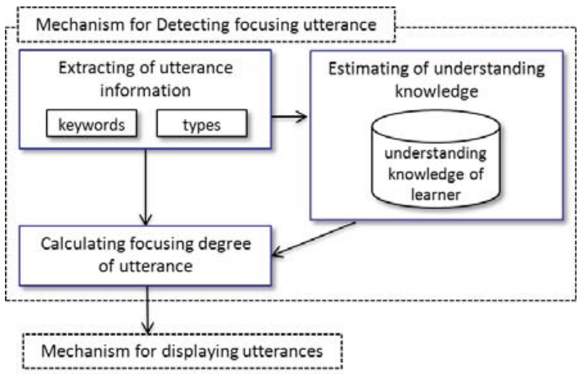

Figure 3: Mechanisms for detecting focusing utterances

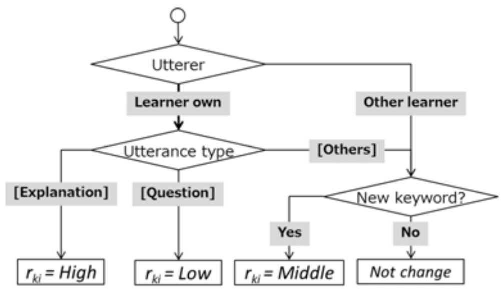

Figure 4: Flow chart of determining understanding degrees of keywords

3. Detection Method of Focusing Utterance

3.1 Extraction of Keywords and Utterance Types from Utterance Texts

Keywords in utterance texts are defined as a noun/unknown word or successive nouns/unknown words and extracted by using morphological analyzer [10] for Japanese language. Utterance types are estimated based on cue words in utterance texts. In order to extract the utterance whose type is "Explanation" or "Question", we analyzed the utterance texts of the past chat log and defined the Japanese cue words for these utterance types respectively. For example, "?" is a cue word for "Question". Currently, we define 33 cue words for "Explanation" and 1 cue word for "Question". If utterance text does not have cue word, it is assigned as "Others".

3.2 Estimation of Understanding Knowledge of Learner

Based on the extracted keywords and utterance types, the understanding knowledge of each learner is estimated as a set of keywords and these understanding degrees. The understanding knowledge of learner X is represented as R_X which includes a set of keyword k_i and their understanding degrees r_{ki}. The degree of r_{ki} takes either *Low*, *Middle* or *High* ($0 \le Low, Middle, High \le 1$).

When an utterance is occurred, the keyword k_i which appears for the first time is added in R_X. Then, understanding degrees of each keyword are determined based on the utterance type and the utterer information. Figure 4 shows the flow chart of determining understanding degrees of keywords. When learner X is an utterer and the utterance type is "Explanation", the understanding degree is set as *High*. On the other hand, the degree becomes *Low* if the type is "Question". In the case of "Others", the degree is set as *Middle* or *not changes* according to the existence of the keyword in R_X. If the utterer is the other learner, the understanding degrees change as the same way as "Others".

3.3 Calculation of Focusing Degree of Utterance

Focusing degrees of utterances for learner X are calculated when the utterer is the other learner and the utterance type is “Explanation”. Following is the equation for calculating focusing degree of utterance u. K_u indicates keywords included in the appeared utterance u, and $K_{u,X}$ shows keywords of utterance u which are included in R_X . The degree becomes large if a number of new keywords are included in the utterance text. Based on the calculated focusing degree, the utterance which is larger than the threshold is judged as focusing utterance.

$$F_u = \frac{|K_u| - \sum_{\forall i \in K_{u,X}} r_{k_i}}{|K_u|} \qquad (1)$$

Texts of focusing utterances are emphatically displayed in the round-table window. The color of a focusing utterance is highlighted and its font size becomes bigger. Moreover, its fading-out time is longer than that of the normal utterance.

4. Experiment

In order to evaluate the appropriateness of the detected focusing utterances, groups 1 and 2 organized by four participants were asked to discuss topics about current Japanese society, i.e. “screening of budget requests”, for 30 minutes using the round-table window.

Before the experiments, participants practiced how to operate in the interface. Representations of the utterance texts of both focusing and normal utterances were explained. After the discussion, participants were asked to select utterances which were useful for understanding knowledge for their discussion from the chat log. The utterances selected by participants were compared with the focusing utterances detected by our method. In this experiment, we set understanding degrees *High, Middle and Low* as 1.0, 0.5 and 0 respectively, and the threshold which judges the focusing utterance as 0.5.

Through the experiments, 112 (in group 1) and 130 (in group 2) utterances were occurred. Table 1 represents the precision and recall rates of detected focusing utterances. From the results, our detection method could detect more than 60% of participants’ focusing utterances correctly. Table 2 is a part of the utterances in Group 2, which is originally generated in Japanese. Although, utterances 32 and 33 included cue words of “Explanation”, the method did not detect these utterances as the focusing utterance. These utterances only explain the feelings of utterers and do not provide new keywords, so no participants selected these utterances as focusing utterance. Therefore, in this case, our method could detect successfully participants’ focusing utterances. On the other hand, utterance 115 selected as a focusing utterance by one participant was not detected by our method. Utterance 115 did not include keywords so that it was not detected as focusing utterances.

In group 2, there was a participant *A* who actively contributed to make utterances for other participants. 60 utterances were made by *A* while the number of all utterances is 130. Within the *A*’s utterances, there were 19 utterances whose types were “Explanation”. After the experiments, some participants commented that *A* had led their discussion. The average of *A*’s recall and precision rates were lower (40.0% and 50.0%) than those of other participants (61.3% and 69.1%). This result indicates that our method could detect focusing utterances of the participants who tend to acquire the knowledge more correctly than those of participants who lead the learning.

Table 1. Precision and recall rates of detected focusing utterance

	Detected focusing utterance	Selected focusing utterance	Correct focusing utterance	Recall rate	Precision rate
Group 1	67	64	41	64.1%	61.2%
Group 2	63	72	42	58.3%	66.7%
Total	130	136	83	61.0%	63.8%

Table 2. Example of utterances (Translated into English)

No.	*Utterer*	*Type*	*Content of utterance*
30	C	Question	Do you mean that there are scenarios written by officials in *1MOF?
31	B	Question	Have government official in *2MEXT already known about it?
32	**A**	**Explanation**	**I'm not sure about that…**
33	**A**	**Explanation**	**If they knew, they would get angry about it.**
114	C	Question	Were about hundred requests screened?
115	**D**	**Explanation**	**I know not all the results of screening were not reflected in actual budget.**

*1MOF: Ministry of Finance
*2MEXT: Ministry of Education, Culture, Sports, Science and Technology

5. Conclusion

In this paper, we proposed a detection method of focusing utterances which are useful for understanding knowledge for their discussion. In the experiment, our method detected more than 60% of focusing utterances correctly. In addition, it reveals that our method could support the participants who tend to acquire the knowledge than the participants who lead the learning. To confirm the effectiveness of our detection method whether learners can acquire new knowledge through the discussion, further evaluations with more groups should be conducted.

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References

[1] Andriessen, J. H. E. (2003). Working with Groupware. Springer-Verlag.
[2] Dourish, P. and Bly, S. (1992). Portholes: supporting awareness in a distributed work group. *Proc. of CHI 1992*, pp. 541–547.
[3] Gutwin, C., Stark, G. and Greenberg, S. (1995). Support for Workspace Awareness in Educational Groupware. *Proc. of CSCL 1995*, pp. 147–156.
[4] Prasolova-Forland, E. and Divitini, M. (2003). Supporting Social Awareness: Requirements for Educational CVE. *Proc. of ICALT 2003*, pp. 366–367.
[5] Looi, C. K. (2005). Exploring the Affordances of Online Chat for Learning. *International Journal of Learning Technology*, Vol. 1, No. 3, pp. 322–338.
[6] Fuks, H., Pimentel, M. and de Lucena, C. J. P. (2006). R-U-Typing-2-Me? Evolving a Chat Tool to Increase Understanding in Learning Activities. *International Journal of Computer-Supported Collaborative Learning*, Vol. 1, No. 1, pp. 117–142.
[7] Hayashi, Y., Kojiri, T. and Watanabe, T. (2010). Focus Support Interface Based on Actions for Collaborative Learning. *International Journal of Neurocomputing*, Vol. 73, pp. 669–675.
[8] Hayashi, Y., Kojiri, T. and Watanabe, T. (2010). Communication Support Visual Interface for Collaborative Learning. *Proc. of IEA/AIE 2010*, pp. 239–248.
[9] Inaba, A. and Okamoto, T. (1997). Negotiation Process Model for Supporting Collaborative Learning. *Journal of IEICE*, Vol. J80-D-2, No. 4, pp. 844–854 (in Japanese).
[10] Morphological Analyzer: Sen. http://ultimania.org/sen/.

The Impact of Learning Styles and Instructional Methods on Students' Recall and Retention in Programming Education

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Abstract: Learning styles are the predetermined indicator which learners respond to and use stimuli in the context of learning. It is the preferred mode that learners perceive and process new information at a certain pace, which in turn affects their academic performance. This paper focuses on the visual-verbal learning styles as well as pair programming (PP) and direct instruction (DI) methods. A group of 83 first year computing students was involved in this experimental study. These students from two intact classes were randomly assigned either to the experimental group that received PP, or to the control group that received DI. During the seven-week treatment, the participants in PP group worked in pairs, and those of DI group worked individually to solve novel programming scenarios. Three computer programming performance tests (CPPT) – a pretest, an immediate posttest and a delayed posttest were conducted to evaluate the students' recall and retention performance on programming comprehension. The post hoc test results revealed that both the visual and verbal students taught in the PP and DI groups performed equally good in recall performance. However, only the verbal students in the DI group significantly outperformed the visual students in retention. In conclusion, the diversity of learning styles influence students' engagement in understanding the programming concepts; significantly affects information retention and later on their academic achievements.

Keywords: Learning style, direct instruction, pair programming, programming performance

Introduction

Computer programming requires students to understand the programming process stages: problem, design, coding and maintenance, in solving programming problems. It is a subject which demands complex cognitive skills such as reasoning, problem-solving and planning that students find it too difficult to comprehend and master [1]. Grand and Smith [2] describe basic programming concepts as a set of rules, like expressions, functions, variables declarative, statements, sequencing and conditionals which first year computing students need to know in following any programming courses.

Various teaching methods have been applied by instructors in teaching these concepts to undergraduate students. According to Baldwin and Kuljis [3], these methods include changing the programming languages which is to be taught first, using different textbooks, slowing the course delivery, lowering the standard, reducing the course requirements, as well as switching between bottom-up and top-down approaches in teaching basic programming concepts. However these methods did not significantly change the students' performance. Thus, some instructors opted to reduce the quality and to lower the standard of material taught and concentrate on "important topics" [3].

Programming concepts tend to be difficult to grasp and require complex cognitive task. Students who have adequate program-solving skills and manage to phase solution to programming problems, could find it difficult to turn the problems into syntactically correct program flowchart and Pseudocode [1][2]. Consequently, they tend to make the same mistakes and become frustrated trying to understand and comprehend even the most basic concepts [4]. Hence, those who are strong in logical reasoning skills outperform their counterparts in the programming course, and others who do not appreciate the beauty of programming will eventually drop out from the field.

1. Learning Styles

Learning style (LS) is a preferred learning mode in which students respond to and use stimuli in the context of learning. For James and Gardner [5] and Kolb [6], it is the way in which students perceive, process, store and recall attempts of learning. These styles have been acknowledged as the prime construct that serve as relatively stable indicators of how students respond to the learning environment [7]. However, with variation, these stable indicators somehow may change from one learning environment to another as the students adapt to the learning approach, progress and respond to the programming problems. Researchers have claimed that students consistently indicate positive improvements in performance when novel concepts are illustrated in their preferred style [8][9]. In this study, the Felder-Soloman’s [10] Index of Learning Style was selected as it focused primarily on learning styles, comprehensive, parsimonious and is relevant to science education.

2. Instructional Methods

Instructional method is an approach used by educators in course content deliveries. It is an educational approach for revolving knowledge into learning which focusing on the “how to” in delivery of training [11]. In this study, two instructional methods and two experience lecturers identified are randomly assigned to the treatment groups. In programming methodology, two basic constructs: (i) sequence and (ii) selection are the syllabus covered in this study. The undergraduate semester one computing students who worked in pairs received the PP instruction method. Those in the control group are taught in the DI method.

3. Research Methodology

The prime focus of this study is to investigate the effects of pair programming as cooperative learning approach on the programming recall and retention performance amongst the visual–verbal learning style dimension computing students. The emphasis of this research is on whether the learning style preference could be the moderating factors when different instructional methods are applied in classroom environment.

3.1 Research Design

A 2 x 2 quasi-experimental design was used to examine the effects of PP and DI on the two dependent variables (recall and retention) with one LS dimension being the moderating variables. These dependent variables were based on the immediate and delayed posttest scores obtained from the computer programming performance test (CPPT). A total of 83 first year undergraduate computing students (n = 83) in this intact group were randomly assigned to the two treatment groups: the experimental group that received the PP treatment and the control group that received the DI treatment.

3.2 Research Instrument

The computer programming performance tests (CPPT) instrument which consist the immediate and delayed posttest were administered to measure the students' recall and retention performance. The tests were designed to assess the students' programming performance on the theories and practical knowledge of the sequence and selection programming constructs. The Felder-Soloman's Index of Learning Styles Questionnaire (ILSQ), based on the Felder and Silverman's [12] learning styles model was used to access the students' learning style preference prior to the treatment. In this study, only one dimension measuring the visual and verbal learning style (Cronbach's Coefficient alpha of 0.78 [13]) was used to determine the students' learning preference. This instrument uses a multiple choice format in presenting options. The students who responded mostly 'a' in the questionnaire were classified as visual learners and those who responded mostly 'b' were identified as verbal learners.

3.3 Data Collection Procedures

The experiment was conducted for seven-week duration to the two intact classes. These two classes were randomly selected from the first year computing course and assigned to the two treatment groups. The ILSQ questionnaire was administrated to these groups prior to the treatment in order to classify the students as visual or verbal learners. During the treatment, the students in both groups received program flowchart and Pseudocode in learning the basic programming concepts: (i) sequence and (ii) selection constructs. In the PP group, each pair consisted of one visual and verbal student with an assigned role of either as "driver" or "navigator". These roles are interchangeable at regular intervals. The pairs worked together on the same programming task to discuss and provide constructive criticisms in generating quality programming solutions.

4. Findings

The quantitative data collected to corroborate the research hypotheses were analyzed using the SPSS 16.0 for Windows and computed at the 0.05 level of significant. As covariate was used in the analysis, the adjusted posttest mean scores were reported. The MANCOVA results clearly revealed a significant difference in recall performance between the visual and verbal students taught in the two treatment groups ($F=6.10$; $p=0.00$; $p<0.05$). A significant difference in retention was also observed between these students who received the different treatment methods ($F=4.30$; $p=0.01$; $p<0.05$). Therefore, a post hoc test was administrated to further examine the differences. This study reveals the comparisons involved only between the visual and verbal students in both the PP and DI groups. The comparisons between the visual students in the PP and DI groups, as well as between the verbal students in both the treatment groups were not the scope of this discussion.

Hypothesis 1: There are no significant differences in recall between the visual and verbal students who received the PP method and those who received the DI method.

In this study, the post hoc result indicates no significant difference between the visual and verbal students taught in the PP group ($M_{PP\text{-}visual}=65.86$; $M_{PP\text{-}verbal}=66.27$; $p=0.89$) as well as those in the DI group ($M_{DI\text{-}visual}=55.31$; $M_{DI\text{-}verbal}=59.65$; $p=0.15$). Thus, this finding has accepted the first hypothesis.

Hypothesis 2: There are no significant differences in retention between the visual and verbal students who received PP method and those who received DI method.

For the PP group, the post hoc test result reveals no significant difference in retention performance between the visual and verbal students taught in this PP method ($M_{PP\text{-}visual}$= 52.03; $M_{PP\text{-}verbal}$= 58.33; p=0.051; p>0.05). However, a significant difference in retention was observed between them in the DI group (MeanDiff =6.53; p=0.037; p<0.05), with the verbal students performed significantly better than those of visual students ($M_{DI\text{-}visual}$=46.95; $M_{DI\text{-}verbal}$=53.48). Thus, the second hypothesis has been rejected.

5. Discussion

This study revealed that the preferred style has significantly correlated and influenced students' programming comprehension; in return affecting their mental process [7][8]. For the recall performance, both the visual and verbal students taught in the PP and DI methods performed equally good in the programming recall test. Knowing the students' individual LS allows them to create a richer learning context of the basic programming concepts. With regards to the instructional methods, LS assists both students taught in the PP and DI methods in that they understand their individual preference in learning programming that create a higher level of conceptual understanding and promote logical thinking skills with respect to programming recall performance [14]. Despite the fact that visual students learn better with diagrams or charts, they are able to adapt and change learning approach from one learning environment to another as they progress and respond to programming problems that subsequently trigger the actual learning process in the long term memory for further information recall [15].

In retention performance, only the verbal students taught in the DI method significantly outperformed the visual students taught in the same method. Working in pairs, both visual and verbal students provided with the opportunity to explain and discuss novel concepts with their partners, thus promotes meaningful learning and retention [16]. Moreover, students are benefited from pairing with heterogeneous LS pair, especially with diversity of thought that fosters learning process [9]. The verbal students in the DI method incline to have longer retention rate on the basic programming concepts taught as the explanation of abstract concepts are predominantly conducted in the form of lectures, written texts and on the whiteboard in the classroom environment [17]. Thus, the verbal students are able to process and build better schemata in long term memory as they remember better through oral and written explanations as compared to their counterparts in both instructional methods. In contrast, the visual students learn and remember better through pictorial form than auditory clues. So, they are experiencing difficulties in attaining the pedagogical goals for programming performance in retention than those verbal students taught in both PP and DI groups [14][18].

6. Conclusion

The study has emphasized the importance of considering LS components in learning the basic programming concepts for classroom delivery. LS is a predictable stable indicator that influences the learning approach of students in perceiving, interacting with and responding to programming concepts. The preferred LS of students and the instructional methods applied in programming classes are correlated with the students' recall and retention performance. Disparity between the LS and instructional methods in comprehending the fundamental programming concepts may cause significant impact on students' overall performance (recall and retention). Therefore, both the visual and verbal representation of novel concepts need to be embraced into the learning context in order to reinforce long term memory retention, enhance cognitive knowledge and promote logical thinking skills with respect to programming performance.

References

[1] Miliszewska, I. & Tan, G. (2007). Befriending computer programming: A proposed approach to teaching introductory programming. *Issues in Informing Science and Information Technology*, *4*, 277-289.

[2] Grant, M. & Smith, S. (2005). Programming languages. *Free software foundation*, (1.02). Retrieved February 10, 2009, from http://www.e-booksdirectory.com/ details.php?ebook=1139

[3] Baldwin, L. P. & Kuljin, J. (2000). Visualisation techniques for learning and teaching programming. *Journal of Computing and Information Technology* – ICT, *8*(4), 285-291.

[4] Stamouli, I., Doyle, E. & Huggard, M. (2004). Establishing structured support for programming students. *Proceedings of the 34th ASEE/IEEE Frontiers in Education Conference*, *2*, F2G-5-F2G-9, Savannah, GA., October.

[5] James, W. & Gardner, D. (1995). Learning styles: Implications for distance learning. *New Directions or Adult and Continuing Education*, *67*.

[6] Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice-Hall.

[7] Deborah, G. (2005). Meeting differing learning styles of non-traditional students in the second language classroom. *Journal of College Teaching and Learning*, August, *2*(8), 1-7.

[8] Pallapu, P. (2007). Effects of visual and verbal learning styles on learning. *Institute for Learning Styles Journal*, *1*, 34-39.

[9] Davis, G. A. (2006). Learning style and personality type preferences of community development extension education. *Journal of Agricultural Education*. *47*(1), 90-99.

[10] Felder, R. M. & Soloman, B. (2000). *Learning styles and strategies*. North Caroline State University, Resources in Science and Engineering Education. Retrieved December 30, 2009, from http://www2.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.html

[11] Nguyen, F. & Clark, R. C. (2005). Efficiency in e-learning: Proven instructional methods for faster, better, online learning. *A publication of the eLearning guides*, November 7, 1-8.

[12] Felder, R. M. & Silverman, L. K. (1988). Learning styles and teaching styles in engineering education. *Engineering Education*, *78*(7), 674-681.

[13] Zywno, M. S. (2003). A contribution to validation of score meaning for Felder-Soloman's Index of Learning Styles. *Proceeding of the 2003 American Society for Engineering Education Annual Conference & Exposition*, American Society for Engineering Education.

[14] Fenrich, P. (2006). Getting practical with learning styles in "Live" and computer-based training settings. *Issues in Informing Science and Information Technology*, *3*, 233-242.

[15] Anabela, G., Alvaro, S., Lilian, C. & Mendes, A. J. (2007). Learning styles in an e-learning tool. *Paper presented at International Conference on Engineering Education – ICEE 2007*, Coimbra, Portugal.

[16] Chung Ruey-Gwo & Lo Chieh-Ling (2006). The study of different cooperative learning and problem-based instructions in promoting students' teamwork competences. *World Transactions on Engineering and Technology Education*, *5*(3).

[17] Layman, L., Cornwell, T., Williams, L. & Osborne, J. (2007). *Personality profiles and learning styles of advanced undergraduate computer science students*. NC: North Caroline State University.

[18] Franzoni, A. L. & Assar, S. (2009). Student learning styles adaptation method based on teaching strategies and electronic media. *Educational Technology and Society*, *12*(4), 15-29.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

The Effectiveness of Web-Based Instruction and Cooperative Learning on the students' listening and speaking skills in Mandarin Language Learning

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Abstract: The purpose of the study was to investigate the effects of the instructional methods using web-based instruction (WBI) and cooperative learning (CL) on listening and speaking skills for Mandarin learning among non-Chinese learners at MARA University of Technology in Malaysia. The students' performance on listening skill was tested by using a standardized listening test while the performance on speaking skill was measured by two oral tests carried out after the treatments. A quasi-experimental study with posttest-only design was applied in the study. Three types of instructional methods, namely individual learning in an unstructured use of WBI (USLG), individual learning in a structured use of WBI (SLG), and cooperative learning with WBI (COOP) were applied. The dependent variables were the scores of a listening test and two oral tests. The sample consisted of 195 students who were taking Mandarin Level 1 at UiTM Terengganu branch campus. The "Learning Motivation for Mandarin" questionnaire was used to investigate any differences among the participants prior to the treatment. The treatment lasted for five weeks. The results of the analyses showed that there were no significant differences in terms of listening skills and speaking skills among the COOP, the SLG as well as the USLG groups. However the descriptive statistics reveals that the COOP group performed slightly better than the SLG group, and the SLG group performed slightly higher than the USLG group for both listening and speaking skills.

Keywords: web-based instruction, cooperative learning, Mandarin language learning

Introduction

Universiti Teknologi MARA (UiTM) offers three levels of Mandarin courses to prepare and train its students. The Elementary Mandarin Language course in UiTM Dungun is intended for the students who have no background in Mandarin or any character-based language. The students will be introduced to the Hànyǔ pīnyīn system (Romanized Mandarin). The students will thus have to learn Mandarin as the third language for their future profession practice [1]. For the purpose of this study, the samples for this research involved those taking Mandarin Level 1 (Elementary level). They are Bumiputera, non-Chinese speaking students who learn Mandarin as a foreign language.

Problem Statement

The three major problems faced include the students' mastery of Mandarin pronunciation, non-performance in listening and speaking aspects as well as time constraints in assisting students in tackling these three problems mentioned. It is hoped that by providing online learning materials such as through Web-based Instruction (WBI), it may supplement students in their Mandarin learning.

Literature Review

The research on Mandarin is at all times related to second language learning. Two teaching principles for Mandarin instruction, namely student-centered, and communicative competence by Li [2] are essentials for Mandarin instruction as they assist in building up students' communicative competence in Mandarin. Web-based instruction is increasingly being used to deliver course content in higher education [3]. This approach is in line with the constructivist philosophy of learning where the learner is encouraged to interact with the environment to construct individual knowledge structure [4]. Cooperative learning refers to instructional methods whereby students are encouraged or required to work together on learning tasks [5]. It is much related to the developing of motivation in the learners. However, most web based learning sites are still limited to the dissemination of teaching materials. Neither the strengths of Internet and Web have been maximized nor have the functions been fully utilized, for instance, supporting cooperative learning [6]. Thus, it is needed to validate the use of cooperative learning in strengthening WBI so as to result in maximum learning outcome. As web-based instruction with the support of cooperative learning that is in tandem with the social-psychological perspective on learning [7], the combination of these two perhaps will give a viable approach in supplementing Mandarin learning for non-Chinese learners.

Research Design

The purpose of this research is to investigate the impact of Web-Based Instruction and cooperative learning on the *speaking* and *listening* skills as well as their perceptions after using web-based instruction and cooperative learning to supplement their Mandarin learning. This research applies quantitative methodology. A quasi-experimental design was applied where six intact groups consisted of some classes of Malay students who are taking Mandarin courses at UiTM Dungun was used as the research samples. A random-sampling method was used in assigning the intact classes to one of the three treatment groups. The independent variable of this study was the instructional approach (unstructured individual learning of WBI learning materials, structured individual learning in WBI and cooperative learning in WBI), and the dependent variables were the students' speaking and listening skills as measured by one listening test and two oral (speaking) tests.

Activities for Each Group

Before the delivery of questionnaires, the participants were trained on the use of the supplementary materials on the *i-Learn System* and *MyTLS* (My Teaching and Learning System). *I-Learn System* and *MyTLS* are the online systems used in this study for web-based instruction. The learning materials were uploaded in these systems to supplement the Mandarin learning and teaching. Table 1 shows the activities for each group. The instructors used the feature in *i-Learn System* to monitor the students' activities. For Group1 (Unstructured use of WBI- USLG), the time spent by the students is not specified. Their accesses to the online activities were not recorded. While for Group2 (Structured use of WBI- SLG) and Group3 (cooperative learning with WBL- COOP), the time in which the students accessed to the online learning materials was recorded using the *i-Learn System*. Each student had to spend at least two hours per week for their online activities.

Table 1: Activities for Each Group

Activities for	Group 1 Unstructured Use of WBI	Group 2 Structured Use of WBI	Group 3 WBI + CL
Speaking skills	Using face-to-face instruction and online learning materials in an unstructured manner without any monitoring from instructors	Using face-to-face instruction and online learning materials in a structured manner with monitoring from instructors	Using face-to-face instruction and online learning materials along with cooperative learning method
Listening skills	Using face-to-face instruction and online learning materials in an unstructured manner without any monitoring from instructors	Using face-to-face instruction and online learning materials in a structured manner with monitoring from instructors	Using face-to-face instruction and online learning materials along with cooperative learning method

The Use of Cooperative Learning Method

The cooperative learning program was conducted over a period of six weeks with four contact hours a week. Group3 consisted of four members in each group. To achieve group heterogeneity, each group consisted of one high achiever, two average achievers, and one low achiever. This categorization is based on the students' pretest (the standardized Mandarin written progress test) results as shown in Table 2. The cooperative learning methods used in this study are Student Teams Achievement Divisions or STAD [8], Teams-Games-Tournaments or TGT [9] and Learning Together or LT [10], [11].

Table 2: Categorization of Students for Group 3

No.	Progress Test Result (%)	Group
1	80 and above	High achievers
2	51-79	Average achievers
3	50 and below	Low achievers

Research Subjects

This research was carried out in UiTM Terengganu, Dungun, Terengganu Darul Iman. A total of 195 students who are taking Mandarin Level 1 participated in this research.

Research Instruments

There are several sets of research instruments used in this study. They are pre-treatment instruments (Motivational Questionnaire [12]), "WBI Perception" [13]) administered for triangulation purposes, and treatment effect measurement instruments (Achievement tests - one listening test and two speaking tests).

Findings

The “Learning Motivation for Mandarin” questionnaire was administered to the participants prior to the treatment to determine that they are homogeneous in terms of motivation in Mandarin learning before the treatment commences. Based on the analysis, it was found that their motivational levels ranged from 3.92 - 4.06 (mean USLG:4.00; mean SLG:3.92; mean COOP: 4.06). The ANOVA test revealed that the differences in motivation between the three treatment groups were not significant (F: 2.51; p: 0.84). Thus, the three treatment groups are homogenous in terms of their motivational aspect prior to the treatment. Hence, this motivational aspect was not used as the covariate in this study, and as a result, ANOVA was used for the data analysis. ANOVA was then used to analyze the students’ *speaking* and *listening* skills, which are based on the two oral and one listening tests.

The results showed that there were no significant differences in terms of *listening* and *speaking* skills among the cooperative learning group (COOP), the structured individual learning group (SLG) as well as the unstructured individual learning group (USLG) in the web-based instruction environment. However the descriptive statistics revealed that the COOP group performed slightly better than the SLG group, and the SLG group performed slightly higher than the USLG group for the *speaking* skills. A post-hoc test also revealed that the COOP group significantly performed better than the USLG in terms of their *listening* skills (mean difference: 0.512; p:0.036). Nevertheless, no significant differences in *listening* skills were recorded between the COOP and SLG, as well as between SLG and USLG.

Discussion and Conclusion

Although there are no significant differences in terms of *listening skills* among the cooperative learning group (COOP), the structured individual learning group (SLG) as well as the unstructured individual learning group (USLG) in a web-based instruction environment, the post-hoc analysis revealed that the COOP group performed significantly better than did the USLG. When the students worked in group, they performed better as compared to working individually. Instilling listening skill is time-consuming and not an easy task especially for those students who are weak in listening [14]. The findings also revealed no significant differences in terms of *speaking skills* among the cooperative learning group, the structured individual learning group as well as the unstructured individual learning group in the web-based instruction environment. This is because speaking training is a very multifarious process. Speaking process requires the understanding of the receiving part through listening skill. The students who can listen well are only then able to reply in a proper manner. If the students cannot listen well, for sure they are not able to speak well. Therefore a NSD (non-significant difference) result on speaking skills might be observed due to the lack of listening skills of the particular learners. Any instructional technology employed does not ensure positive outcomes [15]. For perceptions concerning the effects on *speaking* skills, there is a significant difference between the three treatment groups. This means that the students of the SLG and COOP groups agreed that the web-based instructional materials were effective for the acquisition of speaking skill. The differences between USLG and SLG as well as between USLG and COOP are significant. However, the difference in perceptions between the SLG and COOP groups is not significant. The significant findings showed that WBI is beneficial for *speaking* acquisition. This confers with the findings of Zhu [16] in the study of the use of WBI to support ELT for *speaking* skill development. However studies on the effectiveness of the use of WBI to support *speaking* skill acquisition are still lacking.

Instructors are encouraged to use cooperative learning as expanding the dimensions for the teaching of Chinese as a foreign language [17]. For example, Chen [18] integrated group discussion to support online activities. Network cooperative learning activities carried out are e-mail contacts, network online help, network collaborative learning method, etc [19]. The application of web-based instruction is getting more attention in the teaching of Chinese as a foreign language [20]. To sum up, it is anticipated a feasible and viable use of WBI along with cooperative learning in supplementing the on-campus Mandarin courses in UiTM in particular and for the teaching of Chinese as a foreign language in general.

References

[1] *Course Syllabus of Mandarin 1,2 and 3 (2004).* UiTM Shah Alam: Academy of Language Studies, Mandarin Unit.

[2] Li, Q. (2004). *Thoughts on the Theories of the Teaching of Chinese as Foreign Language*. Beijing, China: Educational Science Publication.

[3] Nachmias, R. & Segev, L. (2003) Students' Use of Content in Web Supported Academic Courses. The Internet and Higher Education 6, 145-157.

[4] McDonald, C.J., Stodel, E.J., Farres, L.G., Breithaupt, K., & Gabriel, M.A. (2001). The Demand-driven Learning Model: A Framework for Web-based Learning. *The Internet and HigherEducation, 4*(1), 9-30.

[5] Lethinen, E., Hakkarainen, K., Lipponen, L., Rahikainen, M., & Muukkonen, H. (1999). *Computer Supported Collaborative Learning: A Review*. CL-Net Project. Available: http://www.kas.utu.fi/clnet/clnetreport.html [accessed 30 November 2006].

[6] Cheng, Y.Y. & Yen. J (1998) "Virtual Learning Environment (VLE): A Web-Based Collaborative Learning System," *hicss*, p. 480, Thirty-First Annual Hawaii International Conference on System Sciences-Volume 1, 1998.

[7] Smaldino, S. E.; Russell, J.D.; Heinich, R. & Molenda, M. (2005). *Instructional Technology and Media for Learning, Eight Edition.* United States of America: Pearson Education, Inc.

[8] Slavin, R. (1978). Student Teams and Achievement Divisions. *Journal of Research and Development in Education*, 12, 39-49.

[9] DeVries, D., & Edwards, K. (1974). Student Teams and Learning Games: Their Effects on Cross-race and Cross-sex Interaction. *Journal of Educational Psychology*, *66*, 741-749.

[10] Johnson, D. W., & Johnson, R. (1999). *Learning Together and Alone: Cooperative, Competitive, and Individualistic Learning*. Boston: Allyn & Bacon. First edition, 1975.

[11] Falchikov, N. (2001). *Learning Together: Peer Tutoring in Higher Education.* UK: Routledge.

[12] Schmidt, R., Boraie, D., & Kassabgy, O. (1996). Foreign language motivation: Internal structure and external connections. In R. Oxford (Ed.), *Language learning motivation: Pathways to the new century* (Technical Report No. 1, pp. 9-70). Honolulu, University of Hawaii, Second Language Teaching & Curriculum Center.

[13] Stepp-Greany, Jonita (2002). *Student Perceptions on Language Learning in a Technological Environment: Implications for the New Millennium.* Language Learning and Technology, Vol. 6, No. 1, pp.165-180.

[14] Hu, B. (2002). The Reflection of Web-based Listening Teaching. In *E-Learning and The Teaching of Chinese as A Foreign Language*. Beijing: Tsinghua University Press, 2002: 299.

[15] Chang, D.Y. (2000). Reducing the use of instructional materials and advanced speaking instruction. *Monograph of Language and Culture Instruction as well as Research, Issue 4*, 2000.

[16] Zhu, L.-Y. (2006). Developing Listening and Speaking Skills in ELT Classroom. *CELEA Journal (Bimonthly), Vol. 29*, No. 4, Aug. 2006.

[17] Ma, J.F. (2003). In Zhao, J.M. (Ed.). (2005). *Introduction to the Teaching of Chinese as A Foreign Language. (Duiwai Hanyu Jiaoxue Gailun)*. Beijing: Commercial Press.

[18] Chen, Z.Q. (2000). The Combination of Group Activities and Online Activities – the Teaching Concept for Chinese Literature and History Knowledge Course. In *Modern Education Technology and the Teaching of Chinese as a Foreign Language.* Guangxi Normal University Press, 2000: 82.

[19] Zhou, X.J., Wu, Z.S., Zhao, X.M. and Zhang, P. (2001). The construction of mode for network users of distance education for the teaching of Chinese as a foreign language. *China Electronic Education*, 2001(11), Monograph of Theses.

[20] Xin, S.C (2002). The experience in application and exploring web-based Chinese instruction. *Nanjing University Journal*, 2002 Special Issue.

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Optimization of a Cooperative Programming Learning System by Using a Constructivist Approach

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Abstract: This work describes a cooperative programming learning system (CPLS) based on a novel constructivist approach. This system embeds various constructivist elements within functions to support each phase of the information process that allows students to construct programming skills through knowledge, tasks, and assessment domains. The CPLS comprises a discussion forum, programming editing forum, design forum with structure charts, project management, project guidance, performance demonstration, and peer assessment models. Effectiveness of the proposed system is demonstrated based on an experiment involving 54 undergraduate students in a private university in Taiwan. Learning effectiveness is analyzed using Pearson correlation coefficients. Analytical results indicate that students using this CPLS more frequently could learn programming skills more easily. Efforts are underway to incorporate more pedagogical models in the proposed system, as well as improve the system interface and functions.

Keywords: Cooperative programming learning system, programming learning, project-based

Introduction

Computer education highly prioritizes programming skills, which are challenging to teach owing to their complexity and hesitancy among students to learn them. Applying program -ming concepts to real world problems is the primary learning objective. Whereas syntax and semantics are insufficient alone in learning a programming language, problem solving must be incorporated [4]. However conventional tutoring strategies for programming courses have difficulty in fostering the problem solving skills of students [1]. Conversely, project-based teaching strategies have been developed as a viable alternative [12]. While representing the best accomplishment for a project, collaborative learning can coordinate project activities into academic and social learning experiences. Technology advances have made it feasible to incorporate more constructivist motion in the design of cooperative learning in programming [5]. Cooperative learning systems have proven beneficial in providing marvelous opportunities for communication during programming learning [3].

This work presents a cooperative programming learning system (CPLS) by applying constructivist pedagogical approaches. An overview of the constructivist approach is provided, followed by a discussion of the transformative role of constructivist education in programming learning. The proposed CPLS consists of knowledge based domain, task based domain, and assessment based domain to construct a cooperative programming environment. A task involving real world scenarios is subsequently assigned to encourage learners to interpret programming knowledge actively, rather than receive it passively.

Students record their experiences on logs, followed by attitudinal questionnaire to understand their use of the system. Additionally, the learning outcome is evaluated based on group-based tasks and an individual knowledge test. Moreover, the effectiveness of the proposed CPLS in enhancing programming learning is analyzed using the Pearson correlation coefficients.

Literature Review

1. Programming Learning

A conventional approach in programming education involves orienting students on programming language concepts and then guiding students to effective strategies for programming implementation. However many studies have cited the knowledge driven method as incapable of solving learner problems when teaching programming [6]. This inability may be owing to the lack of practical experience in becoming competent in programming, despite their previous knowledge of a program language. However, learners could nurture their programming skills if assisted by appropriate instructional tasks and educational technologies [9].

2. Learning Theory Approach

Exactly how constructivist learning theories comply with cooperative programming learning requirements is explained by discussing constructivist learning theories and their implications for the proposed CPLS.

2.1 Constructivist Learning and its Implications

Constructivism is based on the premise that our perceptions are constructed through individual experiences [2]. Learners interpret what they have received through their senses to create knowledge [11]. Constructivism heavily emphasizes cognitive constructivism and social constructivism.

2.2 Cognitive Constructivism

Based on the pioneering work of Jean Piaget as the foundation for teaching and learning, cognitive constructivism posits that individuals must construct knowledge through their experiences to create schemas [12]. Students learn better when information is introduced to support problem solving, in which learning functions as a tool rather than merely as facts.

2.3 Social Constructivism

The social constructivism theory of Vygotsky extends individual learning to collaborative learning by allowing individuals to share background knowledge and participate in a given task to create meaning by interacting with others [14]. Importantly, this theory emphasizes the impact of collaboration and views learning as occurring in social processes [13].

3. Collaborative Activities through CSCL

Collaborative learning motivates individuals to solve problems through individual learning in group work [8]. The task-related activities are performed through group members sharing and discussing task-related information, as well as verbalizing their ideas.

Computer-supported collaborative learning (CSCL) assists students in constructing knowledge through online collaboration [7]. CSCL also performs scaffold processes that are not achieved through face-to-face communication, such as having learners to record their communication through logs [10].

System Design

According to previous literature, this work develops a cooperative programming learning system (CPLS) for a task-construct-based cooperation programming environment. ASP.NET and MSSOL syntax are used as developing tools in the system. Figure 1 illustrates the architecture of the proposed system.

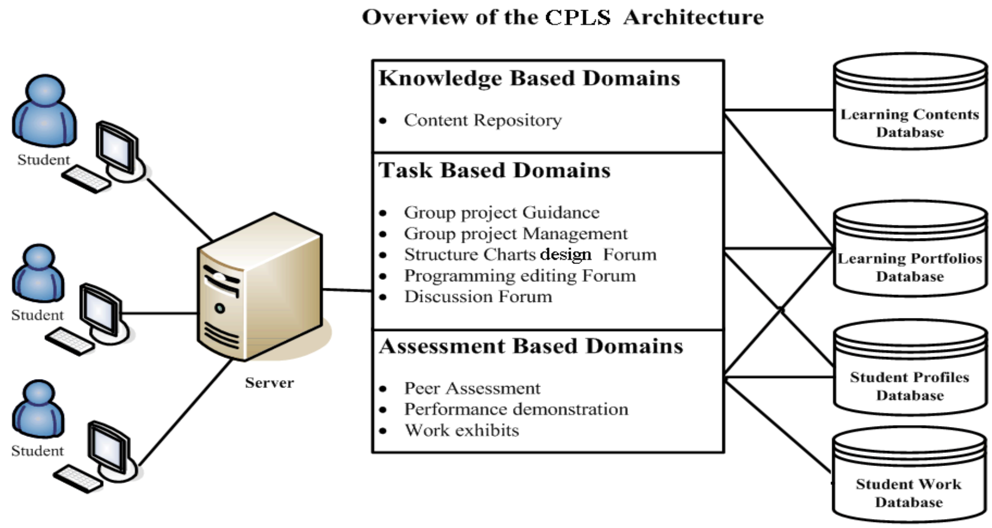

Figure 1： Architecture of the proposed CPLS

The CPLS incorporates various constructivist elements within functions, such as: discussion forum, programming editing forum, design forum with structure charts, project management, project guidance, performance demonstration, and peer assessment models to support pedagogical training as follows:

1. Compliance of the Proposed CPL System with Cognitive Constructivism

The proposed system provides a learning content repository in which students can download and read the teaching materials, followed by completion of real-world related tasks using ASP.NET. The proposed CPLS has the following features:

- The knowledge based domain with a content repository provides online information and resources to allow students to put their knowledge directly into practice.
- The system supports each phase of the information process in which students can construct programming skills through knowledge, task, and assessment domains to complete assigned projects.
- In addition to providing facts and examples, the proposed system is also presented as a medium to solve global problems.

2. Compliance of the CPLS with Social Constructivism

Among the visualized functions that the proposed CPLS provides include a discussion forum, programming editing forum, and design forum with structure charts (Figs. 2-a and 2-b). Group members collaborate with each other in completing all programming tasks.

Figure 2-a

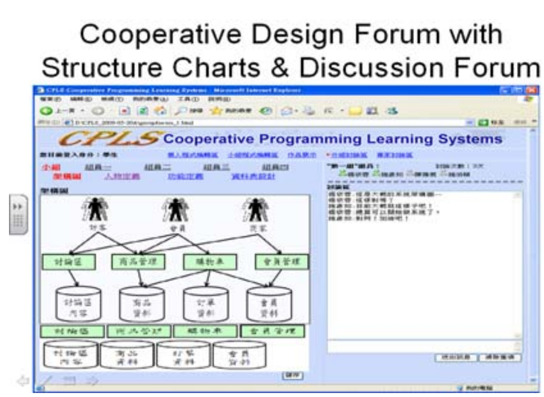

Figure 2-b

The proposed CPLS has the following features:

- The task based domain allows learners to construct knowledge based on their experiences in working group project rather than receiving that knowledge from teachers.
- In the cooperative forum, the leader has the authority for editing or passing the leadership onto another group member.
- The proposed CPLS provides a highly interactive environment that allows learners to complete their programming tasks through social constructivism.

3. Improved Human Knowledge Management Capabilities through the Proposed CPLS

In addition to providing teaching materials and a self-coding panel for individual learning, the proposed CPLS facilitates cooperative learning with the following features:

- A teaching assistant can model a lesson and handle student questions. Learners can serve as apprentices in terms of understanding problem complexity and acquiring knowledge skills.
- The proposed CPLS provides guidance and management tasks that require high levels of processing and facilitate student performance.

The proposed system supports all phases of the following tasks: design of structure chart, online coding, database design, presentation of learning achievement, and peer assessment.

Research Method

Fifty four undergraduate students from a private university in Taiwan participated in the study. The students were enrolled in a web-based programming course using ASP.NET. Basic concepts and knowledge were introduced during the first 9 weeks, followed by a 9-week experimental period. Each group comprised 4-5 students and was assigned a task through the proposed CPLS, aimed at designing an e-commerce website. Students logged their experiences to examine the effectiveness of system implementation. The projects were scored, followed by an individual knowledge test to evaluate the learning effectiveness.

Results

1. System Usage

User logs were corrected to understand the frequency of system use. System functions of “edit database”, “save a file”, “send a message”, and “view the outcome” were used the most during collaborative learning.

2. Correlation between System Usage and Learning Effectiveness

Effectiveness of the proposed CPLS in enhancing programming learning was determined by evaluating the Pearson correlation coefficients to analyze the relation between the frequency of system use and knowledge test score, project score, as well as student attitudes. According to SPSS statistical results, system usage correlated well with the knowledge test score ($r = 0.45$, $p < 0.01$) and the group project ($r = 0.30$, $p < 0.05$) (Table 1). Students that used the proposed CPLS more frequently than others achieved a higher learning outcome, demonstrating the effectiveness of student learning of programming skills.

Table 1 Correlation coefficients between system usage and learning achievements

	System usage	Knowledge test	Project score	Attitude
System usage	1	.45**	.30*	-.04
Knowledge test	.45**	1	.02	-.02
Project	.30*	.02	1	.03
Attitude	-.04	-.02	.03	1

Asterisk (*) denotes the correlation coefficients that are statistically significant at the 0.05 level.
Double asterisks (**) denotes the correlation coefficients that are statistically significant at the 0.01 level.

Conclusion and Future Studies

This work presents a cooperative learning system for programming by providing a complementary discussion function to facilitate group interaction. The proposed CLPS facilitates guidance and management tasks in programming. Analysis results indicate that the proposed system improves learning, but not student attitudes. Future studies should incorporate additional pedagogical models in the proposed system to foster cooperative) learning. The system interface and functions should also be improved to meet user requirements.

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References

[1] Atherton, J. S. (2009) Learning and Teaching; Constructivism in learning [On-line] UK: Available: http://webcache.googleusercontent.com ,Accessed: 30 May 2010

[2] Ben-Ari, M., 2001. Constructivism in computer science education. Journal of Computers in Mathematics and Science Teaching 20 (1), 45－73.

[3] Cavus, N., & Ibrahim, D. (2007). Assessing the Success Rate of Students Using a Learning Management System Together with a Collaborative Tool in Web-Based Teaching of Programming Languages. Journal of Educational Computing Research, 36(3), 301-321.

[4] Clark, R. E. (1992). Facilitating domain-general problem solving: Computers, cognitive processes and instruction. In E. D. Corte, M. C. Lin, H. Mandl, and L. Verschaffel (Eds.), Learning environment & problem solving (pp. 265-285). New York: Springer-Verlag.

[5] Deek, F.P., Ho, K., and Ramadhan, H., (2007), A Critical Analysis and Evaluation of Web-Based Environments for ProgramDevelopment, Journal of Internet and Higher Education, 3, 4, 223-269

[6] Jackson, D., (1996). A software system for grading student computer programs. Computers & Education 27 (3), 171–180.

[7] Janssen, J., Erkens, G., Kanselaar, G., & Jaspers, J. (2007). Visualization of participation: Does it contribute to successful computer-supported collaborative learning? Computers & Education, 49(4), 1037-1065.

[8] Johnson, D. W. & Johnson, R. T. (1994).Learning together and alone: Cooperative, competitive, and Individualistic Learning. (4th ed.).

[9] Kordaki, M. (2010). A drawing and multi-representational computer environment for beginners' learning of programming using C: Design and pilot formative evaluation. Computers & Education, 54(1), 69-87.

[10] Kreijnsa, K., Kirschnerb, P. A., & Jochemsb, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research. Computers In Human Behavior , 19 , 335-353.

[11] Merrill, M. D. (1991). Constructivism and instructional design. Educational Technology, 31(5),45-53.

[12] Salomon, G. & Perkins, D. N. (1987). Transfer of cognitive skills from programming: When and how? *Journal of Educational Computing Research, 3*, 149-170.

[13] Slavin, R. E.(1995). Cooperative learning: Theory, research, and practice. Needham Heights,MA: Allyn & Bacon.

[14] Vygotsky, L. S. (1978), Mind in society: The development of higher psychological processes, Cambridge, MA: Harvard University press

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A Blog-Based Peer Assessment Model to Support Pupils' Composition Activity

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Abstract: In this study, we design a blog-based peer assessment composition model for the elementary school students and try to identify the specific benefits of the blog-based assessment. This study spent effort to explain the characteristics of blog-based peer assessment through designing a composition model. In addition, the preliminary evaluation to understand teachers' initial opinions about this composition model was also provided.

Keywords: The Blog-based Peer Assessment, Blog, Peer review, Composition

Introduction

Peer assessment has extensively explored for several years. In the past studies, researchers evaluated the model of peer assessment with four main categories, including validity, fairness, accuracy and effects (Dochy & Segers, 1999). These studied all investigated the natural effects of pen-and-paper peer assessment model. With the rapid change of technology, web-based peer assessment brings more advantages than before. Many studies paid attentions on which characteristics of web-technology can support the peer assessment. On the whole, it involves more convenient, flexible and plentiful experience of peer assessment with web technology. On the other hand, researches also engaged in developing different web-based peer assessment system.

With the evolution of web-technology, many researchers and developers believed that technology should tend to facilitate an individual to become a provider than only as a recipient. Thereby, the collection and discussion of these personal contributions may bring richer benefits than before. In the recent year, this idea is adopted gradually and fostered various types of web-based application products. Among these web-technology products, a blog is one of typical tools followed this idea. A blog can be seen as a publishing tool that facilitates composition and frequent updating, and also a type of social software that represents the real existence of an author and fosters a high level of interpersonal relationships (Herring et al, 2004). The emphasized characteristics of blog that highlight personalization and social discussion may bring more benefits than traditional web-based peer assessment. Less study focuses on whether these characteristics of blog, which facilitating personal editing and fostering social comment and discussions, enhance the effects of peer assessment. In this study, we design a blog-based peer assessment composition model for the elementary school students and try to identify the specific benefits of the blog-based assessment.

1. Literature review

Peer assessment refers to an evaluation process, comprised a group of people who have similar learning status, in which people individually ponder the quality of products of other people and then give the appropriate feedbacks according to their knowledge background (Topping, 1998). Peer assessment is extensively applied to different levels of education and disciplines. In the past studies of peer assessment, Dochy & Segers (1999) pointed out that peer assessment provides students more opportunity to observe other students' work than do from their teachers. In the recent studies, Rieber (2006) claimed the similar argue, indicating that students have to clearly understand the assessment guidelines for the purpose of checking whether other students followed the guidelines. Therefore, they have the second chance to scrutinize the guidelines. On the other hand, if students are aware that another student will assess their work during the peer assessment, they would become more careful to produce a more exquisite one for assessment (Rieber, 2006).

With the rapid change of technology, web-based peer assessment brings more advantages than traditional paper-and-pencil peer assessment. Many studies paid attentions on which characteristics of technology support the peer assessment. In Lin's study (2001), three advantages of web-based peer assessment was claimed including the anonymity characteristic, easy monitoring for teachers and reducing the cost of photocopies. Besides the study of Lin, Sung et al. (2005) also suggested that technology-supported peer assessment shapes a relatively convenient way to display multimedia, and also decreases the loading of calculating and recoding score and commentary. Furthermore, the flexible feature of the web-technology facilitates various assessment models according to the need of teachers.

With the evolution of web-technology, many researchers and developers believed that technology should facilitate an individual to become a provider than only as a recipient. Thereby, the collection and discussion of these personal contributions may bring richer benefits than before. In the recent year, this idea is adopted gradually and fostered various types of web-based application products. A blog is one of typical tools followed this idea. A blog is a publishing tool that facilitates composition and frequent updating. Blogs are also a type of social software, one that both represents the real existence of an author and fosters a high level of interpersonal relationships (Herring et al, 2004). The posts that are published on a blog reveal core relationships between the wider audiences and the authors (Langellierc & Peterson, 2004). Furthermore, a blog may be regarded as a tool that encourages individual reflection (Park, 2003). Learners consider and learn from other more expert bloggers through observing their opinions (Efimova, 2004). A blog can thus provide a steady place that facilitates interaction and reflection through asynchronous interaction.

As description above, blogs have some affordances which facilitating personal publishing and conversational discussion. Less study focuses on whether these characteristics of blog, which facilitating personal editing and fostering social comment and discussions, enhance the effects of peer assessment. In this study, we develop a blog-based peer assessment composition model, in which student writes articles using personal blog and learn to assess peers' articles socially. We also implement the system to illustrate such a novel conversational discussion peer assessment with personal blog.

2. Methodology

The research methodology program can be divided into three parts. In the first part, we inquire and collect some information about the traditional composition course from the teachers, such as the frequency of composition course per week, any additional support designed by the teachers and so on. In the second part, we design a series of composition process in which student writes articles using personal blog and learn to assess peers' articles socially. The third part mainly involves the preliminary evaluation of teachers' opinions.

2.1 Participants

In order to get a broader vision of actual using in the classroom, we invited eleven elementary teachers as our co-designers to evolve the composition model. They provide experienced advices for us to design the composition model.

2.2 Information inquiry from teachers

Before the composition model design, the information inquiry is adopted for us to understand the actual situation of the traditional composition course in the elementary school. The questions involve the frequency of composition course per week, how teachers plan their composition courses, what teachers provide to support the composition course and so on. The teachers have a short interview with us. In addition, we inquire teachers' initial attitudes and opinions about the blog-based peer assessment composition for the composition process design in the next research process.

2.3 Composition process design

This composition model focuses on the elementary school composition course. The target users are fifth and sixth grade (10–12 years) elementary school students. According to the information inquiry from teachers, we design a composition process which embedded the blog-based peer assessment mechanism. The composition process has three phases.

2.3.1 Phases 1: Writing through Personal Blog

When we interview the teachers for information inquiry, one teacher told us that the composition course in elementary school in Taiwan is curtailed in recent years. Students averagely write articles only four or five times a semester in the school. The composition course is not a regular course and always executed in the course which teacher flexibly use. Students have insufficient practice to improve their composition ability. Blog-based writing is seemed to be a potential solution which supports frequently composition practice.

In this phase, students can practice composition in their own personal blog every day. Teacher assigns three of four topics for each time which is related to the similar subject matter around students' experience, such as "the outing" and "my favorite outdoor activities". Teachers and parents can assist students in writing by cuing some ideas which facilitate students' recollection of experience. When students finish the articles, teachers encourage students to make the article known to the public then students can see other's articles.

In this phase, students keep on writing every day despite they don't have much time to accomplish an entire article in the irregular course at school. Students can dominate their blog to determine whether (and when) the article is public or private. In addition, students accumulate their personal compositions through blog to foster their senses of writing ownership. The main objective in this phase is to cultivate students' daily writing habit.

2.3.2 Phases 2: Peers Giving Reflection and Comments

From the interview, we founded that some teachers have already applied convenient peer assess which with the paper-based rating scale in their composition activity. Teachers initially instruct and explain the meaning of these criterions, and then assigned students to comment peer's articles through this rating scale. This kind of paper-based peer assessment has one potential limitation, especially in the composition activity. The limitation is related to the relatively small amount assessors for each article who are always assigned by the teacher. The assessors have few options to choose the assigned article and have less motivation to savor the article due to the compulsion form teachers. In addition, the more important one is the feedbacks and comments from specific minority would lead to some biased suggestions which confuse the author. In this phase, we use the blog to overcome these drawbacks.

The *blog-based peer assessment* emphasizes the choosing freedom of giving comment and feedback. Students may feel free to read articles from other's blogs before giving any comment. Different from the traditional model which only minority students are compelled to read and comment specific articles, any student who is willing to share opinions is welcome to make the comments in the blog. In addition, students' reading articles and giving comments are no longer only for the teachers but, are replaced by the emotional expression and opinions exchange. More readers stay and savor the articles on the blog should bring more passion of composition.

Students only need to read in the first step. Everyday students can frequently check the blog and look for new articles posted just a moment ago. The feature of asynchronous posting of blog gives the assessors more opportunities to skim through the articles so that facilitate them to pick two or three *just right articles* which can stimulate the authors to naturally make a comment out of personal feeling without any hesitation. In the second step, students can choose two or three articles to give comments. Teachers can provide students with some guidelines to give positive comments. The emotion voice and opinions without the support of guidelines are also encouraged. And then, in the last step, students can keep discussing on the blog. Besides giving comments, the readers and authors are allowed to give comments for others comments through the blog function. The blog system has inherent affordance which supports the conversational comments discussion.

2.3.3 Phases 3: The Autonomic Class Journal

During the interview with eleven teachers, one teacher showed us one composition script which has corrected by the teacher. Besides that, the teacher even designed one specific table, which is similar to the four-point Likert scale, to fill in the composition grade separately according to the different scales. There is no doubt that the teacher industriously engages in correcting every fault the students made. We know that teachers' correcting articles can promote students' composition ability; however, it may cause the sense of frustration and thus lead to low motivation of composition, especially when these young students are at the beginning of their writing journey. Teacher's comment for students is often associated with the authoritative true; compare to teacher's comment, peer's comment is more like a suggestion that could facilitate discussion.

The A*utonomic Class Journal* is followed this idea: a group of peers are as the reviewers to select and edit the articles for the class journal. The class journal is a regular activity. Students can submit their articles to the class journal. One group of peers plays the role of reviewer to examine the quality of the submitted articles and determine whether accept or not. They have to establish consensus for criteria and provide schedule for the class journal. The A*utonomic Class Journal* provides students a peer correcting platform to improve their composition ability.

The blog not only provides authors a personal place to composition but also provides reviewers a channel to communicate the information and exchange ideas with the journal submitter. In the blog-based peer assessment, assessors still can communicate with other people through the blog. For example, a journal committee reviewer can provide some examples of evaluation on the blog for the submitters to understand his judgment criteria. On the other hand, the submitters can communicate with the reviewers about their judgment comments. The conversational feature of blog-based peer assess gives peers more opportunities to communicate and discuss their production.

2.4 Preliminary evaluation for the composition model and system implementation

In order to understand the initial opinions of the teachers who are going to use this composition model and system. We invited eleven teachers as our preliminary evaluators. Each teacher was provided a document with the detail of the composition model design and system implementation. A questionnaire, which has twenty five-point rating scale questions and five open end questions, was also provided. These questions are designed to investigate the attitudes and opinions of the teachers with the following issue.

(a) Students can continue to discuss articles on the blog. Can this blog-based model foster conversational discussion? Would it able to collect more voices from the students?
(b) The blog-based model emphasizes the choosing freedom of giving comments and feedbacks. Would it able to encourage students to write down their opinions and facilitate them to give more appropriate comments?
(c) The class journal activity provides students a platform of peer correction to improve their composition ability without teacher's correction. The author can communicate with the reviewer through blog. Can this model foster student to think of the problems in the article and improve their composition ability?

3. Results

The results from the questionnaire indicated that most of the teachers agreed the issue (a), which mentions that students can continue to discuss on the blog. Teachers believed this blog-based model can foster a conversational discussion and is able to collect more voices from the students. Some teachers provided suggestions for this perspective. One teacher thinks blog can support cross-class interaction and encourage more students to composition through the conversational discussion of blog. Another teacher argued the young children have insufficient experience to express their thinking. The children should accept training to learn how to give comments.

For the issue (b), the result showed that the teachers partly agreed this perspective, which mentions giving students the choosing freedom of giving comments and feedbacks can encourage students to write down their opinions. But not the entire teachers agreed the following descriptions, which the choosing freedom can facilitate students to give more appropriate comments. Some teachers believed the key point of giving appropriate comments mainly depends on the complexity of the article. The teachers suggested that students can begin to write the short essays, because it is relatively simple for the readers to comprehend and organize their thinking.

For the issue (c), the result showed that the teachers partly agreed this perspective, which mentions the class journal activity provides students a platform of peer correction to improve their composition ability without teacher's correction. The teachers agreed that the detailed correction from teacher may bring the sense of frustration. But even thus, the teachers still believed they would give appropriate encouragement in the end of the correction. They don't completely make sure the peer would do it. In sum, some teacher still feel worried about the frustration from peer's provoked comments.

4. Discussion & Conclusion

In this study, we design a blog-based peer assessment composition model for the elementary school students and try to identify the specific benefits of the blog-based assessment. We totally generalized three characters in our composition model design.

(1) The free characteristic of choosing article to give comments and feedbacks.
(2) The conversational characteristic which supports ceaseless discussion.
(3) The communicative characteristic which facilitates the debate between authors and assessors.

In addition, the preliminary evaluation to understand teachers' initial opinions about this composition model was also put into practice. The result indicated the teachers mostly approve this peer assessment approach. But some teachers worried about the provoked comments which may injure the original intention of peer assessment. This model should include more detail about the assessments for student to foster positive attitude during peer assessment.

This study spent much effort to explain the character of blog-based peer assessment through designing a composition model so that the preliminary evaluation only investigates teachers' opinions. The future study should focus on more detailed effects of the proposed composition model.

Acknowledgements

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References

[1] Dochy, F., & Segers, M. (1999). The Use of Self-, Peer and Co-assessment in Higher Education: a review. *Studies in Higher Education*, *24*(3), 331. doi:Article

[2] Efimova, L., & Fiedler, S. (2004). Learning webs: Learning in weblog networks. *Proceedings of the IADIS International Conference on Web Based Communities.* 490-494.

[3] Herring, S. C., Scheidt, L. A., Bonus, S., & Wright, E. (2004). Bridging the gap: A genre analysis of weblogs. *Proceedings of the 37th Hawaii International Conference on System Sciences (HICSS'04)*. *4*(4), 40101b.

[4] Lin, S., Liu, E., & Yuan, S. (2001). Web-based peer assessment: feedback for students with various thinking-styles. *Journal of Computer Assisted Learning*, *17*(4), 420-432. doi:10.1046/j.0266-4909.2001.00198.x

[5] Park, C. (2003). Engaging students in the learning process: The learning journal. *Journal of Geography in Higher Education*, *27*(2), 183–199.

[6] Rieber, L. J. (2006). Using Peer Review to Improve Student Writing in Business Courses. Journal of Education for Business, 81(6), 322-326. doi:Article

[7] Sung, Y. T., Chang, K. E., Chiou, S. K., & Hou, H. T. (2005). The design and application of a web-based self- and peer-assessment system. *Computers & Education*, *45*(2), 187-202.

[8] Topping, K. (1998). Peer Assessment between Students in Colleges and Universities. Review of Educational Research, 68(3), 249-276.

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Study on Learning Effect by Active Manipulation using Tangible Solar System Teaching Equipment

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Abstract: This study aimed to clarify the learning effect through an active manipulation of tangible solar system teaching equipment that was synchronized with a model manipulation. A teaching practice using the tangible solar system teaching equipment was carried out with high school students who had previously been taught using multi-view VR teaching equipment. As a result, an improvement in the understanding levels of students with low proficiency was observed. It is suggested that active manipulation of the teaching equipment may contribute to the improvement of students' levels of understanding.

Keywords: Tangible, Human interface, Active manipulation, Teaching practice

Introduction

It is not easy for children and students to understand the position of the heavenly bodies as they revolve around the sun at different speeds and also rotate at their own axis. It is necessary to switch freely between aspects of Ptolemaic theory and Copernican theory to solve problems of the astronomical field.

Recently, VR technology that supports spatial perception by visual presentation has received attention. Kubota et al. [1] did a study of the filling lack of the moon using a solar system simulation. Moreover, Setozaki et al. [2] developed multi-view VR teaching equipment related to the solar system based on an investigation of the needs of teachers, and examined an effective use method. However, these studies did not employ the interactivity that the VR teaching equipment originally had, and the learner learned passively.

Setozaki et al. [3] instructed classes using VR teaching equipment and models. As a result, the students showed an interest and a desire to learn by actively operating the models. As for tangible [4], it is known as a concept of human–computer interface that creates a computer that touches, and practicing research is performed on an educational site. Yamashita et al. [5] developed tangible teaching equipment that synchronized the globe with a PC, and examined its utility. Moreover, Morita et al. [6] developed tangible solar system teaching equipment that was synchronized with models. In addition, the group study that used the tangible teaching equipment revealed communication between learners. However, the learning effect through active manipulation that uses tangible teaching equipment has not been examined in an individual study.

Therefore, this research aimed to present a teaching practice using tangible solar system teaching equipment, and to examine the learning effect through of active manipulation.

1. Tangible solar system teaching equipment

This research used teaching equipment that had improved graphics accuracy and virtual space of the tangible teaching equipment that Morita et al. [6] had developed.

Figure 1 shows a diagram of the tangible solar system teaching equipment. Because the cameras set up under the table recognize the marker shown in the models, the CG model corresponding to each model can be displayed on monitors. The model synchronizes with the CG model so that the system functions in real time, processed using an AR tool kit (metaio Unifeye SDK) and an interactive manipulation.

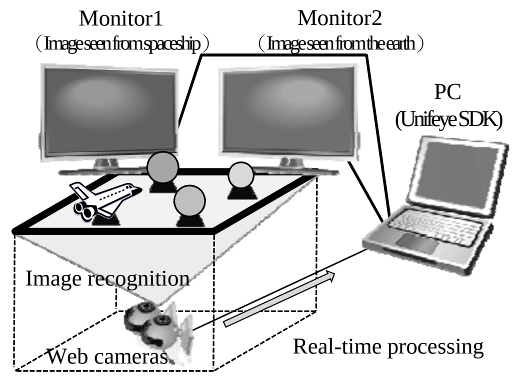

Figure 1: Tangible teaching equipment

2. Procedure

For the teaching practice set up, a high school class of 26 students (15 males and 11 females) whose science lectures materials included VR teaching equipment related to the solar system was considered. Students were organized into groups of three or four and the class practiced for about 15 minutes. First, the lecturer taught the "The reason why the moon waxes and wanes" using the tangible solar system teaching equipment. Next, the students learned actively by taking turn to individually manipulate the teaching equipment.

To investigate students' understanding levels, a pretest and a posttest were conducted before and after the class. Each test involved the same problem. A score scale from 0 to 10 points was considered to evaluate students' understanding levels. Students who scored from 0 to 4 points on the pretest were classified into the "low group" (13 students); students who scored from 5 to 9 points on the pretest were classified "high group" (13 students).In addition, as a subjective assessment investigation, a questionnaire was administered.

3. Results and Discussion

Figure 2 shows the results of the comprehension test. In addition, an analysis of variance was done with two factors, "proficiency" and "score of the test". The result was not significant for the interaction ($F(1,24) = 0.36$, n.s.). However, there was a significant difference in the factor of proficiency as a result of analyzing the main effect ($F(1,24)= 39.70$, $p < .01$). Moreover, there was a significant difference for the factor of score of the test ($F(1,24) = 12.19, p<.01$). Based on the results, it was clear that both the "high group" and the "low group" similarly improved their scores of the test after the class used the tangible solar system teaching equipment. The low group could locate it with students who did not understand the content of learn from the class used the VR teaching equipment. Therefore, we postulated that the score of the low group improved by active manipulation through using

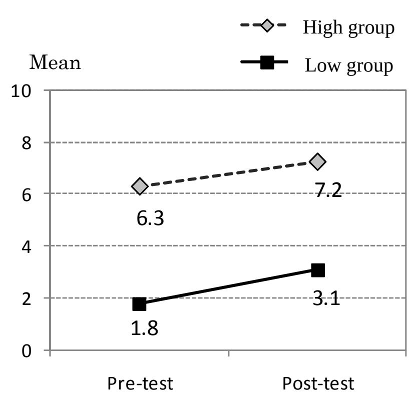

Figure 2: Result of comprehension test

the tangible teaching equipment.

Table 1 shows the results of the subjective assessment. The results of the survey were classified into an affirmative answer and a negative answer, and they were analyzed by the exact probability test. It was confirmed that there were numerous affirmative answers to 9 questions. We hence can conclude that the students' interest and understanding had improved by an active manipulation.

Table 1: Results of subjective assessment

Question item	Affirmative	Negative	proportion
Active manipulation			
The tangible operations expanded my understanding of astronomy.	26	0	0.00
I could easily understand because I could mamipulate the models while watching phenomena from the celestial bodies.	26	0	0.00
Phases of the moon were easy to understand because of the real objects.	25	1	0.00
Operation was easy.	25	1	0.00
I enjoyed maniulating the real models.	24	2	0.00
I wanted to use the system more.	16	9	0.23(n.s.)
I couldn't figure out how to operate the system.	4	22	0.00
Comparison with other teaching materials			
The system made astronomy easier to understand than the VR teaching equipment.	25	1	0.00
The system was more interesting than the VR teaching equipment.	24	2	0.00
The system made astronomy easier to understand than texts and handouts.	26	0	0.00
The system was more interesting than texts and handouts in science class.	25	1	0.00

4. Conclusion

This study aimed to clarify the learning effect through the active manipulation of tangible solar system teaching equipment that was synchronized with a model manipulation. A teaching practice using the tangible teaching equipment was carried out in a high school class whose students had already been taught with multi-view VR teaching equipment. It was found that the low proficiency students' understanding levels improved when they were taught using the tangible teaching equipment. The research results suggest that an active manipulation of the tangible teaching equipment may be one factor in improving their level of understanding.

Acknowledgements

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References

[1] Kubota, Y., Yamashita, J., Okumura, S., Kuzuoka, H. & Kato, H. (2007). Learning and Evaluation the Moon Phases Using a Solar System Simulation, *Journal of science education in Japan*, 31(4), 248-256.

[2] Setozaki, N., Morita, Y. & Takeda T. (2009). Study on Effective Use of a Multi-view VR Teaching Material of the Solar System, *Journal of science education in Japan*, 33(4), 370-377.

[3] Setozaki, N., Morita, Y. & Takeda T. (2009). Examination of Learning Effect by concrete operation that uses model, *Proceedings of the 25th Annual Conference of JSET*, 947-948.

[4] Ishii, H. & Ullmer, B. (1997). Tangible Bits: Towards Seamless Interfaces between People Bits and Atoms, *Proceedings of CHI*, 234-241

[5] Yamashita, J., Kuzuoka, H., Fujimon, C., Hirose, M.（2007）. Tangible Avatar and Tangible Earth: A Novel Interface for Astronomy Education. *Proceedings of CHI 2007*, 2777-2782.

[6] Morita, Y., Setozaki, N. & Iwasaki, T. (2010). Development and Evaluation of a Tangible Solar System Learning Material Relating with Real Model Operation, *Journal of science education in Japan*, 34(2) (in Press).

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A Computerized Approach to Group Discussion and Decision Making

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Abstract: Today, collaborative learning in high-tech institutions is not limited to supply of material by instructors and merely its consumption by students. Instead, learning is viewed as a cooperative task involving group discussions and analysis of the supplied information. Group discussion takes different forms starting from primary school activities till collaborative research and development projects in universities. On the basis of this idea, this paper introduces a practical computerized model for analyzing different viewpoints of a group of individuals on a specific decision problem or a single fact of knowledge. The results are presented using an example of a decision problem including 10 factors where 3 decision makers discuss to reach a consensus over the finalized values of the factors.

Keywords: Group Decision Making; Collaborative Learning

Introduction

Soft computing is used for modeling dynamical and real-life systems with increasingly trusted computer analysis. It has been utilized by decision makers in variety of cumbersome situations. Different methodologies have emerged, including fuzzy logic, artificial neural networks, and heuristic search such as genetic algorithm, particle swarm optimization, etc. Inspired by biological neural connections in human brain, the artificial neural network (ANN) has been of a higher interest among computer scientists. However, with the advent of the fuzzy logic (FL), semantic definition of real-life problems using linguistic terms has become increasingly attractive. Fuzzy cognitive map (FCM) [1, 2] is a graph-like soft computing tool with the benefit of both recurrent (graph-like) neural network, and fuzzy logic. FCM is made up from nodes (factors), and edges (effects of factors). Therefore, the factors can influence each other with respect to the extent (positive or negative intensity) of the effects among them. Experts define the factors and their effects in a given problem and then execute the developed FCM for obtaining decision results, i.e., finalized values of the factors. Usually, decision making involves N_{in} input factors (dependent or independent), and N_{out} decision factors which N_{in} affect N_{out} [3]. However, in some situations these may overlap or exchange role. This paper, examines a decision problem using capabilities of the FCM while incorporating the concept of group discussion. It must be noted that no role (input or output) is assigned to the factors since this paper only discusses the methodology of this technique through a generic example.

Group FCM Decision Modeling

Traditionally, there are two FCM computational models namely definition and incremental formulas [4]. Although FCMs can be trained for more robust decision making, i.e., by genetic algorithms (GA) [5, 6, 7] or Hebbian algorithms [8, 9, 10], however, still the basis of the inference (deriving outputs from inputs) is on either of the two standards frameworks: definition or incremental model. Both models work in cyclic (recurrent) fashion. Eq. 1 shows the classic model of definition [4] where the new weight of each factor c_j ($c_j \in$

n-factor FCM) at cycle (k+1) is defined from squashing the total effect of all factors ($c_1 \ldots c_n$ ∊ n-factor FCM) on c_j into a standard range of (0, 1) using a logistic function symmetrically around 0.5 (sigmoid curve).

$$c_j^{(k+1)} = \left(1 + e^{-\sum_{i=1}^{n} c_i^{(k)} e_{i,j}}\right)^{-1} \quad \text{, and} \quad j \in \{1 \ldots n\} \tag{1}$$

The total amount of the effect is in fact a sum of multiplications of each factor's weight (c_i) from the preceding cycle (k) by the weight of the respective causal link (effect $e_{i,j}$) which connects c_i to c_j. Through this process the factors' weights keep changing until state of convergence in which all factors (more importantly decision factors) converge to their finalized values (e.g., with convergence precision of $\varepsilon = 0.001$). The finalized weights are then used to interpret FCM's decision outputs. FCM can also support group decision making by aggregating multiple decision makers' views on a specific decision problem [11]. The model of [11] is regarded as a practical approach to group decision making using FCM-based inference mechanism. As depicted in Fig. 1, a group of individuals (here S students) can develop S independent FCMs (FCM_1 to FCM_s) by which they define the entire problem domain in their own way. The problem domain includes 1) the problem factors (FCM nodes), and 2) the causal relationships among affecting and affected factors (FCM edges). Therefore, each of the developed FCMs may result into different decision outputs as they have been set-up by independent students.

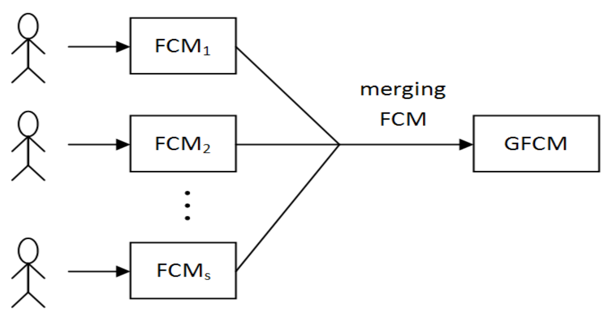

Fig. 1: Development of a group FCM [11]

To obtain consensus over decision outputs, an averaging strategy can be hired to define a group FCM (GFCM) from averaging all available FCMs. The averaging process for obtaining the weights of both factors' (c_j ∊ GFCM) and effects' ($e_{i,j}$ ∊ GFCM) involves summing all respective concepts and dividing them by S, as well as summing all respective effects and dividing them by S. Upon defining the GFCM, and running it for convergence, the ultimate decision outputs can be obtained. On the basis of the above idea, this paper presents an example of a 10-factor FCM where A … J are the factors which make up the FCM's graph, and $e_{A,A}$, $e_{A,B}$ …$e_{J,J}$ are 10^2 causal links (effects) among the 10 factors. There are 3 participants each required to set-up their own FCM by assigning random values to both factors and their effects. The resulted GFCM is the average of the 3 developed FCMs. Fig. 2 is presented to show the results on a student's FCM including defined initial weights of A … J, and the effect matrix {$e_{A,A}$, $e_{A,B}$, $e_{A,C}$ … $e_{A,I}$, $e_{A,J}$; $e_{B,A}$ … $e_{J,J}$} as given in Table 1. The finalized decision outputs are obtained upon running the FCM and reaching a convergence at 63rd cycle (with convergence precision of $\varepsilon = 0.001$).

Table 1: The applied effects matrix for the FCM of Fig. 2

	A	B	C	D	E	F	G	H	I	J
A	0.3674	0.4801	0.5787	-0.0310	-0.7754	-0.7805	0.3466	-0.8153	0	0.1115
B	-0.7358	-0.5303	-0.2647	-0.6963	0.5689	0.8675	-0.9409	-0.9844	0	-0.6311
C	0.4454	0.4699	-0.5879	0.5639	-0.4169	-0.6251	0.0965	-0.1538	0	-0.5759
D	0.7793	0.9412	-0.8267	0.7988	0.2071	-0.4676	0.2197	0.3111	0	-0.8453
E	-0.7650	0.7339	0.5439	-0.4119	0.9288	0.5957	-0.4103	0.4458	0	0.8276
F	0.2814	-0.8275	-0.5887	0.5253	-0.1350	-0.0248	0.3684	0.0624	0	0.4134
G	-0.3424	-0.2671	-0.2235	0.0617	0.3895	0.5379	0.5454	-0.7824	0	0.1156
H	0.3076	-0.2616	0.1036	0.8170	0.5162	-0.2080	0.4229	0.2635	0	-0.3731
I	0.4983	0.3701	-0.5421	-0.1894	-0.1347	-0.4541	0.7493	-0.7470	0	-0.6676
J	0.9664	0.1959	0.2839	0.6821	0.3110	-0.9255	0.7397	-0.7314	0	0.2450

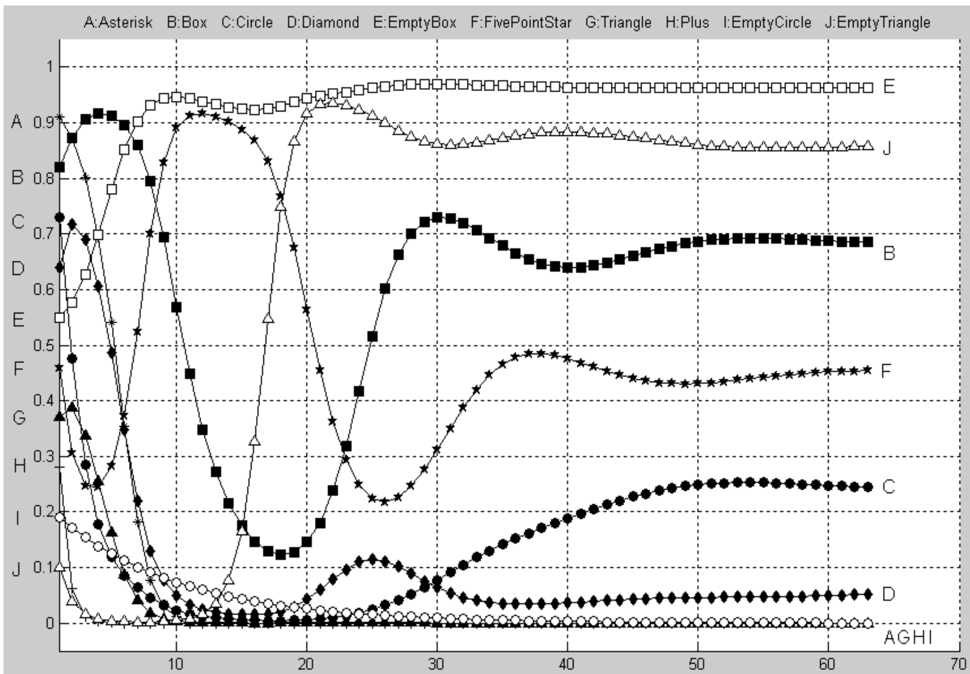

Fig. 2: The example GFCM model (with λ= 1, ε= 0.001). Initial weights of A … J have been: 0.91, 0.82, 0.73, 0.64, 0.55, 0.46, 0.37, 0.28, 0.19, 0.10. The example's effect matrix is given in Table 1.

References

[1]. Kosko, B. (1992). Neural networks and fuzzy systems: A dynamical systems approach to machine intelligence, NJ: Prentice-Hall.

[2]. Kosko, B. (1996). Fuzzy engineering, Upper Saddle River, NJ: Prentice-Hall, Inc.

[3]. Stylios, C.D., Georgopoulos, V.C., Malandraki, G.A., and Chouliara, S. (2008). Fuzzy cognitive map architectures for medical decision support systems, Applied Soft Computing, 8, 1243–1251

[4]. McNeill, F.M., Thro, E. (1994). Fuzzy logic a practical approach, USA: Academic Press Prof. Inc.

[5]. Koulouriotis, D.E., Diakoulakis, I.E., and Emiris, D.M. (2001). Learning fuzzy cognitive maps using evolution strategies: a novel schema for modeling and simulating high-level behavior, IEEE Congress on Evolutionary Computation (CEC2001), 364–371

[6]. Stach, W., Kurgan, L., Pedrycz, W., and Reformat, M. (2005). Genetic learning of fuzzy cognitive maps, Fuzzy Sets and Systems, 153, 371–401

[7]. Ghazanfari, M., Alizadeh, S., Fathian, M., and Koulouriotis, D.E. (2007). Comparing simulated annealing and genetic algorithm in learning FCM, Applied Math. and Computation, 192, 56-68

[8]. Papageorgiou, E.I., Stylios, C.D., and Groumpos, P.P. (2004). Active Hebbian learning algorithm to train fuzzy cognitive maps, International Journal of Approximate Reasoning, 37(3), 219-247

[9]. Papageorgiou, E.I., Stylios, C.D., and Groumpos, P.P. (2006). Unsupervised learning techniques for fine-tuning fuzzy cognitive map causal links, Int. J. of Human-Computer Studies, 64, 727–743

[10]. Papageorgiou, E.I., and Groumpos, P.P. (2005). A new hybrid method using evolutionary algorithms to train fuzzy cognitive maps, Applied Soft Computing, 5, 409–431

[11]. Khan, M.S., and Quaddus, M. (2004). Group decision support using fuzzy cognitive maps for causal reasoning, Group Decision and Negotiation, 13, 463–480

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The Effect on Using Automatic Machine Translation for Motivating Reading Skill

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Abstract: In this paper, we develop a framework to increase student's motivation by applying automatic translations which provide Thai translated output to students. Students have to edit or correct the translation results from the system and receive comments from teacher. Based on this framework, the system enables them to increase their motiction in reading. We evaluate results of our system at Thammasart Klongluang School. The students get a significance improvement and satisfy with the system.

Keywords: reading assistant system, English learning, skill improvement tool

Introduction

English language is recognized as an important language for cross-cultural communication. Based on the statistics of ETS TOEFL score [1], Thai people averagely gain 493 of paper-based test. It is inadequate for them to study in English program curricula which require at least 550 score. This issue also reflects as a barrier on a communication in details and knowledge sharing of Thai specific resources with other countries [2].
To improve language learning, technologies are applied for assisting learners to access resources and educations. However, most of Thai teachers are conservative and tend to ignore applied technologies. Therefore, it is difficult to apply new challenging approaches, and only simple technology such as dictionary and automatic translation can only be exploited. Recently, a research on applying dictionary into e-learning system [3] was purposed for Thai EFL. It helps students' reading by providing bilingual dictionary. It was proven that the system eases students for expanding their English vocabularies. In this paper, translation is applied to English learning although previous researches claimed that translation is not a good approach for such task. In this paper, we focus on how much a translation can help students if translation method cannot be avoided. In this work, a reading skill is concentrated because it is fundamental and lead to other skills acquisition.
One of the most problems on English learning for Thai students is unknown word, inflection and unfamiliar syntax. This effectively lowers students' motivation on learning English. This system attempts to ease the learning on reading passage by providing assistant functions such as dictionary, automatic translation, online discussion with instructor, and so on. These functions leastwise increase a chance for student to overcome a barrier of unknown word and structure which will motivate them more on English language learning.

1. An overview on our system

Motivation is the most important issue for improving a reading skill. Motivation is gained once the reading becomes easier and more understandable. Results from automatic translation will help students to roughly understand the content. For non-fluent English students, it is less suffer than starting from reading all passage which a plenty of difficult words and structures. Moreover, the more learners edit the translation for smoother result and get teacher's feedback, the more students understand and gain motivation and confident on their reading. Figure 1 shows the overview of our system architecture.

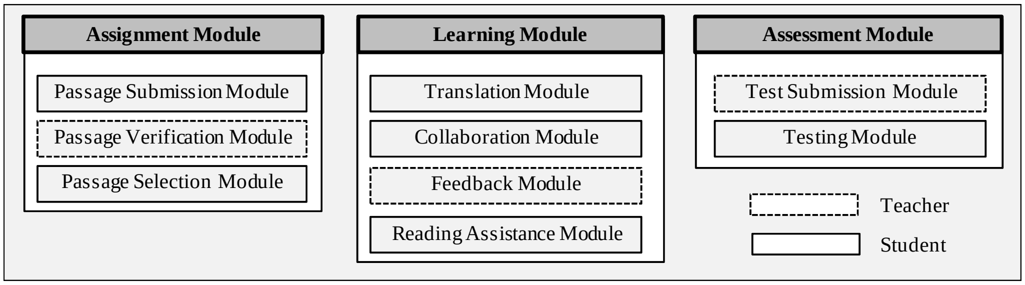

Figure 1: An overview of system architecture

1.1 Assignment Module

This module is designed to enable an appropriate passage selection and classification. Students are required to manually select the appropriate passages from various sources and submit it to teacher. This module can be divided into three sub-modules.

- Passage Submission Module: This module provides a user interface (UI) for students to search and submit their interested passages. It also provides search engine.
- Passage Verification Module: This module is designed to classify passages into appropriate level to control difficulty of the chosen passages. There are two factors. 1) **Passage appropriateness** approves a syntactically correctness of the chosen passage. For example, the passage written by non-native English tends to contain many errors. 2) **Passage Level Decision** checks the appropriate level of passages regarding to students' capability.
- Passage Selection Module: This module shows a UI that lists verified passages for students to select.

1.2 Learning Module

This module consists of four sub-modules.

- Translation Module: This module provides automatic translation of the English passage to Thai. Currently, we provide Google Translation and Parsit [4] with translation memory [5], which enable students to select a translation result which they like most and edit the incorrect translation.
- Collaboration Module: This module enables students to share their edited translations and comment other's works to improve their reading technique together.
- Feedback Module: This module is for teachers to give a feedback and correct students' work.
- Reading Assistance Module: This module provides assistant tool for students to understand more precisely on the passage. This includes dictionary, translated word alignment, and English parsing tree to realize English structure in details.

1.3 Assessment Module

This module is designed for evaluating the student's improvement. There are two sub-modules provided.

- Test Submission Module: In this module, teacher can submit his/her test. Test format and type are designed by using hot potato [6] which enables several test methods. Teacher can separately limit testing time for each test.

- Testing Module: This module shows UI for pretest and protest to students. An automatic scoring result is also provided to teacher by this module.

2. Experiment Setting and Result

In an experiment, 50 students in grade 10 from Thammasart Klongluang School were randomly chosen to join this program. Each student was respectively given three assignments. The first task is to take a pre-test for measuring their English skill. Second, students were grouped into a team of four persons and worked together on translating four personally chosen passages with an aid of automatic translation from our system. Lastly, students took a post-test to show their improvement after using the system. In terms of evaluation, we appraise the system by using questionnaire for its user-friendly and monitoring the difference of score between pre-test and post-test to examine students' improvement. The satisfaction scores in questionnaire are ranked from 1 (worst) to 5 (best). The results of satisfaction scores are shown in Table 1 and Table 3. An improvement of students is illustrated in Table 2.

Table 1: System evaluation

Evaluation topic	Ranking					Satisfaction
	5	4	3	2	1	Score
System Performance	15.85	52.44	28.05	2.44	1.22	3.79
User Friendly	18.29	56.1	22.36	1.63	1.63	3.88
Design	25.2	53.66	19.51	0.81	0.81	4.02

Table 2: Student's tests result

Evaluation	Min	Max	Avg
Pre-test	15	62.5	37.5
Post-test	53.33	100	76.66

Table 3: Student's personal evaluation using questionnaire

Evaluation topic	Ranking (before/after)					Satisfaction
	5	4	3	2	1	Score
English Level	7.32/14.63	48.78/48.78	31.71/31.71	9.76/2.44	2.44/2.44	3.49/3.71
Vocabulary Coverage	9.76/12.2	41.46/53.66	34.15/31.71	12.20/0	2.44/2.44	3.44/3.73
Improvement Ability	12.2/7.32	31.71/48.78	46.34/41.46	9.76/0	0.81/0	3.44/3.59
System Benefit	24.39	56.1	19.51	0	0	4.05

3. Conclusion and Future Work

We implemented the web-based reading assistant system for helping in reading English passages by applying a translation approach. We found that students who joined the program gain more motivation and confidence in their English capability. Their English reading skill is significantly improved. In the future, we plan to develop an automatic system to check a passage level to reduce teacher's load on approving an appropriate level of passage that students select for reading. We also plan to extend this system into an actual English education in a high school program.

References

[1] ETS (2010), TOEFL® Test and Score Data Summary for TOEFL Internet-based and Paper-based Tests: January-December 2009 Test Data.

[2] Wiriyachitra, A.(2002), “English Language Teaching and Learning in Thailand in this Decade”, Thai TESOL Focus, Thailand.

[3] Orrawin M, Pornchai T, Narasak A, Neetiwit B, Buntita P, Thepchai S (2008). “Dictionary-based Translation Feature in Open Source LMS ~ A Case Study of Thai LMS : LearnSquare”. In Proceedings of International Conference on Advanced Learning Technology ICALT '08.

[4] Virach S, Paisarn C, Mothika B and Lalida B (2000). “ParSit: English-Thai Machine Translation Services on Internet”. In Proceedings of 12th Annual Conference, ECTI and New Economy, National Eectronics and Computer Technology Center, Bangkok. (in Thai).

[5] Thepchai S, Kanokorn T and Supon K (2007). “A Cooperative Work Environment for Translation ~ Integrating MT and TM for Community”. In Proceedings of IJCKS 2007.

[6] Half-Backed Software Inc, "Hot Potatoes version 6" [Online], Available : http://hotpot.uvic.ca/index.php

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An Evaluation of Generated Question Sequences Based on Competency Modelling

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Abstract: In order to support lifelong learning, assessment systems have to focus on representation and updating a variety of knowledge domains, rules, assessments and learner's competency profiles. Adaptive assessment provides efficient and personalised routes to establishing the proficiencies of learners. Existing adaptive assessment systems are faced the challenge of dealing with inconsistently measuring and representing student's knowledge. We can envisage a future in which learners are able to maintain and expose their competency profile to multiple services, throughout their life, which will use the competency information in the model to personalise assessment. This paper presents an adaptive assessment system based on a competency model. The system automatically generates questions from a competency framework and sequence the questions based on the taxonomies of subject matter or of capability, making it possible to guide learners in developing questions and testing knowledge for themselves. The questions and their sequencing are constructed from a given set of learning outcomes and the subject matter recorded in an ontological database. The architecture of the system and the mechanism of sequencing the questions are discussed.

Keywords: competency, adaptive assessment, ontology, IMS QTI

Introduction

We introduce the background to the pedagogical and technological issues involved in automatic question generation. A specific approach is described for the automatic generation of questions in any domain by using a particular model of competencies. A system overview of the proposed competency framework, named COMpetence-Based learner knowledge for personalized Assessment (COMBA), is presented. We consider an implementation of COMBA with an ontological database that represents the intended learning outcome to be assessed across a number of dimensions such as levels of cognitive ability and subject matter content involved, an experiment to test its outputs, and the results. Finally, we present some discussion of generated question sequences and conclusions.

1. Background

1.1 Automatically generating questions

Questioning is useful because it challenges learners to respond and it reveals learners' abilities to reason, create, analyse, synthesise, and evaluate. A question should relate to the learning outcomes being measured. Question phrasing should be precise, clear, and easy to understand by using the simplest possible language [1-3]. Good questions should appropriately challenge learners in order to stimulate them to think more deeply about the subject matter. Finally, a good question should help the learner to identify where further study may be useful.

There are currently many systems available to generate questions automatically; these are however confined to specific domains. A number of pioneering systems such as Problets [4], ILE [5], QuizPACK [6], and Jeliot 3 [7], explored the use of automatic generation of questions using parameterised templates. The basic concept uses templates instantiated with random values to generate the questions. A question's template is able to produce a large number of different questions. Problets and Jeliot 3 generate questions about programming using computer language templates. The question generation of Problets is language independent, whereas Jeliot currently supports only Java. Problets and Jeliot are self-contained, lacking interoperability with other systems such as institutional-wide e-learning systems. ILE is a tool that automatically generates exercises for the special case of electric AC circuit problems, given global parameters such as the number of nodes and number of branches. QuizPACK works on automatic evaluation of code-execution questions. A teacher provides the core content of a question, a parameterised fragment of code to be executed, and a variable within that code. QuizPACK randomly generates the value of the question parameter, creates a presentation of the resulting question, and runs the presented code in order to generate the correct answer.

These applications of parameterised questions were developed for computer programming. A correct answer to a parameterised question can be calculated by a formula or executed by a standard language complier without the need for a teacher or author to provide it. Currently, such systems offer remarkable automatic generation of questions, but only for specific domains, and lack integration, interoperability, portability and reusability.

1.2 Adaptive assessment and its applications

Adaptive assessment system aims to assess a learner's competency by posing a minimum number of questions in order to decrease test length, which is one of the main goals in adaptive assessment [8-10]. Another main goal includes offering personalized support according to the needs and ability of each learner [11]. Work related to the proposed approach can be found in the areas of adaptive assessment system. Many adaptive assessment systems have been developed such as A Web-based English CAT prototype system [12], IDEAL [13], Personal-reader [14], COMPASS [15], SIETTE [16], and CosyQTI [17]. These systems are described below.

A Web-based English CAT prototype system and IDEAL are focused on using Item response theory (IRT) to estimate the numerical value of learner's ability level, in order to determine the next item to be posed, and to decide when to finish the test, rather than to assess learners' readiness for further learning. One of the major challenges facing the use of IRT is establishing standards for usability and interpretability issues of the IRT value [18, 19]. In IRT, ability is measured by a scale point. When applied this theory to measure cognitive skills expected to be tested in each learning outcome such as Knowledge, Comprehension, Application, and Evaluation, the theory has some limitations [20].

Personal-reader is developed to personalize a learner's assessment at each moment of the learning process. There are two types of learning content: atomic learning object and linear learning object. In the case where the learner gives wrong answers, the assessment framework should detect the atomic learning objects that have to be studied again, highlights them and gives, if necessary, some additional links that could be used to better understand the current lesson. In the case where the answers are correct, the learner is allowed to continue. Then new course material is generated in the next linear learning object. In summary, this system still has problems of representing learning knowledge and has difficulty with problem solving.

Concept MaP ASSessment tool (COMPASS) is an adaptive web-based concept map assessment tool. Based on an assessment goal that the learner selects from a set of proposed goals, COMPASS engages learners to the assessment and learning process through a set of assessment activities. The system provides different informative, tutoring and reflective feedback components, tailored to learners' individual characteristics and needs by using weight and error categories. The level of performance is represented by Gogoulou's taxonomy [15]. . In summary, this system still has the problems of collaboration with many teachers, and the use of numerous parameters associated with each question for teachers who are usually practically focused and who would have difficulty with controlling user interaction.

Spanish translation of Intelligent Evaluation System using Tests for TeleEducation (SIETTE) is a web-based tool to assist teachers and instructors in the assessment process. The system can be used in two different ways. First, teachers can use it to develop the tests that are defined by their topics, questions, parameters, and specifications. Second, learners can use it to take the tests that are automatically generated according to the specifications, and adapted to the learner's knowledge level. Question selection is based on a function that estimates the probability of a correct answer by using Item Response Theory, leading to an estimation of the learner's knowledge level. This system has the problem with estimating learner's knowledge level of each topic in each test.

The CosyQTI tool supports the authoring process and presentation of personalized and adaptive web-based assessment. The adaptation will be provided by using a form of the IF-THEN rule's trigger point which is a point for activation. This system has not been tested in full in real classroom environments. There are still some problems with estimating and representing learner's knowledge level and formal testing within real environments.

2. COMBA system

We have developed an improved competency model, named COMpetence-Based learner knowledge for personalized Assessment (COMBA), which uses ontologies. The model has been used to automate question generation in adaptive assessment systems. The system focuses on the identification and integration of appropriate subject matter content (represented by a content taxonomy) and appropriate cognitive ability (represented by a capability taxonomy) into a hierarchy of competencies. The resulting competencies structure has been shown to be able to generate questions and tests for formative and summative assessment. These questions can be expressed as IMS Question and Test Interoperability (IMS QTI) compatible XML files to enable interoperability.

The system was built on an ontological database that describes the resources (subject matter, capability, competency) and the relationships between them. An assessment for a competency often actually tests component competencies, and is supported by the linked nature of the competencies hierarchy. For example, a statistics course may test knowledge of the confidence interval [21] by testing the students' ability to calculate, explain, and define the confidence interval in a variety of situations. An assessment item can be directly formulated from a competence by using the parameters of that competence: capability, subject matter content, and other contextual elements. For example, the assessment corresponding to the learning outcome, "Students understand the concept of a confidence interval" might be something like "Calculate the confidence interval for the following situation", or "Explain the importance of the confidence interval in the following situation", or "Define standard error".

2.1 The competency model

COMBA is informed by the results of comparing the competency standards against the desired taxonomy of competence [22]. The improved competency model is represented in Figure 1. A competency involves a capability associated with subject matter content and optionally a contextualisation (the situation or scenario, tools, and standard of performance). A competency can be linked to one or more resources, and a student may evidence a competency in one or more ways.

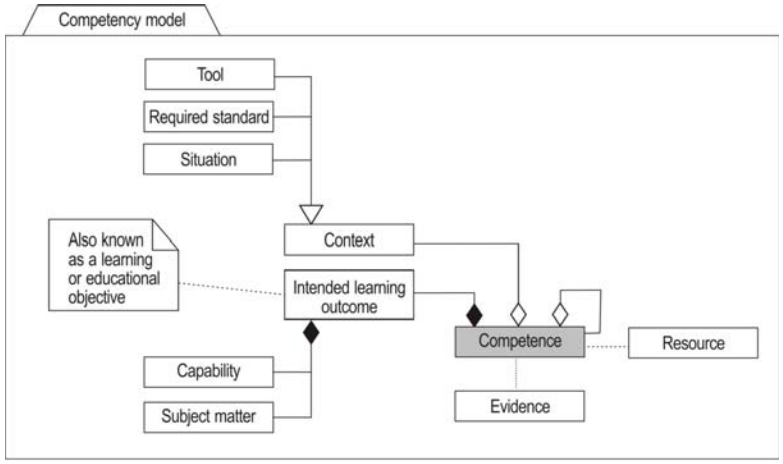

Figure 1 Competency model

Capability is behaviour that can be observed, based on a domain taxonomy of learning such as Bloom's [23], Gagné's Nine Areas of Skill [24], or Merrill's Cognitive Domain [25]. Subject matter content is the subject domain of what the student can do by the end of course. The competency evidence substantiates the existence, sufficiency, or level of the competency, and might include test results, reports, evaluation, certificates, or licenses. External knowledge resources and tools support and promote the problem solving, activity performance or situation handling of the competency. The situation identifies the particular circumstances and conditions of the competency, for example, its time limit.

The proposed competency model involves three important principles: an orientation towards, and focus upon, activity-based teaching and learning, the identification and integration of appropriate subject matter content within a broader teaching and learning context, represented by a hierarchy of linked competencies, and the identification of the assessment that would demonstrate successful teaching and learning has been accomplished.

2.2 Architecture of COMBA system

The COMBA implementation consists of a number of modules, illustrated in Figure 2. The Competence navigator is responsible for retrieving the requested competence, based on the domain request from the student, and passing the competence to the Subject Matter Content and Capability navigator modules. In using the model for the automatic generation of questions, the relevant subject matter and capability data, together with the authoring question template files, are assembled to generate questions derived from the matrix of competencies crossed with cognitive abilities. Given a question which is now ready for further use, it is formatted using the QTI specification.

The QTI specification facilitates the sharing of questions and tests, enabling investment in the development of common tools such as Web-based authoring and delivery applications. For an adaptive test, this specification supports the use of pre-conditions and branching, allowing the embedding of sequencing and adaptive logic into a test. Adaptivity is limited to the questions referred to within the test. As a result, if the student answered, it may not be possible to branch in directions not provided in the test. In addition, the inability to import external data may limit adaptivity. In order to develop a test, the generated questions are linked together for storing in a test bank. For the delivery of the test, the system deploys an assessment delivery service (QTI tools[1]) to allow a student to view a question, to answer it, to receive feedback, and to view the assessment results.

In the COMBA system, the ontology was based on OWL-Lite [26] which was sufficiently expressive to describe the subject matter hierarchy and provides for higher performance reasoning. The ontologies adhere to the criteria of ontology design: clarity, coherence, extendibility, minimal encoding bias, and minimal ontological commitment [27].

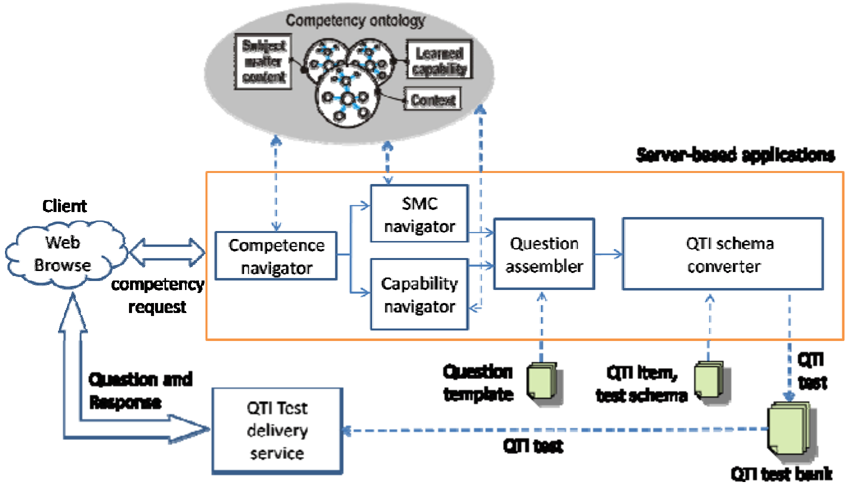

Figure 2 Architecture of the COMBA system

3. Using COMBA for generating adaptive question sequences

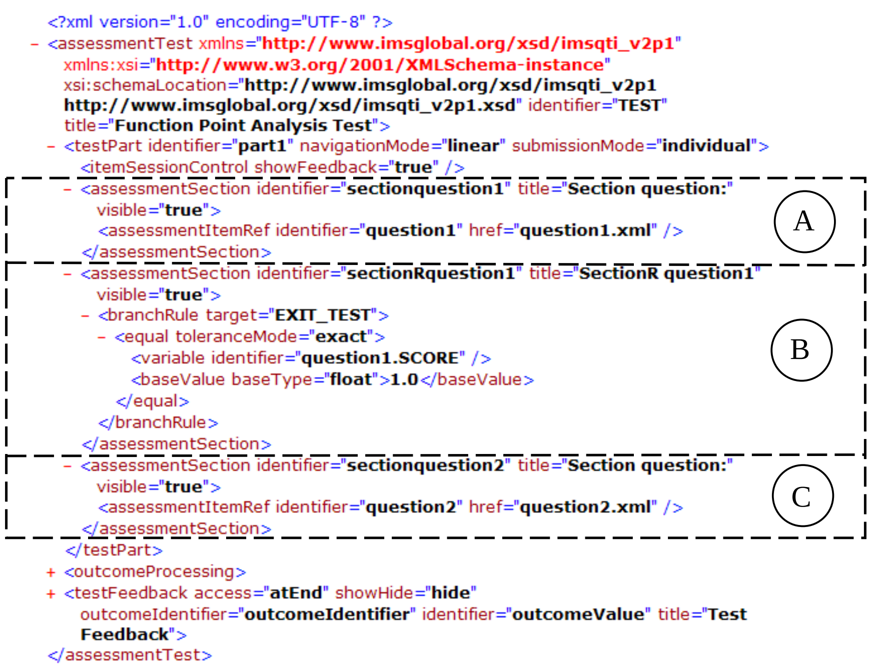

Figure 3 Example of QTI branching rules in XML format

In this section, we present the use of the model in automating question sequence generation. A competency hierarchy supports a variety of adaptive rules to adjust questions to the students' capability and to the nature of their knowledge. Many methods of traversing the competency hierarchy may be applied, involving different starting points and algorithms. These methods may lead to interesting issues which should be considered in adapting to the students' particular talents, strengths, weakness, and own learning preferences. Within a test

[1] http://playr.qtitools.org/playr/

constructed according to the IMS QTI specification, the sequencing and adaptive logic are expressed in branching rules. For example, an adaptive sequence may provide a question at a slightly higher level if a student succeeds or a question at a lower level otherwise. Figure 3 presents an example QTI question file for adaptive assessment using QTI constructs which may be incorporated into a test. Portions labelled A and C show the student items called “question1” and “question2” respectively. The portion labelled B illustrates a branching rule. If the student succeeds on question1, the test jumps forward to the end of the test (shown as branchRule target= ‘EXIT_TEST’) or goes to “question2” in the section labelled C otherwise.

3.1 Experimental validation of generated question sequences

An experiment was designed to validate a sequence of questions, generated using the COMBA model. The particular sequence experienced by a student was dependent upon the student’s answers, and so was adaptive. If the student succeeded on a question, where possible the next question was a question at the same capability level and at a higher subject matter level than the previous question. If the student failed the question, the system presented where possible an easier question. This was a question at the same capability level and at the lower subject matter level than the previous question. Questions started from the highest subject matter level and the highest ability level, and the sequence stopped when the student answered a question correctly.

The experiment focused on the opinions of students on the efficiency and effectiveness of the adaptive sequence. The questions explored student ratings of the sequencing, on the criteria of fairly assessing their knowledge (TestAssessKw), helping them to understand how a given learning outcome separated into “learning outcome components” (DecomposeLO), helping them to separate a given learning outcome into “topics” (DecomposeTopic), adapting to their level of knowledge (AdaptQuestion), being useful for self-assessment (UsefulForSelfAssessment), identifying their lack of knowledge (IdentLO), and providing appropriately difficult questions (ShowDifficultQ).

Competencies were collected from the INFO2007 Systems Analysis and Design course at the University of Southampton. The topic of the course instantiated in the model involved function point analysis and associated issues including: adjusted function points, unadjusted function points, complexity adjustment, the formula for complexity adjustment, degrees of influence, the formula for unadjusted function points, and calculating function points from an ER Diagram. The participants were voluntary 2nd year undergraduate students. Instruction sheets were distributed to all attending students at the end of a lecture, and asked the students to rate the generated questions against the criteria on a 4-point forced-choice Likert scale (‘Strongly disagree’, ‘Disagree’, ‘Agree’, ‘Strongly agree’, coded as 1, 2, 3, and 4 respectively) that best described their opinion.

3.2 Results and discussion

The study gathered data from 19 students. A one-sample t test was used to test differences between the observed sample means and an expected sample mean of 2.5, being mid-way between agreeing and disagreeing on the measurement scale. As can be seen in Table 1, the mean rating was significantly higher than 2.5 for 9 of the 12 measured variables.

The students did not think that the test particularly assessed their knowledge on average. It is not clear why they thought this; one hypothesis is that the ‘stopping rule’ (at the first correct answer) did not give them confidence that their knowledge had indeed been thoroughly tested.

Interestingly, the students agreed that the adaptive sequence helped them to understand how a given learning outcome separated into "learning outcome components", but they did not agree that it helped them to separate a given learning outcome into "topics". Whilst a learning outcome component involves capability and subject matter, a topic involves only subject matter. This suggests that the generated questions helped the students to understand the decomposition of capability, but were not particularly helpful in understanding the decomposition of topics.

Measured Variables	Test Value = 2.5			
	t	df	Sig. (2-tailed)	Mean Difference
TestAssessKw	–0.224	18	0.826	–0.026
AdaptQuestion	5.786	18	0.000	0.711
UsefulforSelfAssessment	2.471	18	0.024	0.500
IdentLO	3.269	18	0.004	0.500
DecomposeLO	3.139	18	0.006	0.447
DecomposeTopic	0.907	18	0.376	0.184
ShowDifficultQ	8.367	18	0.000	0.605

Table 1 t Test

The results of the remaining t-tests were straightforward: the students agreed that their question sequence was well adapted, was useful for self-assessment, helped identify their lack of knowledge, and provided appropriately difficult questions. Broadly speaking, this experiment and the earlier one (reported in [28]) show that the questions and the adaptive test sequences were acceptable to students, and hence that the COMBA model is capable of generating good assessments.

4. Conclusion

While this study successfully demonstrates a data model and a method of automatically generating acceptable and useful questions and sequences, representing competencies and the subject matter is the critical challenge. In addition, more effective algorithms are needed for generating questions and sequences. Any generating mechanism must ensure a high standard of English grammar in the resulting questions. The revised generating mechanisms in this experiment reduced some inappropriate format of questions by using revised SPARQL queries to expand the returned results. This indicates that not only the format of the template itself is important for generating questions and sequences using parameterised templates, but also the algorithm of querying is critical.

The key contribution is supporting a variety of ways of developing adaptive sequences. Future work could focus on methods for generating adaptive question sequences and considered their pedagogical value. For example, it is possible that students might have differing abilities in quite similar content areas. In this case, learners may not achieve an appropriate level of their capability and content. New adaptive question sequences could employ different traversal algorithms. If the learner failed a question, the system could present the next question at a lower capability level and at the same subject matter level; or at the same capability level and at the nearest subject matter level to the previous question. The pedagogical value of a particular method would need further investigation for successful learning and teaching, but having such varieties of methods could provide fruitful areas of exploration.

References

[1.] Horton, W.K., *E-Learning by Design*. (2006), San Francisco, USA: Pfeiffer An Imprint of Wiley.

[2.] Silyn-Roberts, H., *Writing for Science*. (1996), Auckland, New Zealand: Addison Wesley Longman New Zealand Limited.

[3.] McComas, W.F. and L. Abraham, *Asking more effective questions*. (2005), University of Southern California.

[4.] Dancik, G. and A. Kumar. *A Tutor for Counter-Controlled Loop Concepts and Its Evaluation*. in *Frontiers in Education Conference*. (2003). USA.

[5.] Cristea, P. and R. Tuduce, *Automatic Generation of Exercises for Self-testing in Adaptive E-learning Systems: Exercises on AC Circuits*, in *3rd Workshop on Adaptive and Adaptable Educational Hypermedia at the AIED'05 conference, (A3EH)*. (2005).

[6.] Brusilovsky, P. and S. Sosnovsky, *Individualized exercises for self-assessment of programming knowledge: An evaluation of QuizPACK*. Educational Resources in Computing (JERIC), (2005). **5**(3): p. 6.

[7.] Myller, N., *Automatic Generation of Prediction Questions during Program Visualization.* Electronic Notes in Theoretical Computer Science (ENTCS), (2007). **178**: p. 43-49.

[8.] Welch, R.E. and T.W. Frick, *Computerized adaptive testing in instructional settings.* Educational Technology Research and Development, (1993). **41**(3): p. 47-62.

[9.] Askins, D., *Adaptive Assessment*, in *Toolkit - The Nuts and Bolts e-Newsletter*. (2004).

[10.] Way, W.D., *Practical Questions in Introducing Computerized Adaptive Testing for K-12 Assessments,* in *Research Report 05-03*. (2005).

[11.] Brusilovsky, P., *Methods and Techniques of Adaptive Hypermedia.* User Modeling and User-Adapted Interaction, (1996). **6**(2-3): p. 87-129.

[12.] Yu-Huo, T., W. Yu-Lung, and C. Hsin-Yi, *A Practical Computer Adaptive Testing Model for Small-Scale Scenarios.* Educational Technology & Society, (2008). **11**(3): p. 259-274.

[13.] Wang, F.H. *Application of componential IRT model for diagnostic test in a standard conformant eLearning system*. in *the Sixth International Conference on Advanced Learning Technologies*. (2006). Kerkrade, The Netherlands.

[14.] Cheniti-Belcadhi, L., N. Henze, and R. Braham. *Towards a Service Based Architecture for Assessment*. in *Proceedings of 13th Annual Workshop of the SIG Adaptivity and User Modeling in Interactive Systems (ABIS 2005)*. (2005). Saarbrücken, Germany: German Informatics Society (GI).

[15.] Gogoulou, A., et al., *Adapting the Communication-Scaffolding Tools in a Web-based Collaborative Learning Environment.* Proceedings of the ED-MEDIA 2004, (2004). **2004**(1): p. 1153-1161.

[16.] Conejo, R., et al., *SIETTE: A Web–Based Tool for Adaptive Testing.* International Journal of Artificial Intelligence in Education, (2004). **1**(33).

[17.] Lalos, P., S. Retalis, and Y. Psaromiligkos, *Creating personalised quizzes both to the learner and to the access device characteristics: the Case of CosyQTI.* (2005).

[18.] Hays, R.D. and J. Lipscomb, *Next steps for use of item response theory in the assessment of health outcomes.* Quality of Life Research, (2007). **16**: p. 195-199.

[19.] Gibbons, R.D., J.C. Immekus, and R.D. Bock, *The Added Value of Multidimensional IRT Models*. (2007).

[20.] Junker, B.W. and K. Sijtsma, *Nonparametric Item Response Theory in Action.* Applied Psychological Measurement, (2001). **25**(3): p. 211 - 220.

[21.] Field, A., *Discovering Statistics Using SPSS*. (2005), London: SAGE Publications Ltd.

[22.] Sitthisak, O., et al. *Adapting health care competencies to a formal competency model*. in *the ICALT*. (2007). Niigata, Japan: IEEE Computer Society Press.

[23.] Bloom, B.S. and D.R. Krathwohl, *Taxonomy of educational objectives: The classification of educational goals by a committee of college and university examiners*, ed. H.I.C. Domain. (1956), New York: Longman.

[24.] Gagne, R., *Robert Gagne's Nine Steps of Instruction*. (1970).

[25.] Merrill, M.D., *Instructional Transaction Theory (ITT): Instructional Design Based on Knowledge Objects*. (1999).

[26.] W3C, *OWL Web Ontology Language (OWL)*. (2004).

[27.] Kalfoglou, Y., *Exploring Ontologies*. Handbook of Software Engineering and Knowledge Engineering. Vol. 1: Fundamentals. (2001), Washington, D.C.: World Scientific Publishing.

[28.] Sitthisak, O., L. Gilbert, and H.C. Davis, *An evaluation of pedagogically informed parameterised questions for self assessment.* Learning, Media and Technology, (2008). **33**(3): p. 235-248.

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A Virtual Chinese Language Class in Second Life: Lessons Learnt from a Two-Month Pilot Study

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Abstract: Authentic context and active social interaction are two critical factors in the success of foreign language learning. Second life (SL) has been viewed as an attractive platform with potential for foreign language learning because of its virtual authentic real context. However, simply moving students to SL guarantee neither students' active involvement and rich interpersonal interaction nor effective learning outcome. In a two-month pilot study of Chinese learning and teaching in SL, analytical results indicate that there is still more needed to do in SL to help create a more active Chinese language learning environment for Chinese learning and teaching for global learners. While this pilot study focuses on teaching and learning Chinese as a foreign language, the findings and suggestions are also relevant to understanding the related issues of other language.

Keywords: Chinese as a foreign language, second life, social interaction, virtual authentic context

Introduction

Second Life (SL), an online 3-D multiuser virtual environment (3-D MUVE), has been drawing special attention from many researchers and educators since its development in 2003 because of its capability to motivate learners to engage in series of purposeful educational investigation without losing interest and passion [1, 2]. There are over 67,000 regular users spread across 1.5 billion m2 of virtual space by the end of 2009. For foreign language learning, the virtual social community built in SL is especially considered an authentic real environment to help foreign language (L2) learners actively use the target language. As Krashen [3] argued, interpersonal meaningful communication in a natural condition can benefit L2 learners' acquisition of the target language. Van Lier [4] and Long [5] also indicated that learners construct the new language through socially mediated interaction. Long further pointed out that the various modified interaction that native speakers and other interlocutors create are able to render comprehensible input to language learners and consequently enhance learners' acquiring the target language. Consequently, the investigation on usage of SL in L2 learning and teaching has dramatically increased [e.g., 6, 7].

Although many of the researchers studied how L2 learners behave and communicate with other avatars in SL, most of the study used the students they already knew and attended in a regular foreign language class, like English as a foreign language such as [8, 9]. Furthermore, the subjects of the related studies had almost learnt the target language for a period of time. Few studies focused on investigating how unfamiliar students who are total beginners of a foreign language learn the target language in SL. Additionally, many research seemed to let L2 learners freely explore in SL or talk with other avatars of native speakers. The knowledge about how L2 learners learn in a structured inter-avatar, context-avatar interactive scenario is still superficial and worthy of more researchers' attention and effort.

1. Research Questions and Methodology

The purpose of this study is to investigate how learners acquire Chinese as a foreign language (CFL) in a structured learning scenario in SL. This paper reports the results of a two-month experiment to explore the related issues of learning and teaching CFL in SL, such as avatars' engagement in CFL class in SL, inter-avatar interaction, context-avatar interaction, teachers' perception, structured teaching instruments development, and learning outcomes.

1.1 Research Questions

The research questions are as follows:

- What will a Chinese beginner learn Chinese in SL?
- Is SL the right platform on which structured Chinese class can be developed for Chinese beginners around the world?
- What are the Chinese teachers' view about SL used for Chinese learning and teaching?

1.2 Methodology

The study applied a qualitative approach to explore the related issues of integrating SL in CFL class for Chinese beginners. Both teaching journal and video data were collected and analyzed: a journal of teaching activities, CFL learners' behaviors and participation, and inter-avatar interaction; and the learning process was recorded to help understand what components are essential to CFL beginning class in SL.

1.3 Participants

Eight volunteers with beginning Chinese language ability from seven countries participated in the Chinese class. Two Chinese teachers cooperatively taught in this pilot study: while one taught the class, the other helped record the learning process. Table 1 is the information about the class and the participants. From Table 1, we can see that the participants were from Asia, Europe, and South America, and they spoke six different native languages. Most of them had no experience with Chinese except for one who had two months of learning before. Furthermore, the Chinese teachers did not know those students until they joined the class.

1.4 Virtual Context and Instruments

The scenarios of SL used in this study were conducted by Institute for Information Industry, which include a restaurant, an airport, and a hotel as shown in Figure 1. In these scenarios, five teaching units were developed and each was taught for a two-hour period. The second column of Table 1 showed the teaching focus of each unit. Figure 2 is some examples of the two teaching units, Transportation and Food, respectively.

Table 1. The information about the class and the participants

Date (Taiwan time)	Unit theme	Participants			
		Gender	Nationality	Native Language	Chinese Language Ability
11/17/2009 (12:30-14:30)	Check in a hotel	Male	Korea	Korean	Beginner (with two months of Chinese learning experience)
11/20/2009 (13:30-15:30)	Chinese Culture (famous landmarks in Taiwan and Chinese lucky symbols)	Female	The Philippines	English	Beginner
11/21/2009 (10:00-12:00)	Food (Night market)	Female	England	English	Beginner
11/21/2009 (13:30-15:30)	Location & Nationality	Male	Indonesia	Indonesian	Beginner
11/23/2009 (10:00-11:00)	Location & Nationality	Male	Vietnam	Vietnamese	Beginner
12/09/2009 (10:00-11:00)	Transportation	Male	Denmark	Danish	Beginner
12/17/2009 (18:00-20:00)	Location & Nationality	Female	England	English	Beginner
12/21/2009 (09:00-11:00)	Food (Night market)	Female	Brazil	Spanish	Beginner

Figure 1. (a) the restaurant (b) the airport (c) the lobby of the hotel

Figure 2. (a) an example of unit Transportation (b) an example of unit Food

1.5 Procedures

The classes took place from November 17th to December 21st in 2009, with eight 2-hour periods in total conducted during this period as shown in Table 1. Because all the students were new to the teachers, the very first thing to be done in each class is to get to know every participant, such as his/her nationality, native language, and Chinese language ability. Setting up the computer equipment to be used by the participants was also an important thing to be confirmed first. Then the teacher asked some related questions to attract and motivate the participants. As soon as the participants became aware of the focus of the class, key sentences and vocabulary were introduced to help the participants express their idea or responses in Chinese. Given their lack of knowledge in the Chinese language, corresponding PowerPoint slides were used to show the main learning contents of each unit. Moreover, a Chinese input software developed by IQ Technology Company was used by the teachers to type Hanyu Pinyin of the Chinese words or sentences due to the participants' low

Chinese language level. After some text-based practice, the teacher then guided the participants to practice what they just learned via avatar-context interaction. Then, the participants and the teachers were situated in a specific scenario to proceed in a real context practice. Take the learning activities of unit Transportation as an example. After practicing activities about how to express in Chinese the means of transportation and destination, the scenes changes to a bus stop at the airport and the participant would take the bus to school (as shown in Figures 3 and 4). All the units delivered followed similar procedures described above.

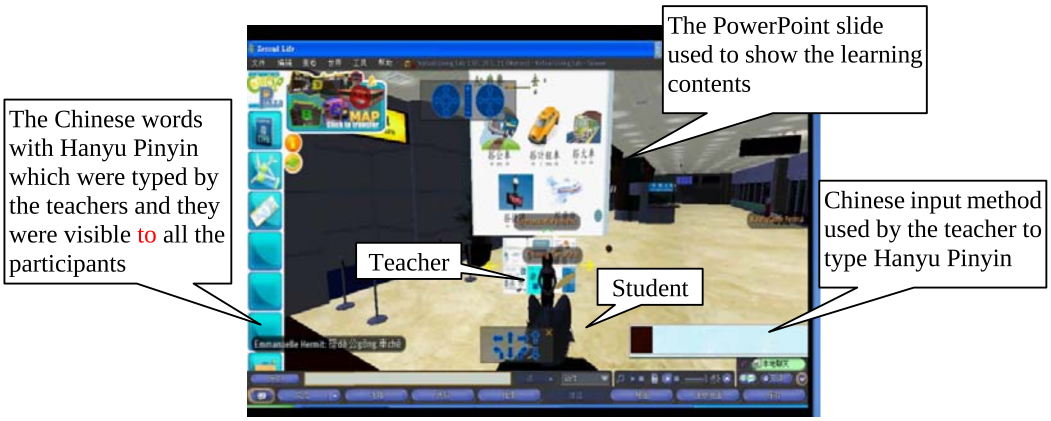

Figure 3. Learning how to say the transportation in Chinese.

Figure 4. Taking a bus to school.

1.6 Data Collection and Analysis

Both teaching journal and video data were collected and analyzed. After each class, the two teachers kept a teaching journal to reflect on how the class was going, such as what was taught, how the teaching materials were delivered, how the inter-avatar interaction went, how the CFL learner learned Chinese, and how they felt about learning Chinese in SL. In addition to the teaching journal, each class was recorded by screen recording software, Camstudio, for further analyzing. The result of video data analysis could help the researchers have a clearer idea about the effect of different teaching approaches to help CFL beginners learn Chinese in SL.

2. Results

The analysis focused on the following aspects: the effective and ineffective approaches to teaching Chinese in SL, the ready state of SL for CFL teaching and learning based on the

Chinese teachers' point of view, and the learning behaviors of the participants. The results are briefly described in the following.

2.1 The Approaches to CFL Teaching

Three different approaches were used to deliver the learning materials in each unit in this pilot study: functional-notional approach, the audiolingual method, and total physical response. Functional-notional approach focuses on breaking down the global concept of language into units of analysis in terms of communicative situations in which they are used. Interpersonal relationship development is an important issue of approaches. Based on habit formation theory, the audiolingual method fosters dependence on mimicry memorization of set phrases and over-learning. In addition, structural patterns are sequenced and taught one at a time using repetitive drills to help learners master the skills. Regarding total physical response, the method is one that combines information and skills through the use of the kinesthetic sensory system. The learners used their body to act out the words or phrases or sentences that the teachers said.

All the learning materials used in this study were function-oriented for daily lives. Teachers first used pictures shown on the slide and functional sentences to guide the CFL learner into the learning context. Then the learner practiced the structural patterns via different learning activities, such as mimicry, substitution, total physical response, and role play. Specific scenarios are provided for the teachers and the CFL learner to do more function-oriented activities.

Based on results of both video data and teaching journal, we found that all the three approaches were effective to CFL beginners' learning Chinese, especially when the virtual scene in SL well matched the learning contents. An approach is "effective" when the teaching flow goes smoothly and the CFL learners were able to catch teacher's meaning well and consequently were able to respond to the teacher's questions to continue the inter-avatar conversation. The bus-taking activity in the Transportation unit (as shown in Figure 4) took place after the instruction of direction and transportation in the airport. Table 2 shows a discourse fragment between the teacher and the CFL learner from Demark. We found that the CFL learner actively involved in Chinese learning and showed enthusiasm when following the teacher to the bus stop to take the bus to school.

Table 2. The discourse fragment from unit Transport

[00:00:00.00]	Teacher: 你要去哪裡？You can add a country name after it.
[00:00:10.58]	Student: 我要去Denmark。
[00:00:15.60]	Teacher: 你要去Denmark嗎？
[00:00:21.68]	(Student typing: Denmark)
[00:00:24.18]	Teacher: Denmark in Chinese we say 丹麥。
[00:00:29.63]	Student: 我要去丹麥。
[00:00:33.69]	Teacher: 很好，你要怎麼去？
[00:00:38.77]	Student:我要搭...去。
[00:00:44.74]	Teacher: If you are going to take plane, 搭飛機
[00:00:49.22]	Student: 我要搭飛機去
[00:01:02.97]	Teacher: 很好，and it's your turn to ask me 你要去哪裡and 怎麼去
[00:01:20.07]	Student: 你要去哪裡？
[00:01:25.64]	Teacher: 我要去學校。
[00:01:28.91]	Student: 你要怎麼去？
[00:01:34.87]	Teacher: 我要搭公車去。Do you know that there is a bus 公車 next to the airport?我們

	去搭公車。
[00:02:11.30]	Teacher: 那是公車。我們一起搭公車去學校。
[00:02:36.91]	Teacher: 我們要怎麼去學校？
[00:02:41.53]	Student: 搭公車。
[00:02:44.81]	Teacher: ok, then we can get on the bus.
[00:02:57.22]	Teacher: 公車會到學校和醫院。你要去醫院，你要怎麼去？
[00:03:25.37]	Student: 我要搭公車去。

The learning activities in the unit Location & Nationality is another effective example. All the CFL learners followed teachers' instruction very well when they were asked to figure out where something was in the hotel lobby. They could even move directly to the correct point, such as the sofa, the fountain, and the counter. On the other hand, in the lobby of the hotel, it was difficult for all the CFL learners to respond to the question "where are you" asked by the teacher based on pictures of different national flags shown on the slide (as shown in Figure 5). This should be regarded as the result of the learners' lack of background knowledge (about national flags), which is not to be confused with the mismatch between the learning content and the background context. Table 3 is a discourse fragment showing an example of the student's difficulty in expressing in Chinese their knowledge of nationality and location in the UK.

Figure 5. Learning the nation's name and location in the lobby in a hotel

Table 3. The discourse fragment from the unit Location & Nationality

[00:00:00.00]	Teacher：妳在哪裡？
[00:00:06.22]	Student：你在哪...
[00:00:10.88]	Teacher：裡。
[00:00:12.96]	Student：裡。
[00:00:14.79]	Teacher：很好， you cannot make the sound is too strong, ok?
[00:00:24.83]	Teacher：Ok, 很好，you made a good pronunciation of 你在哪裡 means "where are you." Ok, 你在哪裡？I can type the Pinyin for you, 'cause there is no Pinyin on the PPT. 妳在哪裡. Ok, so one more try, 你在哪裡？
[00:00:49.16]	Student: 你在哪裡？
[00:00:55.32]	Teacher: 很好，你在哪裡？Ok, then, so where do you come from? Where are you now? I mean in real life, not in Second Life.
[00:01:18.53]	(Student typing：me? UK.)
[00:01:21.08]	Teacher: UK, 英國. Ok, so that you can say, "我在英國" is just like here, I can type for you.
[00:01:31.65]	Teacher: Ok, you can use... If someone asks you 你在哪裡, you can answer the real place you are in, the country, ok? So, see the flag of your country. You can say, "我在英國" means "I am in the UK." Can you repeat？我在英國。

[00:01:58.39]	Student: 我在英國。
[00:02:04.99]	Teacher: uh, pretty good, 很好。So, it's 英國. The first word "英" is first tone. 我在英國，one more try!
[00:02:20.75]	Student: 我在英........(Teacher：國)國
[00:02:33.20]	Teacher: It comes from the back of your throat and sounds like this "ㄍ", "g" sound, 國
[00:02:41.19]	Student: 國
[00:02:42.90]	Teacher: 很好，很好，good. So, ok, see the flag of China? In this sentence pattern, you can put a country's name after "在". It means I am somewhere. So, if I am in China, this is the flag of China right? China is called "中國".

Although the approaches used in this study were well-applied by the teacher in the virtual context to guide the CFL learners, there were still some problems. The learners' poor pronunciation was a major one. All the learners are Chinese beginners. They were unfamiliar with the tones and pronunciation of Chinese characters, words, and sentences. Watching the teacher's face and mouth movement is a usual method to help CFL learners learn Chinese pinyin system. But it is almost impossible in this teaching environment. Even when the teacher used the Chinese input software to type the pinyin symbols on the screen, it still was not an easy task to help the learners to pronounce correctly. In addition, the overly public virtual world was another problem. A case showed the difficulty in class control when a guy appeared in the system, and after talking to the learner, the stranger and the student left the system together. The class on December 9th 2009 only lasted about one hour, leaving the teacher not knowing what actually happened in the virtual class.

2.2 The Ready State of SL for CFL Teaching

Is SL ready for CFL teaching and learning? How about for the CFL beginners? The answer is "yes" and "no". For the answer "yes", the Chinese teachers thought that the virtual scenes in SL are able to provide a promising environment in which the teachers can easily lead the CFL learners to limitless learning. They can see objects that cannot be reached in real life, go to various places, meet Chinese native speakers, or experience unusual events, instantly and freely. Regarding the answer "no", as mentioned above, teachers' demonstrations of pronunciation with clear mouth motions are important for Chinese beginners to catch the features of Chinese pronunciation. Although the avatar in SL can do many different gestures, a clear mouth motion to demonstrate Chinese pronunciation is still unavailable. In addition, some common and easy gestures which are helpful to language learning are uneasy to do in SL, such as pointing to a person or an object, taking out an object and sharing with others, showing shopping goods with other avatars, and so forth. Consequently, a complete Chinese learning environment is currently impossible for beginning Chinese teaching. The problem could be identified in Table 3. We can find at the beginning of the class, the CFL learners had lots of problems in understanding the meaning of the key sentence patterns and vocabulary, and the teacher used lots of English to explain. Furthermore, cooperative structural discovery learning task is also difficult to implement in SL because of the difficulty of inter-avatar sharing and discussion when the team avatars are in different locations. Cross-culture issue is another problem to teachers and CFL learners in addition to the above obstacles. In the unit of Chinese culture held on November 20th in 2009, some Chinese lucky symbols, such as bats standing for good luck and deer signify prosperity, are difficult for the CFL beginners to understand. In conventional CFL classes, the teachers usually use videos to introduce culture related contents while it is not available in current SL technology.

In a word, SL itself is a potential technology for Chinese learning, but it can be very hard to find what we need. It is still a long way for us to go.

3. Conclusion

In this pilot study of beginning CFL in SL, it was found that the matching degree between the learning contents and virtual scenes in SL has big influence on CFL teaching and learning. In addition, one activity that integrates context with learning activities and has the CFL learners to use the target language in a language task is an effective approach to motivate CFL learners' motivation. In contrast with the promise that SL is an effective CFL learning environment, some limitations of current SL technology in CFL learning also identified the lack of technical support in resolving the lack of using body gestures and mouth motions to aid CFL beginners' pronunciation and comprehension. Cross culture is also a challenging issue for SL researchers. Furthermore, the effective approaches to implementing cooperative learning and structure discovery learning activities for CFL learning in SL are worthy of more attention.

In sum, there is, of course, a possibility and promising future for using SL in CFL teaching and learning. Yet, more efforts should be made to make SL a more suitable environment for this purpose.

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References

[1] Jarmon, L., Traphagan, T., Mayrath, M., & Trivedi, A. (2009). Virtual world teaching, experiential learning, and assessment: An interdisciplinary communication course in Second Life. *Computers & Education, 53*, 169-182.

[2] Doherty, P., Rothfarb, R., & Barker, D. (2006). Building an interactive science museum in Second Life. *Proceedings of the First Second Life Education Workshop, Part of the 2006 Second Life Community Convention* (pp. 19-24). UK: The University of Paisley.

[3] van Lier, L. (1996). Interaction in the language curriculum: Awareness, autonomy and authenticity. London: Longman.

[4] Long, M. H. (1996). The role of the linguistic environment in second language acquisition. In Ritchie, W. C., & Tej K. B. (eds.), *Handbook of second language acquisition*, pp. 413-468. San Diego: Academic Press.

[5] Sykes, J. M., Oskoz, A., & Thorne, S. L. (2008). Web 2.0, synthetic immersive environments, and mobile resources for language education. *CALICO Journal*, *25*(3), 528-546.

[6] Sadler, R., & Nurmukhamedov, U. (2008, March). *Second Life and task-based learning*. Paper presented at CALICO annual conference, San Francisco, CA.

[7] Krashen, S. D. (1981). Second language acquisition and second language learning. USA: Pergamon Press.

[8] Wang, C. X., Song, H., Xia, F., & Yan, Q. (2009). Integrating Second Life into an EFL program: Students' perspectives. *Journal of Educational Technology Development and Exchange*, *2*(1), 1-16.

[9] Peterson M. (2008). Virtual worlds in language education. *The JALT CALL Journal*, *4*(3), 29-36.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Effects of Automatic Hidden Caption Classification on a Content-based Computer-Assisted Language Learning System for Foreign Language Listening

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Abstract: This study develops a content-based computer-assisted language learning tool for training English listening through multimedia. The system automatically provides instant vocabulary translation and classification to users whenever they pause while watching videos. Experiments were conducted to compare the novel system with the traditional solution using a translation machine to support subtitle comprehension. The first goal of the novel system is to support listening comprehension, and the second goal is to confirm its usability. These two goals were successfully achieved in the study. Eye tracking was used to observe variations in gazing and reliance on subtitles. The results of vision analysis show that the degrees of reliance on subtitles remain unchanged.

Keywords: instant translation, automatic vocabulary classification, subtitles, listening comprehension

1. Introduction

Language is the instrument for communication. Listening plays an important role regardless of the use of first or second foreign language. Previous research has investigated the importance of listening, speaking, reading, and writing in English in 146 freshmen and found that more than 51% of participants considered listening to be the most essential aspect of language [8]. In Taiwan, learning English is of vital importance because it is the major international communication tool. However, many English teachers had focused on teaching grammar and enhancing the vocabulary acquisition of learners in the past few years [4], so that English listening comprehension has become the weakest skill of the Taiwanese. Training in English listening has currently become more convenient and easier to access because of the progress of technologies; for example, computers and the Internet had brought many new media and diverse formats for listening training. Digital multimedia, such as MPEG Audio Layer III (mp3) and Digital Video Disk (DVD), can expose EFL learners to English programs, songs, and videos. Many Web sites provide online English learning, such as nonstopenglish (www.nonstopenglish.com), englishforums (http://www.englishforums.com), englishclub (http://www.englishclub.com), and tefl (www.tfel.net). There are also online film databases, such as imdb (http://www.imdb.com/) and Drew’s scripts-o-rama (http://www.script-o-rama.com). These digital formats often offer various subtitle choices, repeatable viewing at will, and easy storage of files.

Many studies have confirmed the contributions of subtitles or captions in learning foreign languages through movies, films, or videos. In recent decades, research has indicated that videos with subtitles are helpful in learning reading, vocabulary, and listening in a foreign language [1]. The scholars stated that videos with subtitles are conducive to listening comprehension, especially because the learners are encouraged to select the movies or videos they are interested in to practice their listening skills [7]. Although comprehension of foreign culture and internationalization from the videos are difficult, the subtitles can help solve the comprehension problems. Still, learners cannot rely solely on reading subtitles all the time to train their listening proficiency. Other studies have indicated that the lack of subtitles in a video induces learners to pay attention to various pronunciation appearances, such as reduced forms, assimilation, elision, and resyllabification [11], such that translation subtitles should not always be provided for listening practice. They have also suggested that subtitles should be time-toggled on and off to assess their usefulness [3, 12].

This study aims to investigate whether the automatic caption classification and vocabulary interpretation functions provided by the content-based CALL system can support the listening comprehension of English learners. It utilized multimedia, such as videos, movies, and films, in English for learners to make adaptations to oral dialogue and to train their daily listening comprehension skills. The issue of providing time-appropriate support during video play was incorporated into the pause button, which was used by learners to obtain auxiliaries once they encounter listening comprehension problems. Thus, this study introduced the innovation approach of the automatic caption difficulty classification hidden or appearance as well as interpretations for listening training and comprehension.

2. Literature Review

Many certifications, such as TOEFL, TOEIC, and GEPT, have included listening examinations, so students learning English as a foreign language must develop listening comprehension proficiency. Previous studies have indicated that captioned videos for foreign language learning bring the native speakers' voices of foreign language into the learning surroundings. Further, these have become more and more common due to their use as a pedagogical tool in online courses, especially that they are easily accessed and produced [12].

Vision can provide both context and non-verbal input. Videos provide simultaneous seeing and hearing for foreign language learners, which remedy the lack of sufficient language knowledge and comprehension resulting from learning by listening alone [9]. Multimedia can provide the listener with various conditions, including voice, vision, and texts in the form of subtitles or captions offered in different languages. Previous studies have shown that computer technology is useful for language learning, and the use of multimedia is beneficial for vocabulary learning [5]. Foreign language films with subtitles have also been shown to help listening comprehension [7]. Slowing down or speeding up broadcasting tempo is not necessary for listening comprehension [2, 11].

2.1 Literature Summary and Research Questions

Past studies have pointed out that captioned videos had better listening comprehension and learning outcomes than non-captioned ones [10]. However, there are few works on the development and exploration of an assisted language learning tool similar to the system developed in this study. The experimental group will be exposed to automatic classification of degrees of vocabulary difficulty in order to determine the necessity of subtitles. Thus, the captions of easier words will be hidden, while those of difficult words will be automatically shown with translations. The experimental group will be compared with the comparison group using captioned videos that have been verified to produce better listening comprehension than non-captioned videos. Eye tracking will be used to observe gaze variations while the learners watching the video in the experimental and comparison groups.

Finally, all participants will be assessed using the Computer System Usability Questionnaire (CSUQ) [6]. The following are the research questions that will be explored:

1. Does the experimental group achieve similar comprehension of video content and learning of vocabulary as the comparison group?
2. Do eye movements with classified hidden captions have differences or similarities with the eye movements with captions shown throughout?
3. Do the users perceive any difference in usability between the experimental group and the comparison group?

Based on prior research, captioned videos result in better listening comprehension than non-captioned ones. Therefore, the first hypothesis in this study is that the experimental group exhibits comprehension and vocabulary gains similar to the comparison group, so the independent paired t-test between the experimental and comparison groups shows no significant differences. The ordering effects of the two groups have been excluded from the counterbalanced experiment design. The experimental group is also expected to demonstrate high usability.

3. Method

The participants in this study were learners of English as a foreign language, and the sound track and captions of the video were both shown in English. Both control and experimental groups were unable to see subtitles in their first language during the video play. The comparison group was exposed to normal video play in a computer. Students in the comparison group were instructed to push the pause button of the broadcast software whenever they were not able to comprehend what they heard, allowing them to consult a dictionary and find the Chinese translation of the unfamiliar words, just like the traditional and common practice. All the English captions were shown at the bottom of the screen throughout the video duration. For convenient and quick dictionary consultation during video play, instant translation was embedded in the broadcast software. When the video is paused, and the user pointed to an unfamiliar word in the caption, its Chinese translation will be shown in a small window on the right.

The experimental group was exposed to the novel system, where the easier captions were automatically hidden, and the Chinese translations of the more difficult words were displayed in a small window on the right when the video is paused. The system automatically classified the words based on their degree of difficulty. Each participant was included in both groups and so was able to experience both control and experimental treatment. To exclude the ordering effects of the two different instruments, the experimental research method had a counterbalanced design (Table 1).

Table 1. Counterbalanced Design

Duplication	Instruments	
	Experimental group method	Comparison group method
Earlier	31 participants	20 participants
Latter	20 participants	31 participants

There were 31 students who used the experimental method first and then used the control method afterwards. On the other hand, 21 used the control method first and then used the experimental method later.

3.1 System framework

The broadcast content of the video files provided both visual and aural stimulus. The database stored vocabularies, translations, difficulty levels, and usage frequencies. When the player software is paused, the words within the difficulty level that the learner set are hidden, while the words beyond the difficulty level are automatically translated. The player software was designed with functions specific for English listening training (Figure 1). The research tools include headphones, video files, eye-tracking machine (Mangold Vision), and a personal computer installed with the system.

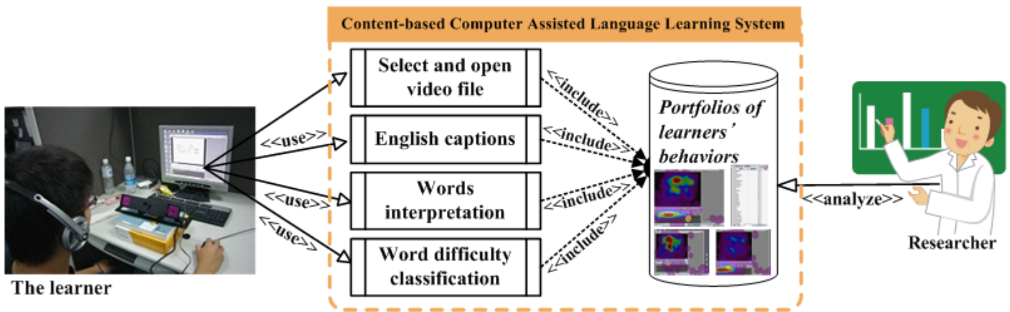


Figure 1. Architectural diagram of the system

Because past research has been pointed out that it is not necessary to slow down or speed up broadcasting tempo in terms of listening comprehension, the study will not taken the buttons of slowing down or speeding up into consideration. The listeners have to practice getting used with the common oral speed. The basic functions in the video player program are the buttons of the play, pause, and replay. The study only used the buttons of play and pause during the experiments lest the function of replay interferes with the results of the study. The study aimed at investigating the effectiveness of the captions-filtering when the player is paused, so that the experimental group can provide users with automatic classification of the caption words by an easy and quick action.

3.2 Participants

A total of 51 freshmen from the same department participated in the study. The English learning experience of the participants was controlled, with seven years' experience on the average for each participant. Some experienced the control method first, while some were exposed to the experimental method first.

3.3 Materials

3.3.1 Videos

Two videos of the same consistency were selected: one for experimental group and the other for the comparison group. Both short videos were related to computer science knowledge, had the same degree of English difficulty, and were of approximately similar lengths.
To avoid interference between the two videos due to familiarity after watching one of them, the two videos were of different themes introducing computer science. One video is an introduction to personal computer hardware, and the other is on network information searching. The participants were not allowed to open and select videos by themselves.

3.3.2 Listening and comprehension tests

The pronunciation of two native speakers of English was recorded in advance for the listening tests. Both of them are professional English teachers for more than five years. The recorded contents of the listening tests were related to video content. The comprehension tests were related to the professional knowledge taught and the vocabulary used, and was designed by a computer science teacher after watching the video.

3.3.3 Questionnaire

There are 19 questions in the CSUQ (Lewis, 1995) with seven-point Likert scales. Three dimensions can be investigated by the questionnaire, including perceived ease of use, usability, and satisfaction.

3.4 Procedure

After introducing the functions and operation of the broadcast program to the users, they were exposed to both the experimental and comparison groups. The video was selected and opened by the researcher beforehand. After being exposed to one group, the participants were made to take the listening and comprehension tests related to video content. The duration of every treatment stage and the distribution of the participants are shown in Figure 2.

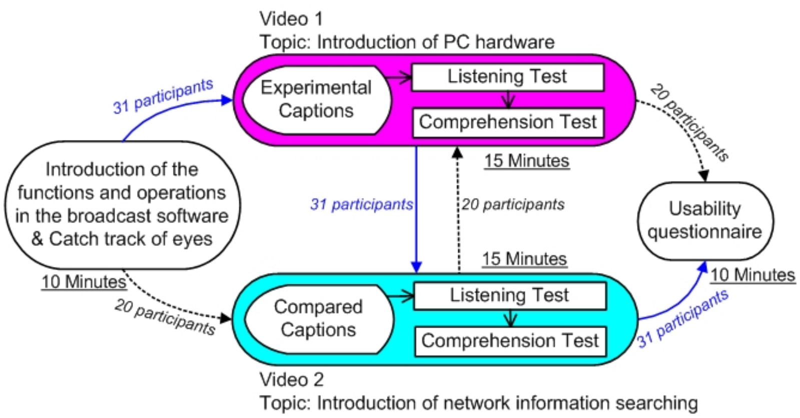


Figure 2. The flowchart o the experimental procedure.

3.5 Data Collection and Analysis

The participants took the listening and comprehension test right after watching each video. The scores were collected for paired-samples t test. The lack of significant differences between the two groups indicates that the automatic caption classification system trains the listening of the learners better than without captions while producing the same comprehension degree as the captioned videos. The movement of the eyes and the frequencies of the stare positions were classified and analyzed from the data collected by the eye tracking machine. After the experimental treatment, the students filled in the usability questionnaire, and the results were analyzed.

4. Results

4.1 Research question 1: Does the experimental group achieve similar comprehension of video content and learning of vocabulary as the comparison group?

The mean scores between the experimental and comparison groups were measured after conducting the counterbalanced instruments. The mean scores of the listening test in the experimental group were improved by more than five marks, while those of the comprehension test were upgraded by more than four marks. Table 2 presents the descriptive statistics.

Table 2. Results of the listening and comprehension tests

Two tests after the counterbalanced instruments	Order	N	Listening test Mean	Listening test Sd	Comprehension test mean	Comprehension test Sd
Experimental group	Earlier	31	55.65	31.43	63.71	25.69
	Latter	20	55.00	30.99	61.25	24.97
Column average	**Integration**	**51**	**55.39**	**30.95**	**62.75**	**25.19**
Comparison group	Latter	31	52.42	30.52	57.26	26.77
	Earlier	20	46.25	24.70	60.00	24.87
Column average	**Integration**	**51**	**50.00**	**28.28**	**58.33**	**25.82**

Paired-samples t-test of the two treatments revealed no significant differences in the listening outcomes (t=1.35) and comprehension degrees (t=1.07) (Table 3). Thus, the first research hypothesis is accepted. The CALL system that partially hides captions automatically has the same efficacy as captioned videos. Moreover, the novel system appears to be more effective than the provision of captions throughout video play.

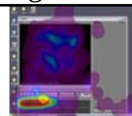
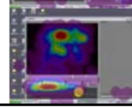
Table 3. Paired-Samples T-Test of the control and experimental groups

Experimental – comparison group	N	Paired Differences Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Listening test	51	5.39	28.42	3.98	1.35	50	0.182
Comprehension test	51	4.41	29.46	4.12	1.07	50	0.290

4.2 Research question 2: Do eye movements with classified hidden captions have differences or similarities with the eye movements with captions shown throughout?

Analysis of the hot areas detected by the eye tracking machine shows that there is no remarkable difference between gaze focus in the control and experimental groups. Thus, the system does not evidently change the habits of the participants when watching videos in a foreign language. The stare positions were categorized into three types, and their distributions are shown in Table 4. More than 70% of the participants have the habit of depending on captions when they watch movies in a foreign language.

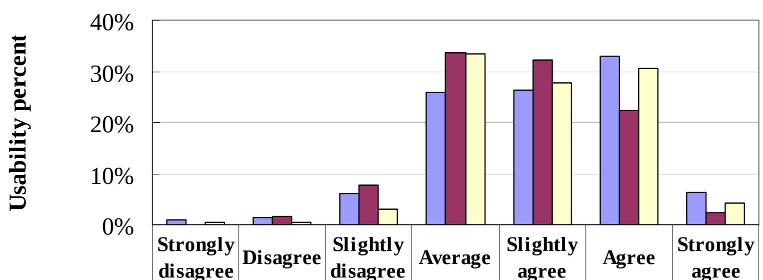
Table 4. Distribution of visual focus of the participants

Stare position	Example figures	Comparison group			Experimental group		
		Latter	Earlier	Total	Earlier	Latter	Total
Mainly on the captions		23	15	38	24	16	40
Mainly on the video		4	2	6	3	3	6
Both captions and video		4	3	7	4	1	5
Total numbers of students		31	20	51	31	20	51

Among the six participants in the comparison group staring mainly on the video and not on the captions in the experimental group, four achieved full marks in both tests. Thus, higher-level students are not affected by the lack of captions, while general-level students do not notice the captions when they have fewer captions to depend on.

4.3 Research question 3: Do the users perceive any difference in usability between the experimental group and the comparison group?

The results of 51 questionnaires are displayed in Figure 3. These show that 65% the students found the novel system to be agreeable and easy to use, and only a few did not perceive usability. More than 62% of the participants were satisfied with the system. Positive responses were received based on ease of use, usefulness, and satisfaction.



	Strongly disagree	Disagree	Slightly disagree	Average	Slightly agree	Agree	Strongly agree
Ease of use	0.84%	1.40%	6.16%	25.77%	26.33%	33.05%	6.44%
Usefulness	0.00%	1.68%	7.84%	33.61%	32.21%	22.41%	2.24%
Satisfaction	0.39%	0.39%	3.14%	33.33%	27.84%	30.59%	4.31%

Figure 3. Results of the usability questionnaire investigation

5. Conclusion

The study developed a content-based computer-assisted language learning system. Counterbalanced experiments revealed that automatic classification, concealment, and interpretation of words resulted in listening and comprehension degrees comparable with those of the comparison group that used real-time captioning and translation software. Moreover, the novel system appears to be even more effective than the control method. The usability questionnaire showed that more than 60% of the participants found the novel system to be usable in terms of ease of use, usefulness, and satisfaction. In addition, the eye tracking system detected that the different display modes of captions did not result in remarkable differences in the dependence degrees on captions of the students. The study correspondingly provides two suggestions for future research in this area. First, in light of system development, vocabularies with difficult degrees and usage frequencies should be expanded to include more words and classification levels. In the perspective of teaching experiments, the pre-test can be taken into consideration. Moreover, video displays with various lengths or videos in other languages can be further included in the experiments. Overall, the novel system proposed in this study is expected to be used for adaptive learning in foreign language listening training.

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References

[1] Danan, M. (1992). Reversed subtitling and dual coding theory: New directions for foreign language instruction. *Language learning, 42*(4).497-527.
[2] Derwing, T. & Munro, M. J. (2001). What speaking rates do non-native listeners prefer? *Applied linguistics*, *22*(3), 324–337.
[3] Grgurovi, M., & Hegelheimer, V. (2007). Help options and multimedia listening: students' use of subtitles and the transcript. *Language learning & technology*, *11*(1), 45-66.
[4] Liu, P. L., Chen, C. J., & Chang, Y. J. (2009). Effects of a computer-assisted concept mapping learning strategy on EFL college students' English reading comprehension. *Computers & Education*, *54,* 436-445.
[5] Liu, M., Moore, Z., Graham, L., & Lee, S. (2002). A Look at the Research on Computer-Based Technology Use in Second Language Learning: A Review of the Literature from 1990-2000. *Journal of research on technology in education*, *34*(3), 250-273
[6] Lewis, J. R. (1995). IBM computer usability satisfaction questionnaires: Psychometric evaluation and instructions for use. *International journal of human-computer interaction, 7*(1)**,** 57-78.
[7] Markham, P., Peter, L. & McCarthy, T. (2001). The effects of native language vs. target language captions on foreign language students' DVD video comprehension. *Foreign language annals*, *34*(5), 439–445.
[8] Ou，H.C. (1996). The effectiveness of teaching English listening comprehension as a second or foreign language learning. New York: Longman.
[9] Seo, K. (2002). The effect of visuals on listening comprehension: A study of Japanese learners' listening strategies. *International journal of listening*, *15*, 57–81.
[10] Stewart, M. A. & I. Pertusa. (2004). Gains to language learners from viewing target language close-captioned films. *Foreign language annals*, *37*(3), 438–447.
[11] Vandergrift, L. (2007). Recent developments in second and foreign language listening comprehension research. *Language teaching*, *40*(03), 191-210.
[12] Winke, P., Gass, S., & Sydorenko, T. (2010). The effects of captioning videos used for foreign language listening activities. *Language Learning & Technology*, *14*(1). 65-86.

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Integrating Social Networking Site into Teaching and Learning

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Abstract: Social networking site (SNS) which is a typical application of Web 2.0 technology has been popular and widespread across multiple age groups in various educational institutions. This study attempted to adopt one of the most popular SNS - Facebook - to implement the WIRE model, a teaching and learning strategy aims to close the cognitive gap of classroom lessons between students and teachers before class, and links up learning experiences from inside to outside of classroom. A quasi-experiment has been performed to study the learning effect according to the achievement, motivation, and interaction. The results were positive and also revealed some issues for future research.

Keywords: Social networking site (SNS), Facebook, WIRE learning model

Introduction

Social networking sites (SNSs) such as Facebook, Ning, and MySpace, which are the typical application of Web 2.0 technology, has been popular and widespread across multiple age groups in different educational institutions over the past few years. They not only allow users to meet strangers but also enable users to articulate and make visible their social networks [2]. According to latest researches about the use of SNSs in higher education, more than 80% students were using social networking sites in their daily lives [12 & 13], and even used SNSs every day [14]. Although the trust on SNSs may obstruct users' willingness to use them [11], most, such as Facebook and MySqpce, were used to bridge online and offline friendships without worry about the problem [13].
According to some academic literature, researchers showed that most web-based learning systems were made for just one-shot use and cannot continuously attract people to use them. The SNSs may have the potential to improve this predicament. Therefore, this study attempted to adopt one of the most popular SNS - Facebook - to implement the WIRE model [4], a teaching and learning strategy aims to close the cognitive gap of classroom lessons between students and teachers before class, and links up learning experiences from inside to outside of classroom. A quasi-experiment has been performed to study the learning effect according to the achievement, motivation, and interaction. The results were positive and also revealed some issues for future research.

1. Social Networking Sites in Higher Education

In general, social networking sites allow people to create personal social networks and the groups who have common interests. A wide variety of tools are provided in SNSs for attracting people to interact with their friends, such as message push, discussion tool, blogs, media sharing, third party plug-ins, and so on. Most users of the SNSs are youngsters who were named 'Digital Natives' [9], especially the majority are the students in higher education. They often used SNSs to stay in touch with their offline friends or bolster existing connections rather than to make new relationships [12, 13, & 15]. That revealed an important message that the SNS could be a potential medium to gain more popularity of online learning than traditional e-Learning platform if the elaborately designed activities can be closely integrated into the features of SNSs.

However, elaborately designed activities in instructional plans must be made prior to the adoption of SNSs in classroom since not all digital natives are eager to have such skills of using these technologies [5]. Furthermore, voluntary interactions among students rarely occurred in asynchronous online discussion and too much instructor intervention also cannot attract more interaction among students [1]. Most digital natives rarely use SNSs for educational purpose but the entertainment and friendship [7]. Therefore, to ensure these arguments, the authors carefully designed a suitable process in appropriate timing with proper use of technology.

2. Modification of the WIRE Model

Based on the ideas of Just-in-Time Teaching (JiTT) [8] and Peer Instruction (PI) [6], the WIRE model was designed to close the cognitive gap of classroom lessons between students and teachers, and to link up the learning experiences from inside to outside of classroom [4]. A specially designed blog-based learning system (BBLS) was introduced to support students' warm-up before class, interaction in class, and review and exercises after class. The experiment proved this model can effectively enhance the learning achievement, increase learning motivation, and facilitate the interaction between teacher and students and among students.

With different online discussion environment from the BBLS, this study attempted to adopt social networking site, Facebook, to implement the WIRE model. The BBLS provides each student a personal space to blog the notes for each learning stage while the Facebook provides a collective and opened space for each group. This study applied a group in Facebook which was dedicated to the experimental group as a common forum. By taking advantage of the interactive feature of SNSs, the authors anticipated the learners would be voluntarily attracted to interact with each other, because, in contrast, this feature is just the weakness for BBLS.

In order to exert the Facebook's superiority, the instructional design in this study also has some differences from the original WIRE model. Before class, this study required students to post at least three questions in Facebook while the previous study asked students to answer the assignments on BBLS. After class, this study required students to answer the warm-up questions of each other while the previous study asked students to modify the answers in warm-up stage. These changes were made to prevent the plagiary in answering the warm-up assignments because all group members can publicly view all messages posted in the group discussion board in Facebook.

3. Research method

This study adopted quasi-experimental research method to evaluate how the social networking site can support learning. A long-term instructional experiment was conducted for 16 weeks over 9 lessons in three undergraduate classes of Department of Information Management in a university of science and technology in Taiwan. The subject is 'Data Structure' which is an obligatory course for 2nd graders. Following subsections will detail the participants, instructional design, and evaluation tools.

3.1 Participants

One class with totally 50 students participated as experimental group and another class with 38 students participated as control group. While the control group did not use any web-based learning tool, the experimental group was treated by using the social networking site Facebook. All participants were sophomores who major in Information Management and had studied Computer Programming using Java for one semester. In order to identify that all participants possess the equal level on prior background knowledge for learning the new subject Data Structure, they took a pretest for the concepts of Java programming and basic algebra. The results of t-test for each comparison between the two groups revealed no significant difference ($t=.620$, $p=.537 > .05$).

3.2 Instructional design

Each group was treated by different learning activities in this experiment. Table 1 shows the major learning activities conducted in different stages. Before class, the experimental group was asked to post at least three questions on the Facebook after reading the assigned materials, while the control group also read the same materials but was asked to write down at least three questions on paper. In class, both groups were taught by adopting the peer instruction and group discussion with using the Classroom Response System (CRS) or Personal Response System (PRS), which is a set of remote controls held by each student for quick response to teacher's questions. Teachers can use the system to enable lectures to become more interactive and measure student responses to any variety of instructor questions in real time.

Peer instruction (PI) is one of the collaborative learning strategies in order to facilitate critical thinking, problem solving and decision making skills in a large-scale collective class [3, 6]. Students are engaged in learning activities because they have discussion opportunities with peers for solving the same problems in classroom [6]. Through providing concept tests interweaved with lecturing by the use of Instant Response System, teachers can probe students' comprehension degree of the latest lecturing and then adapt the following instructions.

Group discussion is different from the PI in collaborative members. Students in group discussion activity are divided into some groups with constant members to collaboratively discuss the assigned issues, while the students in PI activities discuss with the peers nearby. The instructional design for the classroom learning adopted both methods to inspire students' abilities of critical thinking and problem solving.

After classroom learning, the experimental group was asked to reply the warm-up questions of each other on the Facebook while the control group was asked to do the assignment on paper. To maintain the same learning content among the three groups, the assignments for control group were designed by referring to the warm-up questions posted in Facebook. In addition, the teacher may occasionally assign additional questions to both groups for further practices.

Table 1. Treatments for each group

Stages	Experimental group	Control group
Warm-up before class	Read printed textbook and post at least three questions encountered on the Facebook's group forum	Read printed textbook and write down at least three questions encountered on paper
Interaction in class	Lecturing and interactive events by peer instruction and group discussions with using the Classroom Response System	
Review and	Answer the questions the students	Answer the assignment on the paper

exercise after class	posted on Facebook's group forum before class Answer additional questions offered by the teacher

3.3 Evaluation tools

This study used the learning achievement test to evaluate the learning effect, used the questionnaire to survey the degree of agreement about the learning model and learning system, used the IRS response rate and correctness rate to assess the performance of classroom learning, and finally used the focus-group interview to provide the qualitative evidences in explaining the quantitative data.
The learning achievement test consists of pretest and posttest to measure the difference among the three groups. The items of pretest had been validated by three domain experts and had been tested by 32 students, who were selected from the same department of the participants, for the measurement of reliability of internal consistency (Cronbach α=.822).
During the classroom learning, the CRS provides an interesting and directed evaluation means to attract students in participating in learning activities. All response data from students will be recorded so that we can calculate the response rate and correctness rate to evaluate the learning performance.
After the experiment, the experimental group took a questionnaire using the five-point Likert scale to evaluate the level of agreement with the learning model and the usage of learning systems. In addition, ten participants of the experimental group were selected for focus-group interview by various levels of learning achievement and article posting.

4. Results and Discussion

4.1 Learning achievements

All participants took a pretest before the experiment to verify their homogeneous background knowledge in Java programming and basic algebra which consist of the necessary skills before studying the course Data Structure. After the experiment, they took a posttest to examine the learning achievement. The statistic results are shown in Table 2.

Table 2. Group statistics for the pretest

Test	Group	*N*	Mean	Std. Deviation	Std. Error Mean	t-test
Pretest	Experimental group	50	46.72	14.054	1.988	t=.620 p=.537 > .05
	Control group	38	45.05	10.046	1.630	
Posttest	Experimental group	50	67.62	20.776	2.938	t=3.378 **p=.001 < .05**
	Control group	38	52.84	19.714	3.198	

In pretest, the result of *t*-test between the two groups shows no significant difference between them. That indicates all participants had the homogeneous degree in Java programming and basic algebra to learn the course Data Structure. In posttest, the mean score of experimental group is significantly better than control group. That indicates using social networking sites can enhance learning achievement.

4.2 Learning behavior analysis

Facebook provides an open discussion board for group users to share information together. Users can view all articles in a column to quickly get ideas and post feedback around the discussion topics. However, this feature may cause similar questions posted in warm-up stage and similar replies posted in the stage of review and exercise in this experiment. There were 90 articles for warm-up and 53 articles for review and exercises posted in Facebook discussion board by experimental group. Two students actively replied to and discuss with other students were found. They attracted more students to join the follow-up discussion, although some articles, as predicted, were similar. As mentioned in literature [1], voluntary interactions among students rarely occurred in asynchronous online discussion and too much instructor intervention also cannot attract more interaction among students. In addition to the repurposed use of discussion board like this study, active students can play as the facilitators who can inspire passive students to think and to publish something about the learning topics.

In classroom learning, totally forty-one questions were asked by the CRS. There were seven times over the totally nine lessons that the average CRS response rate was higher in experimental group than in control group (see Figure 1). The overall average of experimental group was also greater than control group, although the results of *t*-test do not reach the significant level (see Table 3). Maybe the students were interested and motivated by the fresh learning technology – CRS.

Table 3. Average CRS response rate and correctness rate for each group

	Experimental group	Control group	*t*-test
Average CRS response rate	82.31%	77.31%	t=1.550 p=.124 > .05
Average CRS correctness rate	63.12%	59.36%	t=2.520 **p=.013 < .05**

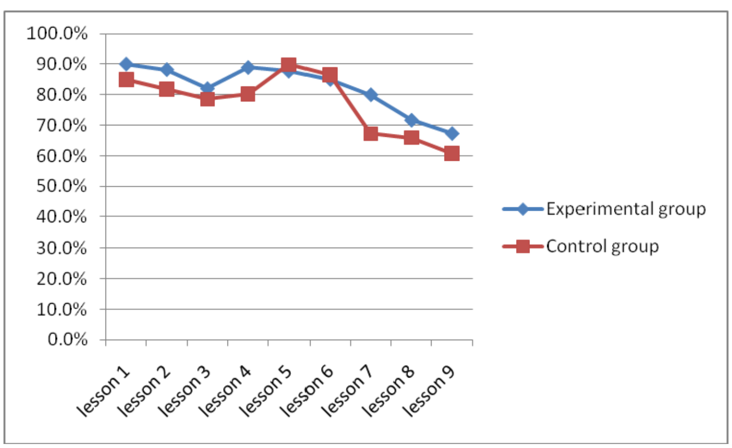

Figure 1. The average CRS reponse rates of the two groups for each lesson

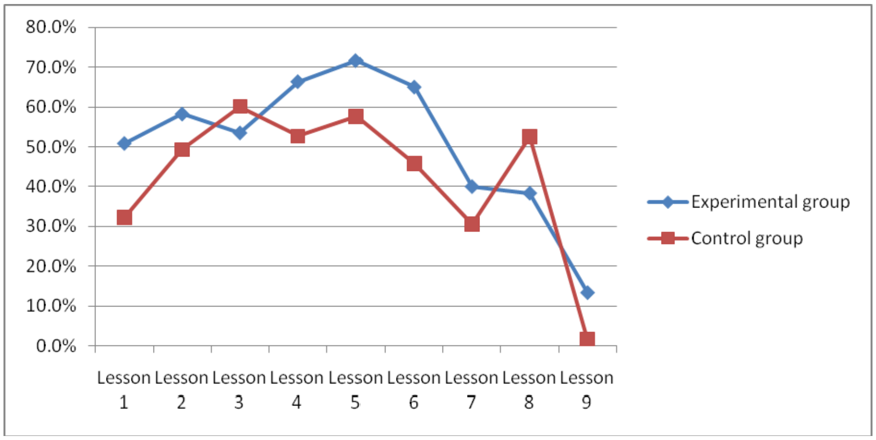

Figure 2. The average CRS correntness rates of the two groups for each lesson

By comparing with the CRS correctness rates of the two groups for each lesson, there also were seven times over the totally nine lessons that the average CRS correctness rate was higher in experimental group than in control group. In particular the overall average of experimental group was significantly greater than control group. That indicates the learning model with using Facebook discussion tool can enhance the effect of warm-up and hence the classroom learning performance.

4.3 Questionnaire and focus-group interview

The questionnaire items fed by experimental group were categorized into three dimensions of learning effect, the motivation, interaction, and sense of achievement (see Table 4). In the dimension of motivation, most respondents agreed the warm-up strategy with using Facebook discussion tool can increase their learning motivation, especially the attention in classroom.

Table 4. Results of the questionnaire*

Categories	Items	*M*	*SD*
Motivation	1.1: The warm-up strategy with using Facebook discussion tool increased my learning motivation in studying this course.	3.56	0.915
	1.2: The warm-up strategy with using Facebook discussion tool increased my attention while sitting in classroom.	3.78	0.773
	1.3: I was actively engaged in classroom learning because of the warm-up.	3.67	0.735
	Average:	3.67	
Interaction	2.1: The warm-up strategy with using Facebook discussion tool increased interaction between teacher and me.	3.92	0.877
	2.2: The warm-up strategy with using Facebook discussion tool increased interaction between classmates and me.	3.93	0.785
	2.3: I often discussed the learning content face to face with my classmates before class.	3.12	0.811
	2.4: Using CRS in classroom learning increased	4.03	0.748

	interaction between teacher and me.		
	2.5: Using CRS in classroom learning increased interaction between classmates and me.	4.05	0.660
	2.6: Group discussion facilitated the interaction between classmates and me.	4.24	0.572
	2.7: Group discussion facilitated the collaboration between classmates and me.	4.16	0.644
	Average:	3.92	
Sense of achievement	3.1: The warm-up strategy with using Facebook discussion tool improved my understanding of the content the teacher taught in classroom	3.81	0.682
	3.2: I often found questions and misconceptions about the learning content	3.75	0.779
	3.3: The warm-up with using Facebook discussion tool increased my learning effect in classroom.	3.76	0.916
	3.4: The warm-up with using Facebook discussion tool increased my confidence in taking this course.	3.44	0.876
	3.5: The warm-up with using Facebook discussion tool increased my sense of achievement.	3.39	0.831
	3.6: After the classroom learning, I had solved most problems that I asked for warm-up before class.	3.84	0.721
	3.7: Through the reviews and exercises on Facebook, I could link up the knowledge learnt before and after class.	3.67	0.711
	3.8: Through the reviews and exercises on Facebook, I could clarify my misconceptions of the lessons.	3.72	0.812
	Average:	3.76	

*Using the five-point Likert scale, in which 1=strongly disagree and 5=strongly agree.

In the dimension of interaction, most respondents gave high rating to the warm-up strategy with using Facebook discussion tool, the use of CRS in classroom learning, and group discussion. However, they rated relatively low score to the face-to-face discussion with classmates before class. This result may implicate the respondents do not have the habit of warm-up before class or preferred to study by themselves. From the focus-group interview, when asked how they chose questions to post on Facebook in warm-up, half interviewees expressed they stopped reading textbook when they had already found three questions, which was the minimum requirement the teacher asked for. That implies some students were passive to study by themselves. Posting warm-up questions and reply to the assignments may be only the perfunctory effort to deal with the learning tasks. One reason explained by two interviewees was that some chapters of the textbook were difficult for them to study by themselves. Therefore, the difficulty of learning materials and careful design of warm-up strategy could be the critical issues in the future.

In the dimension of sense of achievement, most respondents agreed not only the warm-up with using Facebook discussion tool increased their sense of achievement but also the review and exercises improved their understanding of the lessons and solved most problems found in warm-up. From the focus-group interview, most interviewees expressed they felt much sense of achievement since the Facebook discussion tool provided an opportunity for them learning from the articles posted by the outstanding classmates of their class. Furthermore, six interviewees believed that they were really affected by a good learning experienced from the warm-up of lessons.

5. Conclusion

In conclusion, the social networking site - Facebook - can effectively raise students' learning achievement, motivation, and interaction in adopting the modified WIRE model that consists of warm-up, review and exercise of classroom lessons. Facebook effectively inspired more discussions and more learning achievement after the long-term employment. This study also found students were passive in study by themselves and cannot bear the frustration when they encountered questions. The difficulty of learning materials and careful design of warm-up strategy could be the critical issues in the future research.

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References

[1] An, H, Shin, S. & Lim, K. (2009). The effects of different instructor facilitation approaches on students' interactions during asynchronous online discussions, *Computer & Education*, *53*, 759-760.

[2] Boyd, D. M. & Ellison, N. B. (2007). Social network sites: Definition history, and scholarship. *Journal of Computer-Mediated Communication*, *13*, 210-230.

[3] Cortright, R. N., Collins, H. L., & DiCarlo, S. E. (2005). Peer instruction enhanced meaningful learning: ability to solve novel problems. *Advanced Physiological Education*, *29*, 107-111.

[4] xxxxxxx (2009) xxxxxxxx<hidden for double blind review>xxxxxxxxxx.

[5] Kennedy, G., Dalgarno, B., Gray, K., Judd, T., Waycott, J., Bennet, S., Maton, K, Krause, K.-L., Bishop, A., Chang, R. & Churchward, A. (2007). The net generation are not big users of Web 2.0 technologies: Preliminary findings. Paper presented at the Proceedings Ascilite Singapore, Singapore.

[6] Mazur, E. (1997). *Peer Instruction: A user's manual*. NJ: Prentice-Hall.

[7] Murray, C. (2008). Schools and social networking: Fear or education? *Synergy*, *6*(1), 8-12.

[8] Novak, G. M., Patterson, E. T., Gavrin, A. D., & Christian, W. (1999). *Just-in-Time Teaching*. NJ: Prentice Hall.

[9] Prensky, M. (2001). Digital natives, digital immigrants. *On the Horizon*, *9*, 1-6. Retrieved 17 May 2010, from http://www.marcprensky.com/writing/Prensky - Digital Natives, Digital Immigrants - Part1.pdf

[10] Ajjan, H & Hartshorne, R. (2008). Investigating faculty decisions to adopt Web 2.0 technologies: Theory and empirical tests, *Internet and Higher Education*, *11*, 71-80.

[11] Dwyer, C., Hiltz, S. R., & Passerini, K. (2007). Trust and privacy concern within social networking sites: A comparison of Facebook and MySpace. Proceedings of AMCIS 2007, Keystone, CO. Retrieved May 21, 2010 from http://csis.pace.edu/~dwyer/research/DwyerAMCIS2007.pdf

[12] Ellison, N. B., Steinfield, C., & Lampe, C. (2007). The benefits of Facebook "friends": Social capital and college students' use of online social network sites. *Journal of Computer-Mediated Communication*, *12*, 1143−1168.

[13] Subrahmanyama, K., Reich, S. M., Waechter, N., & Espinoza, G. (2008). Online and offline social networks: Use of social networking sites by emerging adults, *Journal of Applied Developmental Psychology*, *29*, 420–433.

[14] Higher Education Research Institute. (2007). College freshmen and online social networking sites (HERI research brief). Retrieved May 21, 2010, from http://www.gseis.ucla.edu/heri/PDFs/pubs/briefs/brief-091107-SocialNetworking.pdf

[15] Lampe, C., Ellison, N., & Steinfield, C. (2007). A Face(book) in the crowd: Social searching vs. social browsing. *Proceedings of the SIGCHI conference on human factors in computing systems*. 434−444.

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Applying Social Media for Encouraging Mutual Support and Social Creativity

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Abstract: This study applied the features of social media to implement a picture book in facilitating the students collaborative creative activity. Based on Amabile's componential theory, this study evaluated the influences of social media in students' creativity behaviors. The results showed that the students were more active to present multi-thinking, as well as revealed higher significant satisfaction in the perceptions of the ownership of working and peers' mutual support. Moreover, the collaborative creative environment engaged the students in developing creative works.

Keywords: Social media, creativity, collaborative, mutual support

Introduction

In the knowledge economy era, cultivating students to learn in a manner of creativity is an important topic of contemporary education, in which creating and distributing information and knowledge is far more important than merely replicating the same thing [5]. Sawyer [12] indicated that nothing is more important than learning to think creatively for today's children, because the learning is came up with innovative solutions to the unexpected situations that will continually arise in their lives. Therefore, creativity and generating ideas are the core of contemporary economy, and nurturing students to innovative methods is very important in their learning process. However, in the knowledge society, creativity often occurs under the settings of complex organizational and collaborative environment. Many research studies revealed that creative ideas are more often the scheme of social interaction and influence than of periods of thinking in isolation [9] [10]. In particular, the individual's creativity is influenced by the social creativity because the groups and organizations were identified as sites of engagement in creativity [2] [17]. Madjar [8] suggested that the individual creative performance can be stimulated when peers represent any new information and knowledge, which in turn trigger new ideas and alternative solutions. In other words, by reflecting personal experiences, creating, and sharing ideas with others in the contexture of social environment could facilitates students' creativity. Based upon the importance of creativity for students and the impact of social environment in fostering students' creativity, it is essential to explore how a social context of the workplace in a way that will facilitate the beneficial influence of students' creativity and collaborative behaviors.

With the prevalence of Internet, it has accelerated the connection among people around the world for sharing information and knowledge. In particular, the social media on the World Wide Web has changed a variety of cultural forms among people's interaction [1], such as

Flickr and YouTube provide the stages in which sharing and distributing images and videos respectively. Because many of the adolescent activities involve in this type of social media can create a great deal of contents which are able to raise the social media in order to provide the opportunities in developing and showing creativity [4]. The feature of these social media is to allow participants to share their own works on the platform, and to work with other's contributions in order to connect and derive. Therefore, it enables students in collaborating, knowledge sharing, and customizing with significant opportunity for creating socially engaging tasks [14]. For the same reason, Shneiderman [13] suggested that the assistance of technology can support and promote the creativity. He further describes this creativity support tools are able to extend users' capability to make discoveries and inventions from early stages of gathering information, hypothesis generation, and initial production to the later stages of refinement, validation, and dissemination. This kind of creativity support tools broadens from the social media, such as Wiki and media sharing, that further enables thousands of individuals to develop and represent personal creative works collaboratively through remixing and integrating.

As social media is popular among adolescents and students, it is important to investigate that whether the social media can be a creative arena to cultivate and encourage students' creativity. Based on Amabile's componential theory [2], this study proposes a social media oriented platform, called Multimedia Picture Book which is designed for elementary students in order to support their collaborative creative activity.

1. Multimedia Picture Book

1.1 Collaborative Creative Platform

This study proposed and implemented a web 2.0-based collaborative creative platform, the Multimedia Picture Book, to encourage the creator involved in collaborative creating work. Regarding to the componential theory, the notion of the Multimedia Picture Book is to augment personal expertise with resources, promote social creativity with remix and derivation, and further enhance creativity motivation through contextual support. The purpose of this notion is to assist the creators shape the innovative ideas, as well as represent the diversity of creative works through the function of remixing and various choices of media resources. In addition, it is considered as the catalyst in encouraging social creativity via participants' interaction and collaboration. More detail illustrates as following.

1.2 Augmenting Personal Expertise with Peers and Online Resources

The Multimedia Picture Book furnishes with various resources to fulfill in developing participants' creative work. Since the resources of work environment is one of important factors to cultivate the children's creativity, the Multimedia Picture Book allowed the creator not only to express the idea by portraying with painting brush, text, and vocalizations narrative (Figure 1), but also to collect the online open resources into a picture book, such as free music and images - The Mutopia Project and Flickr, respectively (Figure 2). Meanwhile, all participants can contribute their creative works into the web repository and access other's contributions freely.

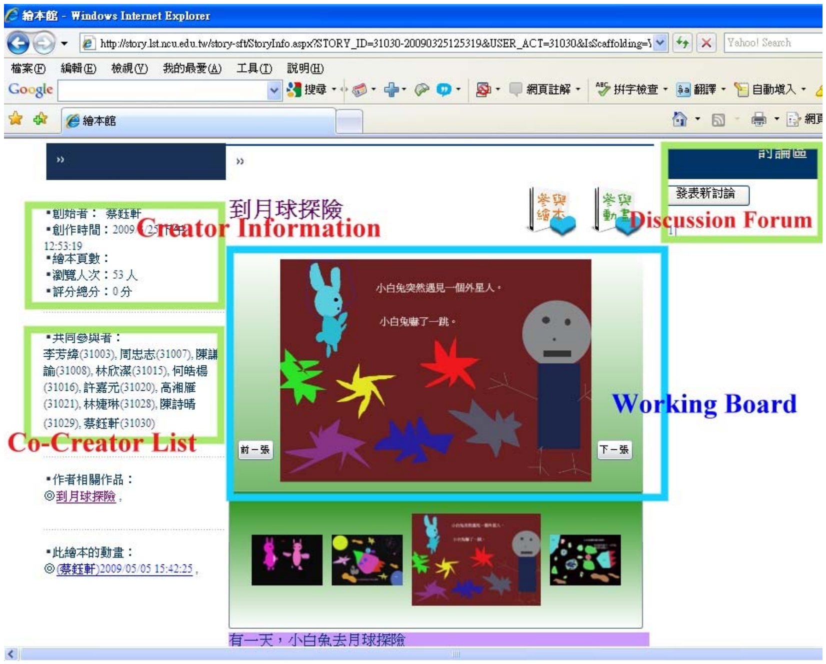

Figure 1. A sketched picture book

Figure 2. An image was inserted into a picture book from a open resource website: Flickr

1.3 Promoting creative thinking skills with deriving and remixing

Even with the support of various resources to cultivate the participants' creativity, the practice of working environment also is essential to carry out the creative activity. One considerable feature is the freedom or autonomy of works conduct. For this reason, the Multimedia Picture Book designed the mechanism of deriving and remixing. The remix function, which represents the process of generating new idea through deriving or combining existing idea [7], is a widespread tool on the Internet. The deriving function indicates that a shared work can be reproduced through a series of modification. Therefore, the participants in the Multimedia Picture Book can derive other's creative work to a new one. In addition, the co-creator list would accompany with the deriving work in order to recognize all contributors (the left block of Figure 1). Meanwhile, every participant may browse all works available in a storyboard, and combine one or more works to develop a new story plot by linking selected works (Figure 3). The process of deriving and remixing would be iterative in the collaborative duration of creative activity. In other words, participants can interpret and organize the representation of a work in their own way by orchestrating a shared pool of creative works. Contributors in such a mechanism may be more willing to help each other and engaging in the collaborative creative activities.

Figure 3. Participant created a new story plot by linking selected creative works

1.4 Enhancing Creativity Motivation Through Contextual Support

Maintaining the creativity motivation is the core of cultivating the creativity in work [2]. In addition, the contextual support is not only an important implication for team effectiveness, but also to facilitate the contextual awareness in group interaction and opportunity of linking with others [6]. For this reason, besides the aforementioned mechanism of attribution of co-creator list and creating work portfolio, the Multimedia Picture Book employed the chat room and discussion forum as synchronous and asynchronous communication ways in supporting creators' discussion and information exchanging to sustain the contextual support among creators' interaction. Therefore, the activity of derivation and remix would be apparent in the attribution of co-creator list and portfolio while the communications were available in mutual support. Consequentially, by deriving and remixing resources could provide the opportunities in creating new ideas and represent in a personal approach. Also, the Multimedia Picture Book intends to retain and further augment the participant's creativity motivation with supporting the interaction with each other in a trusting and mutual supportive way.

2. Methods

2.1 Participants and Storytelling Activity

The participants of this study consisted 57 third-grade elementary school students in Taiwan. Clarification of storytelling activity is one such important way in cultivating students to learn the concept of how to collaborate with others, and to foster one individual's creativity through the reflection by linking and exchanging personal experiences and ideas with others [3][15], this study conducts a collaborative storytelling activity through the Multimedia Picture Book to represent the creative story in various type of multimedia. When developing stories with peers in the Multimedia Picture Book, a four-week storytelling activity took place and each week took forty minutes. Within these four weeks, the participants will not only experience various remix behaviors, such as creating, contributing, sharing, deriving, and remixing creative works, but also inspire individual ideas through these remix behaviors and peers' interaction under the scheme of social media. At the same time, how the participants behave through the Multimedia Picture Book is screen captured for further analysis. Moreover, in order to understand the perception of participants towards the influence of creativity came from the collaborative storytelling activity, a questionnaire is administrated after the storytelling activity.

2.2 Data Collection and Analysis

The research data were collected from two approaches. One is the questionnaire was filled out by participants after the collaborative storytelling activity. This questionnaire was use to investigate the influence of social media, Multimedia Picture Book, which was designed to practice the componential theory. The questionnaire includes two aspects, which involved 10 closed statements of a five-point Likert scale. Each statement was reviewed by two primary school teachers. One of the teachers was the teacher of the participants. Therefore, the statements of the questionnaire are appropriately understandable for the participants. Before conducting the questionnaire, the teacher explained the meaning of every question. While reading questions and writing answers, the participants may also get immediate support if they had any problems. A total of 57 valid questionnaires were obtained. The reliability of the Perception of Mutual Support was 0.83 and the reliability of Satisfaction of Creative Activity was 0.72. The composite reliability of this 10-question instrument (alpha composite) was 0.87. These reliability values all reached the satisfaction and expectation of the study.

The other collected data is the screen capture of participants' operation processes in performing storytelling activity. These qualitative data were considered as the objective representation to validate the perceptions from questionnaire. In order to clarify the cause -effect relationship based on the participants' operation timeline, the data needed to be translated into explicit steps. This translating procedure was conducted by two reviewers who first translated the data independently and then discuss with each other and reached 90% agreement about the translation.

3. Results and Discussion

3.1 Perception of Mutual Support

The Perception of Mutual Support from the participants showed convergent opinion (Table 1). The questionnaire results showed high agree in the devotion of peers in collaborative creation (1^{st} item) and promoting the refinement of creation by mutual support (2^{nd} and 3^{rd} items). Note that the contribution and recognition of participating in the collaborative work reached the agree level (4^{th} and 5^{th} items). The researchers believe the interactions of participants in Multimedia Picture Book not only fulfill the ambiance of positive concurrence but also amplify the perception of self-consciousness.

The researchers inferred that Multimedia Picture Book can inspired participants' creativity and facilitated multiple expression approaches by deriving and remixing peers' creative works. With the support of Multimedia Picture Book, even the participants destroyed peers' creative works, the destruction would soon be recovered. For example, in one of the screen capture a student drew messy lines on other's work. However, after this student found his name has been listed as the co-creator of the story, he decided to undo the destructive behaviors right away. This implies that the features of the Multimedia Picture Book are helpful to reduce the edit wars on social media [16] which may reduce participants' willingness to contribute works and impede the social creativity.

Table 1. Mean value of Perception of Mutual Support

Item and description		Mean	SD
1.	My classmates were devoted to support my creation.	4.33	1.00
2.	With the supports from my classmates can enrich my creative work.	4.35	1.09
3.	Combining my classmates' contributions would enrich my creative work.	4.47	0.94
4.	I think I am one of the creators when my classmates and I create works collaboratively.	4.37	0.90
5.	I think my contributions are very important when my classmates and I create works collaboratively.	4.18	1.02

The qualitative data also revealed Multimedia Picture Book can promote the mutual support among participants, and only very few of them did not engage in creating. For instance, two of the participants utilized the discussion forum and derivation for mutual support. First of all, participant W derived participant G's creative work, and then left a message to G. When G saw the message, she browsed all of her works and found out W's contributions from the co-creator list. Then, G reviewed W's creative work and added new content to W's work to show her appreciation. These screen capture timeline showed the Multimedia Picture Book can stimulate the interaction among participants and encourage the mutual support by the contextual awareness, which supported through attribution of co-creator and message exchanging. Consequently, the participant could make decision by him/herself to accept or reject suggestion from peers and remix any resources of repository in Multimedia Picture Book.

3.2 Satisfaction of creative activity

Table 2. Mean value of Satisfaction of creative activity

Item and description		Mean	SD
1.	I think I benefited from creating works with my classmates.	4.53	0.76
2.	I feel happy when people appreciate our collaborative works.	4.61	0.75
3.	I like to work for a common goal with my classmates in Multimedia Picture Book.	4.53	0.80
4.	I am satisfied with the creations which were developed collaboratively by my classmates and I.	4.39	0.90
5.	I want to use Multimedia Picture Book to create work again with my classmates.	4.65	0.61

Table 2 shows the participants' perception of satisfaction of collaborative creative activity. All of those results showed the participants have positive impression of Multimedia Picture Book. Especially it can prompt the feeling of happiness when personal creations were appreciated by peers (2^{nd} item). In addition, the participants demonstrated higher intention of future usage in this kind of collaborative creativity platform (5^{th} item).Therefore, it is rational to predict the satisfaction of collaborative creative activity is correlated with the positive perception of mutual support (section 3.1). And, Multimedia Picture Book also promotes participants' engagement in achieving a common goal (3^{rd} item). The qualitative data also verified that once the participants found he/she can contribute ideas and works to the collaborative activity, he/she would devote more contributions in creating.
Rhodes [11] highlighted four essentials about creativity, such as the person, process, product, and place. Moreover, Amabile [2] precisely emphasized that maintaining own

creativity in work depends on maintaining personal own intrinsic motivation which should be synergistic with extrinsic motivation from work environment. In the Multimedia Picture Book, two key elements encourage the accrual of creativity. First, effective supports help to take shape the creativity and express multiple interpretations through the work environment which is equipped the mechanisms of derivation and remixing. Second, contextual supports from the work place could stimulate the interaction among peers and motivate them to produce more creative works.

4. Conclusion

This study set out with the intention of encouraging students' creativity by proposing a social media oriented platform, the Multimedia Picture Book. The qualitative and quantitative results indicated that this social media platform which was designed to fulfill the approach of Amabile's componential theory [2] can satisfied the user's creativity experience in motivation and interaction. According to the findings, this study asserted that the personal expertise can be augmented by furnishing with sufficient various types of resources for developing and concreting the innovative ideas. The creative thinking skill can be cultivated through the mechanism of derivation and remixing for arousing multiple interpretations and enriching the creative works. In addition, the Multimedia Picture Book represents a contextual support in peers' interaction and co-creator listing to motivate the users participated in creative activity. This framework of the Multimedia Picture Book demonstrates the approach between the Amabile's componential theory and the design of social media platform.

Within such an approach, the findings revealed that the derivation and remix stimulate the opportunity of collaboration and interaction between the participants for creating works. However, the recovery of destruction in this social media also emerged the importance in preventing inferior creative behavior. Additionally, this social media can augment the participants' positive concurrence and encourage their creativity by mutual support and recognition of contribution. The findings expressed a positive intention to use the Multimedia Picture Book and its features for more inspirations, richer representations, and more satisfactory artifacts in the collaborative creativity experience. The expected outcomes and participants' experience represented in this study also have revealed important research questions in creativity improvement and future research should focus on assessing students' creative thinking skills. Consequently, evolving research on the use of social media in promoting students' creativity can expand in the broader goals in the contemporary educational setting

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References

[1] Alexander, B. (2006). Web 2.0: A new wave of innovation for teaching and learning. *Learning, 41*(2), 32-44.
[2] Amabile, T. M. (1997). Motivating creativity in organizations: On doing what you love and loving what you do. *California Management Review, 40*(1), 39-58.
[3] Bruner, J. S. (1990). *Acts of meaning.* Harvard University PressHarvard Univ Pr.

[4] Bull, G., Thompson, A., Searson, M., Garofalo, J., Park, J., Young, C., & Lee, J. (2008). Connecting informal and formal learning: Experiences in the age of participatory media. *Contemporary Issues in Technology and Teacher Education*, *8*(2), 100-107.

[5] Drucker, P. F. (1994). *Post-capitalist society*. HarperCollins Publishers New York, NY, USA.

[6] Janz, B. D., Colquitt, J. A., & Noe, R. A. (1997). Knowledge Worker Team Effectiveness: The Role of Autonomy, Interdependence, Team Development, and Contextual Support Variables. *Personnel Psychology, 50*(4), 877-904.

[7] Knobel, M. & Lankshear, C. (2008). Remix: The art and craft of endless hybridization. *Journal of Adolescent & Adult Literacy*, 52(1), 22-33.

[8] Madjar, N. (2005). The contributions of different groups of individuals to employees' creativity. *Advances in Developing Human Resources*, *7*(2), 182-206.

[9] Osborn, A. F. (1963). *Applied imagination.* Scribner New York.

[10] Perry-Smith, J.E., & Shalley, C.E. (2003). The social side of creativity: A static and dynamic social network perspective. *The Academy of Management Review*, *28*(1), 89-106.

[11] Rhodes, M. (1961). An analysis of creativity. *Phi Delta Kappa*, 42, 305-310.

[12] Sawyer, R. K. (2006). Education for innovation. *Thinking Skills and Creativity, 1*(1), 41-48.

[13] Shneiderman, B. (2007). Creativity support tools: Accelerating discovery and innovation. *Communications of the ACM, 50*(12), 20-32.

[14] Sigala, M. (2007). Integrating web 2.0 in e-learning environments: A socio-technical approach. *International Journal of Knowledge and Learning*, *3*(6), 628-648.

[15] Turner, S. R. (1994). *The creative process: A computer model of storytelling and creativity*. Lawrence Erlbaum AssociatesL. Erlbaum.

[16] Viégas, F. B., Wattenberg, M. & Dave, K. (2004). Studying cooperation and conflict between authors with history flow visualizations. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (pp. 575-582).*Vienna, Austria.

[17] Watson, E. (2007). Who or What Creates? A Conceptual Framework for Social Creativity. *Human Resource Development Review*, *6*(4), 419-441.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

A Novel Approach for Assisting Teachers in Assessment of Student Reading Ability in web-based Learning Environment

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Abstract: Reading exercises are critical for developing strong reading comprehension. However, due to resource constraints and a lack of accurate evaluation methods, English instructors can hardly assess student reading ability effectively. In past decades, learning by reading is known to be challenging for both teachers and students involved, especially for students learning English as a Foreign Language (EFL). To cope with this problem, in this paper, we proposed a Tag-based assessment approach to both elicit reading behaviors from EFL learners and assist the teachers in tracing and evaluating the student reading ability effectively. The experimental results showed that the novel approach can not only find out the relations between learners' tags and their comprehension, but also help teachers to evaluate students' reading ability.

Keywords: Social tagging, Collaborative learning, Evaluation methodologies, Information retrieval

Introduction

For learners of English as a Foreign Language (EFL), accurate assessments of student literacy are critical to the success of language instruction, but unfortunately several studies have demonstrated that teachers, due to either a lack of administrative support or time constraints, are unable to assess student literacy effectively [5]. English language teachers rarely have enough time to properly teach reading comprehension, forcing students to rely predominantly on their own intuitions and perceptions when students attempt to understand the structure and concepts of instructional reading material. In some cases, this problem can lead to significant learning obstacles for students in the future.

Consequently, the challenges teachers face when assessing student reading ability levels, are not only limited to a lack of resources, training, or time, but also involve concerns with how assessment tests are conducted. To cope with these problems, we develop an on-line Tag-based Collaborative reading learning (TAC) system designed to aid teachers in accurately evaluating English reading ability.

The remainder of this paper is organized as follows. First, the paper outlines how this paper's social tagging system works to evaluate and score reading comprehension. It then describes how users interact with the TAC system website. Next, it presents our experimental design, reading comprehension results, and the survey feedback data from teacher and student participants. Finally, section five concludes, discusses potential problems with the interpretation of the paper's results, and proposes ideas for future research.

1. A Tag-based Reading Assessment Approach

The assessment approach proposed within this paper gives serious consideration to improving the ability of teachers to evaluate student reading comprehension skills. This section further explains how student tags are used to judge a student's progress in reading comprehension.

1.1 Data Preprocessing

Figure 1 illustrates how this preprocessing phase works, with particular emphasis on several preprocessing techniques for information retrieval, including Porter stemming, irregular verb return to base form, and stop word. Given the different types of input data contained with articles and article summaries, our preprocessing method generates a number of different types of input data for scoring function on different data sparseness processes and different text summarization algorithms.

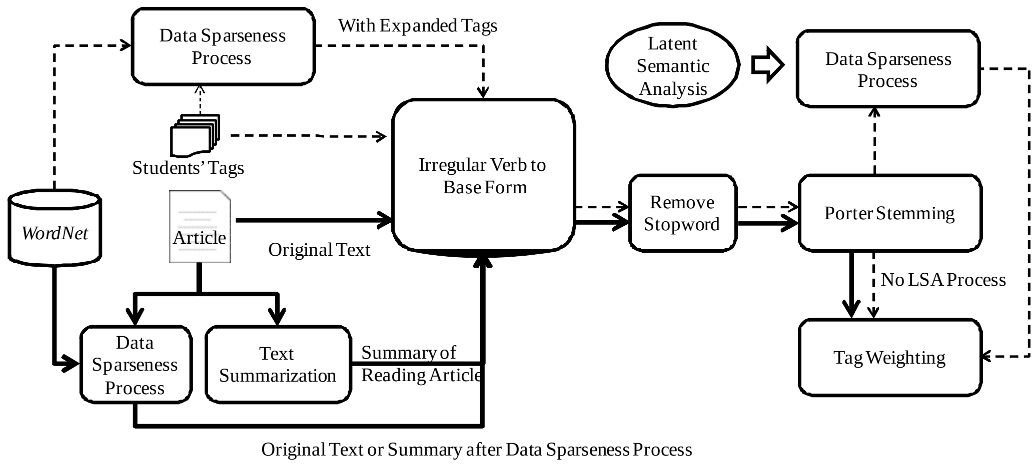

Figure 1: The Process of Student Tag and Article Preprocessing

First, the data sparseness problem is an important concern when implementing text-processing techniques, especially with data retrieved from the web. In order to diminish the impact of data sparseness, this study uses both the WordNet and Latent Semantic Analysis (LSA) methods. WordNet and Latent Semantic Analysis (LSA) also work to ensure the true meaning of the student's tag is successfully captured. Moreover, we apply two summarization algorithms to extract important terms and paragraphs from articles: Context Sensitive Frequency-based text summarization [4] and Latent Semantic Analysis-based text summarization [2]. These two methods of text summarization are sentence-based. Each extracts one sentence for each step in the algorithm process.

Weight calculator for the Article Terms and Student Tags

When weighting terms for articles, we use local weighting $L(i)$ for each term i within the article. This weight is based on the term's frequency, although two possible alternatives are also applied. The first of these alternatives is no weight, where $L(i) = tf(i)$, and the second is a logarithm weight, where $L(i) = \log(1+tf(i))$. In the case of more than one article, a global weight by factoring the frequency of each term and document length, $G(i)$ is applied to each term i, which is defined as follows:

$$G(i) = \log(N / n(i)) \cdot \frac{(k_1 + 1)tf(i)}{k_1((1-b) + b(L_d / L_{ave})) + tf(i)}$$

Where N is the total number of articles (documents), and $n(i)$ is the number of articles (documents) that contain term i; L_d is the article length; L_{ave} is the average article length for the whole collection; k_1 and b are represented as the term frequency scaling and the effect of article length normalization, respectively, these parameters are positive tuning parameters.
In the absence of such optimization, experiments have shown reasonable values are to set k_1 and b to a value between 2 and 0.75 [3]. After local and global weights are determined, the weight of each article term is finalized as $L(i) \times G(i)$. Initial student tags are weighted as $S(i) = 1$ for each student tag i. When tag i contains an expanded tag from WordNet, the synonym tag is $S(i) \times 0.5$, and the hypernym tag is $S(i) \times 0.3$.
In order to extract semantic relationships from terms and students' tags, the follow procedure was followed. First, a bi-graph was constructed to perform a spreading activation [1] to find all patterns of tags related to a set of article terms. Then, such patterns facilitate to construct semantic relationships, which would be used to draw semantic inferences from generated vector. After final tag activation vectors are generated, the tag weighting ratio was measured by the percentage of tag weight on specific tag, which is defined as

$$S(i) \times \; w_i / \sum_{j=1}^{m} w(j)$$

Where $W(j) = \{w_{i1}, w_{i2}, \ldots, w_{im} \mid w_i \in W(j)\}$ denotes the final activation vector of tag i, and w_{im} denotes the activation energy (weight) between tag i and tag m.

1.2 Scoring Function for Reading Comprehension

In this paper, the overall *Scoring Function* uses a conventional information retrieval method for weighting articles (documents) by their term frequency, and then computes the cosine similarity between the reading article and student tag vector.
This score can then serve as an important reference for evaluating student comprehension. Since the *Scoring Function* is based on the techniques of a vector space model and vector similarity, the result of the *Scoring Function* is a numerical value. Here, large values signify a strong reading comprehension score. It is important to note however, that in some cases, this value may not be an interval between 0 and 1. As stated previously, the *Scoring Function* is *Scores of Students* = $f(S_j, C_k,)$, where $S_j = \{s_{j1}, s_{j2}, \ldots, s_{jn}\}$ is a set of student tags, and $C_k = \{c_{k1}, c_{k2}, \ldots, c_{kn}\}$ is the different type of input elements related to the reading article.
As mentioned within the preprocessing section earlier, each element in S_j and C_k is a vector by its weight (the vector may or may not be a unit vector), where vector $s_1 = \{s_{11}, s_{12}, \ldots, s_{1n}\}$ implies that student s_1 has n tags, and vector $c_1 = \{c_{11}, c_{12}, \ldots, c_{1n}\}$ implies that the input content c_1 has n terms. The next step is to then perform the dot product calculation between these two vectors in order to calculate each student's individual score:

$$\textit{Score of one Student's Tags} = s_j \times c_k = \sum_{i=1}^{n} s_{ji} c_{ki}$$

2. A Tag-based Collaborative Reading Learning (TAC) System

Given the scoring methodology of our system outlined above, this section also covers the teacher interface designed to aid teachers in student assessment.

Figure 2 shows the teacher interface for browsing the portfolios of individual students, and provides an assessment of the student's learning status, recently tagged discussions, TACA score and tags related to discussions. The 'Learning Status' information reflects the reading status and tagging behavior of individual students, which helps teachers observe student thought processes, track changes in ideas to item tags over time, and create channels for social interaction.

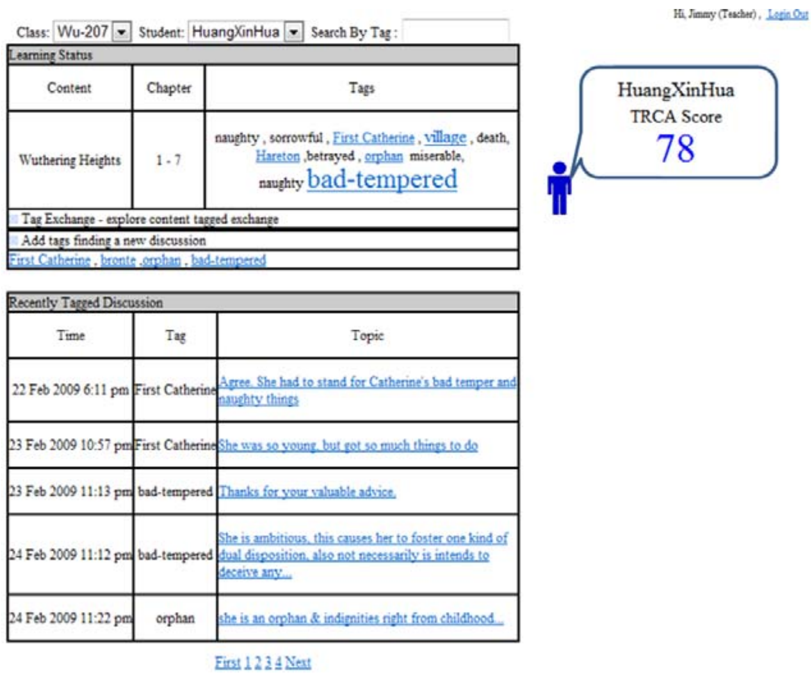

Figure 2: Interface of Tag-based Reading Comprehension Assessment

3. Experiment and Analysis

In order to thoroughly verify the relationship between reading comprehension and student data tagging, and in order to help teachers' judge student comprehension, this paper created an experimental test. First, test scores were obtained from the reading tests, and expert rating tag sets were obtained by evaluating tags that students used. This set of data represents the available variables for judging student comprehension. In our evaluation of this information, we calculated the Spearman Rank Correlation between the expert scores and the TACA scoring results of the student tags. For compiling the expert opinions of teachers, we employed a questionnaire based off of the Delphi method. In this method, researchers use multiple rounds of questionnaires to collect data until expert consensus of opinions emerges.

Table 1 depicts the scores from these experts, and their correlation with the results of the Scoring Function process. From the experimental results, it is clear that the preprocessing of tag sparseness significantly enhances the assessment of student performance. For example, the different preprocesses of student tags significantly increased the correlation value. This was verified using a 2-tailed t-test on performance between different methods that have a statistically significant difference. As the results show, "WordNet" is better than "LSA," but not significantly. However, if "WordNet" and "LSA" are combined, the results of this combination are significantly better than "WordNet" alone.

Table 1: The Spearman Rank Correlations between the Scoring Function and Expert Scoring

	Spearman Rank Correlation (Delphi – Five Experts)	Different types of data sparseness preprocessing for student tags			
		Original Tags	**Original Tags + WordNet**	**LSA Process**	**LSA + WordNet**
Input text for scoring function	Sum_{Human}	0.791**	0.829**	0.790**	0.848**
	Sum_{LSA}	0.660**	0.715**	0.730**	0.770**
	Sum_{CF}	0.712**	0.740**	0.745**	0.787**
	Students' Tag Set	0.610**	0.643**	0.670**	0.700**
	Expert's Tag Set	0.688**	0.714**	0.716**	0.755**
	All Reading Text	0.702**	0.730**	0.721**	0.775**

** $p < 0.01$

4. Conclusions

As stated throughout this paper, the primary goals of our TAC system are to help teachers gauge student progress and literacy. The experimental results described above strongly imply that our social tagging-based method accomplishes these goals. Currently, we are planning to extend TAC to contain more functions and options, such as additional avenues for brainstorming and in-depth discussions, which might be useful in analyzing the usage of those digital materials and the reading behaviors of students.

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References

[1] Chi, E. H. & Nairn, R. (2010). Information seeking with social signals: anatomy of a social tag-based exploratory search browser. *Intelligent User Inferfaces Conference Workshop on Social Recommender Systems*. (2)

[2] Gong, Y., & Liu, X. (2001). Generic text summarization using relevance measure and latent semantic analysis. Paper presented at the *Proceedings of the 24th annual international ACM SIGIR conference on Research and development in information retrieval*, New Orleans, Louisiana, United States. (4)

[3] Jones, K. S., Walker, S., & Robertson, S. E. (2000). A Probabilistic Model of Information Retrieval: Development and Comparative Experiments (parts 1 and 2). Information Processing and Management, 36(6):779-840. (6)

[4] Nenkova, A., Vanderwende, L., & McKeown, K. (2006). A compositional context sensitive multi-document summarizer: exploring the factors that influence summarization. Paper presented at the *Proceedings of the 29th annual international ACM SIGIR conference on Research and development in information retrieval*, Seattle, Washington, USA. (7)

[5] Wang, T. H, Wang, K. H. & Huang, S. C. (2008). Designing a Web-based assessment environment for improving pre-service teacher assessment literacy. *Computers and Education*, 51(1), 448-462. (8)

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Development of Class and Learning Materials Design Tool based on Instructional Design

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Abstract: We have proposed the class design and the learning materials development method by creating the "class outline" and "contents outline". The class outline is the design of the whole activities in the class and the "contents outline" focuses especially on the contents. In this paper, we define the class and learning materials design method as a systematic process by making the class outline and the contents outline, and we develop the support tool (COEdit) for this method.

Keywords: e-learning, learning materials, design, development, support tool, class outline, contents outline

Introduction

In a self-learning style course, it is very important to develop the learning materials so that learners can surely understand. To design such learning materials, instructional design (ID) concepts and systematic models are variable and helpful. When we develop the learning materials, we need to design not only the class activities following the ID models but also the detailed structures and contents of the learning materials. However, sometimes it is very hard and time consuming to develop learning materials strictly following the ID models.

We have reported that we have designed and developed the learning materials for Java programming course with student assistants' participation [1], and we have proposed the class design and the learning materials development method by creating the "contents outline" which focuses especially on the contents in addition to creating the "class outline" which is the design of the whole activities in the class.

We found that, by creating the contents outline, teachers could share a very detailed image of the learning material contents with assistants and estimate the amount of work for the contents development [2]. It means that the contents outline is useful and effective even if we develop the learning materials without extra staffs' participation.

In this study, we have developed the support tool for the class and learning materials design following our method. Before developing the tool, we have indicated the role of the class outline and the contents outline in our method. We have designed and developed the class and learning materials for a laboratory course using this tool.

1. Class design and learning materials development following the ID models

So much attention has been paid to ID as an e-Learning course design and learning materials development method. The systematic design models have been adopted especially for e-learning courses. In systematic models, such as ADDIE model, the output from the prior step is used as an input to the following step. Dick and Carey's model is a famous systematic model which contains feedbacks from the formative evaluation step [3].

Nakai et al. have described the nine step model [4]. Their procedures are systematic and fitted for the class design at the universities. Among the ID models, the systematic procedures for learning materials development have not been described in detail because the less experienced staffs' participation in the learning materials development would not be assumed. We are going to define the learning materials design and development method as a systematic process in the next chapter.

2. Class design and learning materials development process including preparation of "class outline" and "contents outline"

2.1 Whole flow of learning material development

A large part of our class design process depends on the reference [4]. We have taken ID concept into consideration when we design our learning material development process. A whole flow of the learning material development is as follows.

(1) Analyze and design the entire course
The entire course is analyzed and designed in this stage, and then the objectives of the course are allocated to each class.

(2) Design each class
Each class is designed in detail. Activities in each class are also designed in this stage. The class outline is made by bringing these together.

(3) Design learning materials
The details of the learning material contents are designed based on the class outline. The contents outline is made in this stage.

(4) Develop learning materials
The learning material contents are made according to the contents outline.

(5) Implement learning materials
The learning material contents are converted into Web pages, and presented on the CMS.

(6) Evaluate learning materials
The learning materials are evaluated and revised after they had been made or they had been used in the course.

We have developed the class outline and the contents outline in stage *(2)* and *(3)*. The details of a class outline and a contents outline are mentioned below.

2.2 Class outline

The class outline is design of each class, which is edited focusing on learning activities. The composition of the class outline is shown in Figure 1.
In a class outline, we design a composition and a flow of the whole class which also includes learners' activities. Therefore the contents of the class outline are not necessarily equivalent

to the contents that should be put in the learning materials, and it may contain some information which is not directly related to learning materials development.

- Objectives of the class
- Test items of the class
- List of the items that should be explained to achieve the objectives
- A flow of the module
  - Introduction
  - Contents of the learning material
  - Learner's activities
  - Test items of the class
  - Progressive studies

Figure 1. Composition of the class outline

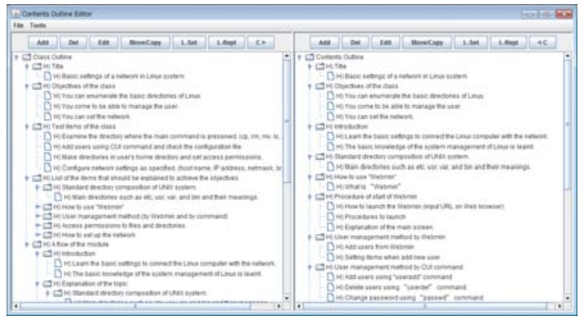

Figure 2. Main screen of the class and learning materials design tool.

2.3 Contents outline

In contrast to the class outline which is written focusing on a composition and a flow of a whole class, the contents outline is written focusing on the structure of the pages of the learning materials. A flow of the developing learning materials based on the class outline is as follows.

1. Design the composition and the flow of learning materials in the whole class.
2. Determine the structure of the pages of learning materials according to the composition and a flow designed above.
3. Develop the explanations and the assessments, etc. on each page.

The item 1 and 2 mentioned above is designed in making a contents outline. We write the structure and elements which should be explained in the learning materials as in detail as possible, such as what sorts of thing are included and how to explain these elements.
The contents outline has been developed when we asked some high-achieving students to participate in the learning materials development as assistants. The contents and the composition of each page of the learning materials are clarified by introducing the contents outline. It will reduce the part that the student assistants need to design by their own thoughts. However, we think that the contents outline is effective even when student assistants do not participate in learning materials development.

3. Development of a support tool for class and teaching materials design

Following the process defined in Chapter 2, you can design a class and develop learning materials systematically by making the class outline and the contents outline. However, you have to work by making or referring the different outlines in each step. If you can work step by step obeying appropriate instructions or you can edit these outlines together, you will be able to work more effectively.
There is an evaluation process in the ID model. It is performed when learning materials have been completed or the teaching practice using the learning materials has been finished. Because we use two outlines when we design class and learning materials, it is troublesome

to correct them when we evaluate and revise the class activities and the learning materials. If the outlines are not properly maintained, it will be difficult to evaluate and revise them. To solve these problems, we have developed the support tool, which can be used when you design class and learning materials following the process defined in Chapter 2. We call this tool "Class / Contents Outline Editor (COEdit)". The following functions are required for COEdit.

- The class outline and the contents outline are displayed at the same time.
- These outlines are displayed by the tree form so that the levels of headings are clearly shown.
- It has the wizard tool to support the class outline and material design following the procedure.
- The items can be edited by using add, delete, modify and copy functions.
- It can save and read the outline data written in Microsoft Word document format.
- The related items are linked so that they can be edited together.

COEdit was developed using Java Swing. The main screen of the tool is shown in Figure 2.

4. Practices of the class and learning materials design using the tool

We have designed the class activities and the learning materials of the "Laboratory on Information Science 3". This course is set for third year students in the distance learning course in the information and computer science department. The class outline is written following the instructions provided by the wizard tool. Some items in "a flow of the module" step were copied from the former steps. Many items in the contents outline were copied from the class outline. The bookmark function in Microsoft Word is used for the link between items in COEdit. The bookmarks are set automatically when new items are added, and the bookmarks are kept when the items are copied. Hence we do not need to set the bookmarks again. Therefore we could work efficiently by using COEdit.

5. Discussion

We have defined the class and learning materials design method as a systematic process. It is recommended to follow the process when you write the class outline because this process is based on the ID theories. However, we think that it is not always necessary to write the contents outline. The contents outline will be necessary when we develop the learning materials with less experienced staffs' participation. For instance, we need to ask them to participate in a large-scale development of learning materials. In such cases, the contents outline will be necessary. We have developed the contents outline when we asked student assistants to participate in the learning materials development for Java programming courses, in which we needed to prepare four 15-class courses [1].
Because there were only 7 classes which use web based learning materials in Laboratory on Information Science 3, one teacher in charge made the whole learning materials. In that case, the learning materials have been developed in Microsoft Word after the contents outline has been made using COEdit. If the learning materials development is small-scale so that the teacher can work alone, the teacher who has enough experience and skills might be able to develop them based on the class outline without making the contents outline. However, when we design the details of the learning materials by making the contents

outline, we sometimes review and revise them. It seems that the contents outline also has a role that designers can evaluate and review their work.
Jung et al. are aiming at the following by prototyping [5].

(1) Imagine and discuss various sides of the learning materials design.
(2) Clarify the idea and physical properties of the class.
(3) Take early feedback from the learners.

It seems that our aims to make the contents outline are similar to (1) and (2). Needless to say, you cannot use the contents outline to conduct the evaluations to obtain feedbacks from learners.
We have implemented the class design wizard and the function to edit these outlines together by linking related items in COEdit. We think that the wizard function is useful when we write the items in “Objectives of the class”, “Test items of the class” and “List of the items that should be explained to achieve the objectives”. On the other hand, we need to improve the wizard interface for “A flow of the module”. Because “a flow of the module” step is divided into more detailed steps, these steps should be included in the wizard.
Moreover, it is hoped that COEdit will be able to support the analysis and the design phase for the entire course, and can manage all the data for the course design. These points will be our future works.

6. Conclusion

In this study, we have defined the class and learning materials design method as a systematic process by making the class outline and the contents outline. We have developed the class and learning materials design tool (COEdit) which has the class design wizard and the functions to edit these outlines together by linking related items. COEdit seems to be very useful when we design class and learning materials following the proposed process.

Acknowledgements

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References

[1] Sasaki,S.,Arai,M.,Furukawa,F. and Watanabe,H. (2008) Web-based Learning Material Development with Less Experienced Staffs' Participation, Proc. of International Conference on Computers in Education 2008 (ICCE 2008), 445-449
[2] Sasaki,S.,Arai,M.,Furukawa,F., Watanabe,H. and Takei, S. (2008) Web-based Learning Material Development with Student Assistants' Participation, Proceedings of research meeting for information in education in 2007, C1-4, 174-177
[3] Dick,W., Carey,L. and Carey,J.O. (2001) Systematic Design of Instruction (5th ed.), Addison-Wesley Educational Publishers Inc.
[4] Nakai,T., Yamasato,T., Nakajima,H. and Okada,T. (2003) e-Learning Handbook, Manahouse, Japan.
[5] Jung, I., Kubota, K. and Suzuki, K. (2008) Instructional Design by the OPTIMAL Model – Effective Method for Blended Type e-Learning, Tokyo Denki University Press.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Lecture Video and Scene-related Knowledge Sharing Common Platform Design and its Prototyping

-A Practical Example of Learner-centric Open Video Content Service-

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Abstract: Open Course Ware (OCW) was first adopted by universities to release text-based lecture notes, and lecture videos are a recent addition. We have designed Web site which can be shared among OCW member universities without their own facility for sharing lecture video and lecture-scene-related-knowledge. We initially propose the ‘Social Curator Collaboration Model’ which creates an environment that general public user other than course lecturer can participate as learning assistant to reply to other learner’s questions or opinions. We also propose Web-API function mash-up architectural design to realize OCW common platform. We have evaluated the functionality of our proposed model by prototyping the infrastructure and challenged it with real OCW lecture video.

Keywords: video sharing, knowledge sharing, open courseware

Introduction

Online video learning is flourishing due to the explosion of high-speed Internet access. 23 Japanese universities have joined JOCW, a consortium of OCW-related organizations in Japan, and begun OCW activities. Most launched OCW-site with text based lecture notes at first, but have begun to publish lecture videos. We have opened a Web site which can be shared among universities without their own facility for distribution of lecture video [1].
Public opinion poll concerning JOCW activities has been conducted in the form of the Internet research annually since 2006. They show more than 80% of the respondents want to use OCW materials for their own learning and 80% of people would like to watch lecture videos and exchange opinion among users regarding lectures [2].
Lecture video distribution and opinion exchange are so expensive to implement that a common OCW platform is essential. Down-to-earth gathering of lecture video viewer’s feedback and resulting collective-intelligence on the common platform shall improve learner’s better understanding. Lecture video and its scene-related- knowledge sharing in the learner-centric usage scenario rather than simply distributing content shall be realized.
In this paper we initially propose the ‘Social Curator Collaboration Model’ which allows public users to participate as learning assistants by replying to other learner’s questions or comments. To realize the OCW common platform, we introduce a Web-API function mash-up architectural design. In this paper OCW common platform design methodology and experimental Web site prototyping as well as functional evaluation through real OCW lecture video content are described.

1. Learner-centric Common Platform Design for Open Content Sharing

1.1 Challenge in learning via open environment

Unlike closed environments such as formal classrooms, open environments for self-learning have great difficulty in motivating general public users. Thus it is necessary to provide functions such as teaching assistance or opinion exchange. On the other hand OCW consortium members are unable to provide follow-up support because it is an open and free publication of formal university course. An interesting tactic is to create an environment that allows the general public to collaborate and support each other. Existing comment sharing facilities allow users to conduct detailed discussions, however, actively discussed or not are uncertain under the circumstance that who replies and when replies are unknown. In this meaning learner-centric workflow fitted to OCW activities is unclear.

1.2 Usage Scenario

We propose ‘Social Curator Collaboration Model’ and typical usage scenario is shown in Figure 1. Original lecture video content is uploaded to OCW portal site. General public users freely review any lecture video contents on the site at any time without membership subscription. Subscribed users (hereafter learners) can post lecture-related questions on the bulletin board. A learner who can support other learner (hereafter social curator) is allowed to answer for the questions. Questions and answers are accumulated so that other learners might discover recent Q&A activities. Workflows are realized by both OCW member university’s voluntary work and general public’s collaborative work.

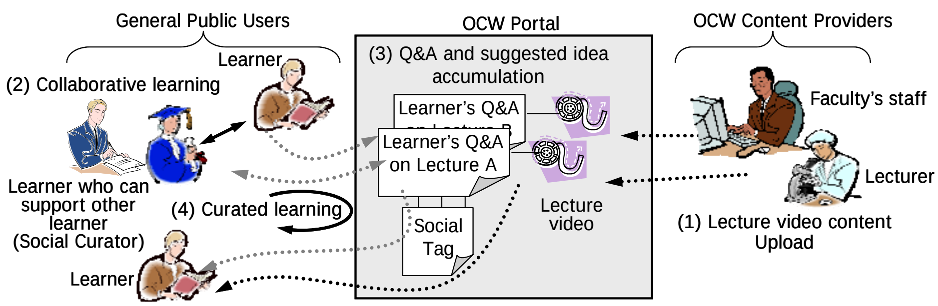


Figure 1 Usage scenario of ‘Social Curator Collaboration Model’

1.3 Minimum Requirements

The common platform must satisfy the following requirements:
Lecture video content shall be uploaded and published among general users by lecturer or faculty’s staff.
Learners can discover and review their favorite lecture video.
Learners can put and share comments such as Q&A, suggested ideas, or opinions linked to its original lecture video.
Learners are able to find lecture video with Q&A(s).

2. Prototype Implementation

2.1 OCW Common Platform Implementation

MIT and other OCW member universities already have their own YouTube-based facilities. As a video content distribution only infrastructure, YouTube is thought to be one of the best

solutions from the viewpoint of acquiring a specific reputation. In contrast, we focused on the concept of incrementally enhancing the effectiveness lecture videos through the collection and publication of lecture related-comments such as Q&A or suggested idea with less increase of university's faculty stuff's voluntary work.
As described in 1, workflow design for 'Social Curator Collaboration Model' remains unfixed so the infrastructure must be flexible enough to develop in a trial and error manner. Unlike previous research [3], we create our common platform by using the Web-API function mash-up of a video sharing site and a bulletin board, ClipLife [4] and SceneKnowledge [5], respectively, as shown in Figure 2. ClipLife provide resource exhausting video sharing functions such as video content storage, video-format conversion, and video streaming. ClipLife and SceneKnowledge provide Web-API functions so that common platform has been implemented on OCW Web portal sub domain and management workflow and operational rules fitted to educational purposes can be designed in a simple manner. Only very small applets that use HTTP/JSON WEB-API calling procedures are needed to access lecture video content sharing functions including video format conversion and data store for video streaming function provided.

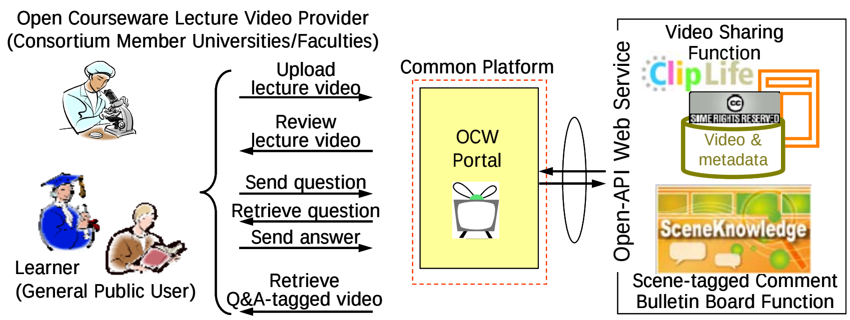
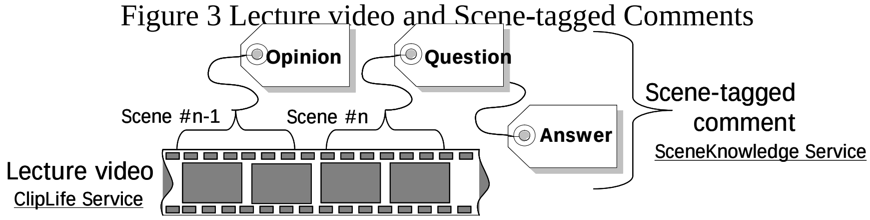


Figure 2 Common Platform Implementation based on Web-API service mash-ups

2.2 Functional Implementation

By using ClipLife video sharing service, member universities can upload up to 500M bytes lecture video of widely available video format at any time without their own video distribution facilities such as storage and video streaming. ClipLife provides a function to set the by-nc-sa (Non-Commercial-Share- Alike) Creative Commons License condition [6] which allows learners to download original lecture video content and view it off-line.
SceneKnowledge bulletin board service handles 'Scene-tagged comment' as shown in Figure 3 and provides a user-friendly Web interface to annotate lecture videos, post scene-tagged comment and share among the pre-defined members. Its Web interface appearance is shown in Figure 4. SceneKnowledge was used to evaluate over the lecture video on the closed user group (i.e. registered students for each course lecture) [7], however, this is the first trial to evaluate its ability to gather lecture-scene-related comments on open environment. Currently, lecturer can choose or change the status of bulletin board publication for each lecture video; if scene-tagged comments are not desired, only the video sharing function is active.

Figure 3 Lecture video and Scene-tagged Comments



2.3 Learner-collaboration Workflow prototyping

Our initial implementation of trial workflows is listed below.

1. List of available bulletin boards linked to lecture videos can be checked.
2. Learners post scene-tagged questions and social curators retrieve scene-tagged comments with ease and reply to each. Status of questions replies can be checked.
3. List of accumulated Q&A and their review frequency can be checked.

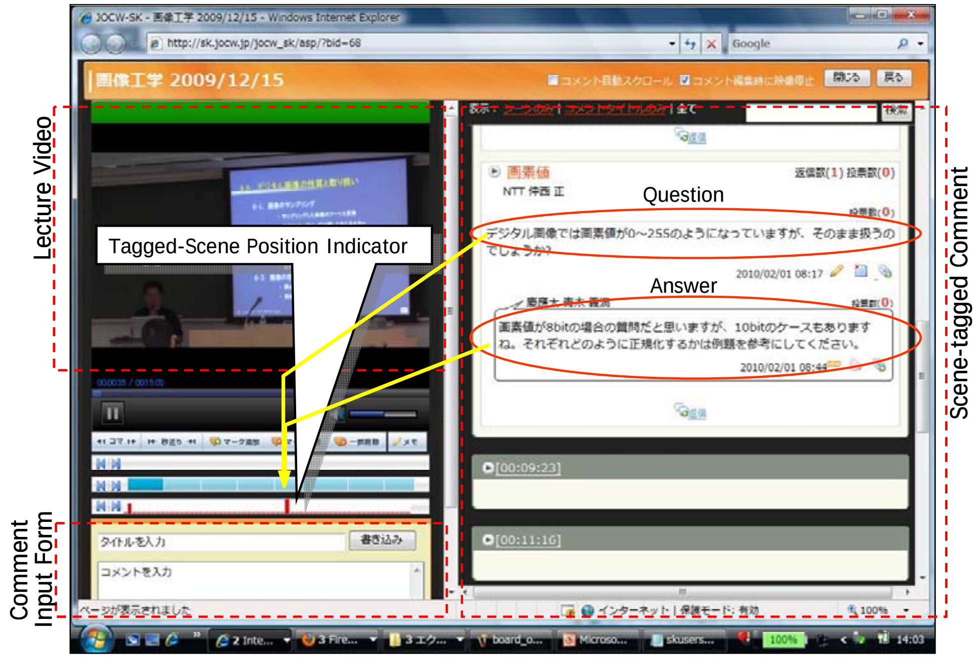


Figure 4 WEB Interface of SceneKnowledge Bulletin Board

The Scene-tagged comments enables users to exchange detailed or specific discussions, however, it is difficult for other users to discover these exchanges. Our solution is to realize typical Q&A routine among learners (denoted as ‘Quick Q&A Turnaround Workflow’). Each time a learner visits the OCW portal site, a list of recent initial scene-tagged comments can be displayed with one click linking to directly review the comment of interest. This function reduces the delay until a response is posted, which will encourage learners to keep asking questions.

3. Functional Evaluation

3.1 Video sharing facility evaluation

Video sharing workflow has been implemented and a total of 111 lecture videos from Kagawa Nutrition University, Keio University, and Meiji University were uploaded and made available via the Internet. Each video has been encoded at 768kbps Flash Video (H.264 Codec), which is nearly equivalent to the quality of YouTube’s standard definition (SD) mode. Average time required to upload each lecture video is approximately 6.2min, much faster than its production. The bottleneck is the manual editing of lecture videos before uploading. An automated approach to postproduction editing will ease this bottleneck [8].

3.2 Scene-tagged comment sharing facility evaluation

Four persons with SceneKnowledge bulletin board experience evaluated scene-tagged comment sharing facilities. Eight of 39 lecture videos were scene-tagged with comments and shared. Typical access time from ‘choosing one of recent Q&A by clicking hyperlink’ to ‘start reviewing tagged-Q&A with original lecture video’ is 5sec. We functionally confirmed the ‘Quick Q&A Turnaround Workflow’ as shown in Figure 5.

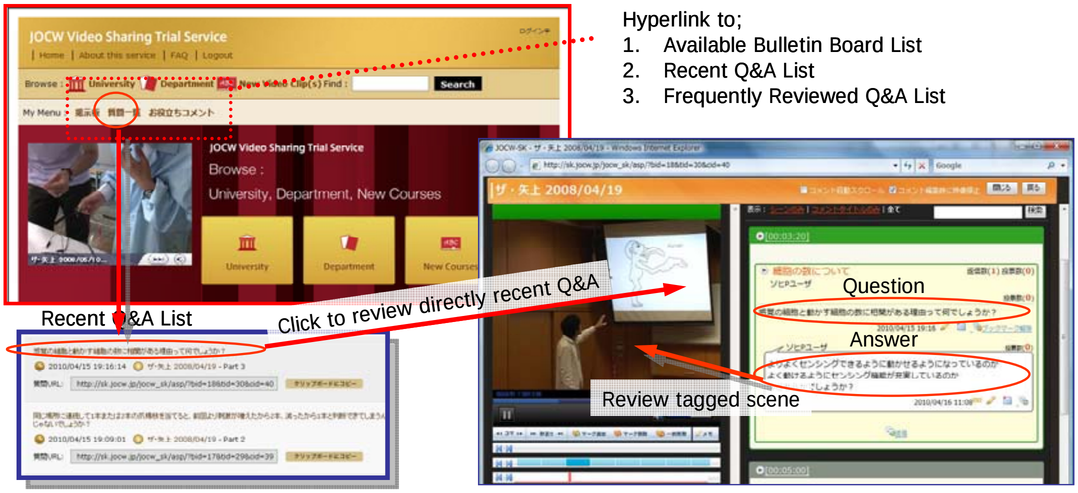


Figure 5 ‘Quick Q&A Turnaround Workflow’ utilizing Web-API functions

4. Conclusion

In this paper we proposed the design methodologies for an open content sharing portal service which can be shared among OCW member universities without their own facility for lecture video and lecture-scene-related-knowledge sharing.

We initially propose the ‘Social Curator Collaboration Model’ which allows learners to assist each other and prototyped OCW common platform by a combination of video sharing service and bulletin board scene-tagging service. We implemented ‘Quick Q&A Turnaround Workflow’ as a typical Q&A routine among learners and evaluated its functionality by challenging it with real OCW lecture video. Proposed Web-API mash-up method was confirmed effective for trial and improvement style workflow design. We will qualitatively evaluate trial workflow under open environment in the near future and refine it utilizing Web-API function mash-up methodologies.

References

[1] Nakanishi, T., Fukuhara, Y., Open Course Ware Video Content Sharing Service Prototyping, IEICEJ Tech. Report, Vol.108, ET2008, pp.129--134(in Japanese).

[2] Fukuhara, Y., Current status of OCW in Japan, Proc. of APRU 9th Distance Learning and the Internet Conference 2008, 19-22, November 2008, pp.221-223.

[3] Brusilovsky, B., Developing Adaptive Educational Hypermedia System. In Murray, T., Blessing, S., & Ainsworth, S. (Eds.), Authoring Tools for Advanced Technology Learning Environments, pp. 337--409, Dordrecht, Kluwer Academic Publishers.

[4] goo ClipLife, URL:http://cliplife.goo.ne.jp/api

[5] Teranaka, S., Azuma, S., Shimada, S., Kojima, A., Majima, Y., Field Experiments in Nursing to Evaluate the Knowledge Sharing System using Videos, Proc. of IEIEC Conference, D-15-21, pp.199, 2009-03-04.

[6] Creative Commons, URL: http://creativecommons.com/about/, 2007(in Japanese).

[7] Majima, Y., et.al., A Study of Nurses’ Communication State by Movie Sharing System using Nursing Skill Videos, In Proc. of JSiSE Conference, 2009, pp.468--469, (in Japanese).

[8] Nakanishi, T., Shimada, S., & Fukuhara, Y. Automated Post-production of Learning-friendly OCW Video Content, Proc. of 1st Asia Regional OCW Conference, 2009, URL: http://ocw.korea.edu/ocw/center-for-teaching-and-learning/the-1st-asia-regional-ocw-conference-2009/

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A Technique for Error Awareness in Pencil Drawing

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Abstract: Training in realistic drawing is a basic technique of art education. Even though a novice artist may feel something is wrong in his or her sketch, the novice often cannot explain what the errors are. It is typical for a drawing teacher to try to advise a student about errors during drawing training by using analogical explanation. Analogical explanation provides the learner with an image of a solid that reflects his or her errors. However, the significance or merit of this kind of explanation is not well understood, even though the importance of learning by error is well known in practical education conditions. This paper describes a technique for error awareness in pencil drawing. The technique involves the creation of a three-dimensional model that reflects the learner's errors as acquired from a scanned digital image of the learner's pencil drawing.

Keywords: Learning by errors, error awareness, error-based simulation, pencil drawing

Introduction

Realistic drawing, that is, drawing things as they are seen, is fundamental to art education. Students must train not only their hands but also their eyes [4]. Repeated training in pencil drawing is a typical pedagogical technique. To master realistic drawing requires a great deal of discipline.

During such training, most novices cannot recognize the errors in their sketches, even though they may sense that something is wrong. They often cannot improve their sketches and are not able to explain which parts of the drawing are in error. A drawing tutor will not only correct a drawing, but will also explain the reasons why a student's drawing needs correction. This kind of tutor's advice can be thought of as a "scaffold" [3] for the learner to deeply understand the source of the error.

We interviewed a drawing instructor and found that a tutor's advice regarding errors can be categorized into the following 3 classes [2]. (A) Explanation of the location of an error in a sketch. This type of explanation points out the learner's errors in a sketch. (B) Explanation about how to correct a drawing. This type of explanation shows a learner how to correct a sketch. (C) Analogical explanation of the errors in a sketch; for example, "The dish in your drawing looks like a rugby ball." This type of explanation gives the learner a solid image reflecting their errors.

Novices often fail to improve upon their errors through if only type (A) and (B) advice is offered because they do not understand their errors. In such cases, a tutor's type (C) advice is regarded to be more effective [1]. Figure 1 shows the mechanism of analogical explanation (type (C) advice). Differences between the novice's sketch and the tutor's sketch are unclear to the learner. However, differences between the subject of a drawing and an erroneous object that reflects the leaner's errors are obvious to the learner. To generate an analogical explanation, just preparing a correct answer is not sufficient; the explanation needs to be generated from the learner's errors. This mechanism is the same as the Error Visualization of Hirashima.

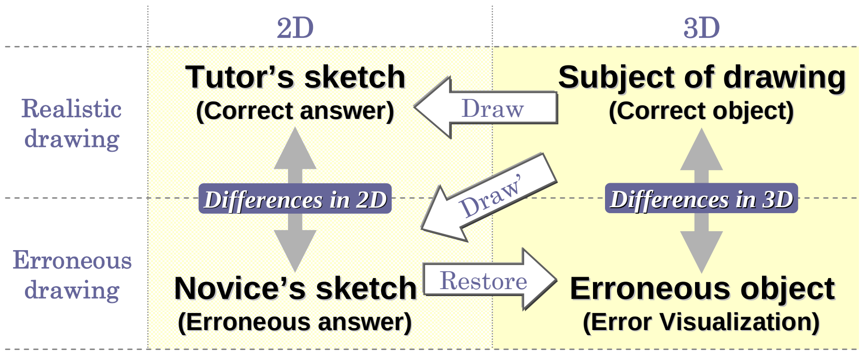
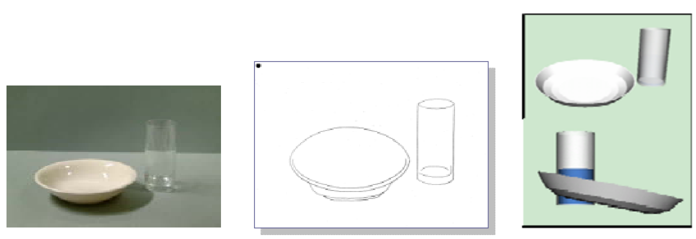


Fig. 1 A tutor's analogical advice provides a learner with an erroneous solid object image that reflects the learner's errors.

This paper describes an attempt to visualize errors by using a three-dimensional model of a novice's two-dimensional pencil drawing. In pencil drawing, plates, mugs, apples, and flowers are typical drawing subjects. These are called motifs because they include geometries that students need to learn, and they are easy to prepare. Our error visualization already contains standard 3D models of typical motifs that are used to generate erroneous 3D models. An erroneous 3D model is generated by a scale transformation of the standard 3D model.

For example, Figure 2 shows the motif, novice's sketch, and error visualization. The dish was drawn as if the novice had looked down upon it from a higher position. The error visualization shows the dish floating and inclined as if the novice were seeing it from the side.



Subject of drawing *Novice's sketch* *Error-Viz*

Fig. 2 Error visualization from a novice's sketch.

We developed an application called Error-Viz for use in realistic pencil drawing training. To use Error-Viz, a tutor chooses the motif from among standard 3D models. Then the tutor inputs the size of the drawing's subject and a parameter indicating the viewpoint of the student. Error-Viz makes a 3D model and a 2D image of the motif. After the novice completes the drawing, it is scanned or photographed. Error-Viz obtains feature parameters from the novice's sketch and makes an erroneous 3D model.

1. Errors in Realistic Drawing

In order to document a learner's errors, we observed a pencil drawing class for a period of 5 days [2]. The tutor of the class provided 677 suggestions regarding their sketches to 19 students. The following were the 8 most frequently cited errors:

(**E1**) **Too high drawing position of a dish:** In comparison with the glass, the oval shape of the top of a dish is drawn too wide for the learner's viewpoint.
(**E2**) **Wrong dish size:** A dish is drawn too large compared with the size of a glass.
(**E3**) **Wrong glass width:** A glass is drawn too thick compared with the width of a dish.
(**E4**) **Wrong relationship between cross sections of a glass:** The cross sections at different heights of a glass should be different.
(**E5**) **Wrong glass width:** A glass is drawn with an imbalanced width. It should be uniform.
(**E6**) **Wrong breadth of the brim of a dish:** The breadth of a dish brim is drawn unnaturally.
(**E7**) **Wrong inclination of a glass:** A glass drawn is inclining.
(**E8**) **Wrong dish depth:** The depth of a dish is drawn unnaturally compared with the width of the dish.

2. Technique of Error Visualization

This section describes the procedure of error visualization; an overview is shown in Figure 3.

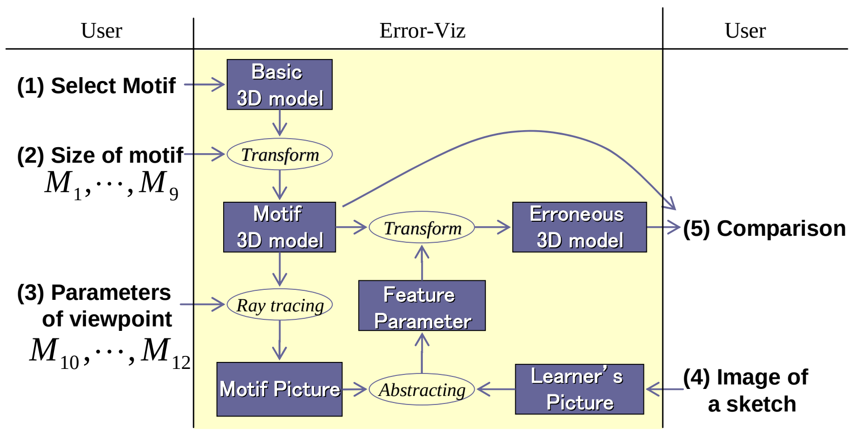


Fig. 3 Overview of error visualization.

2.1 Constructing the 3D Model and Picture of the Motif

The basic models are distinguished by some feature parameters independent of scale. To transform a basic model into a 3D model of the motif the tutor selected, the tutor measures the parameters $M_1, M_2, \cdots, M_{12}$ of the motif, where $M_1, \cdots, M_6$ are for the dish 3D model (Fig.4); M_7 and M_8 are the diameter and height of the glass, respectively; and $M_9, \cdots, M_{12}$ are the distances between a learner and the objects in the motif (Fig.5).

If position vector **S** is the basic model and matrix **R** is the scale-transformation with parameters $M_1, M_2, \cdots, M_{12}$, the motif 3D model **P** is

$$\mathbf{P} = k_{3D}\,\mathbf{R}\,\mathbf{S},$$

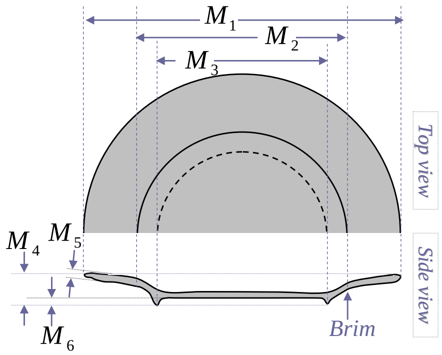


Fig. 4 Parameters of the dish 3D model.

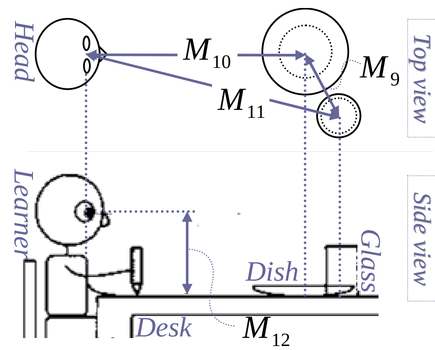


Fig. 5 Distances between a learner and objects in the motif.

where k_{3D} is a ratio used to convert the size of the motif to the 3D model. The tutor controls k_{3D} to adjust the size of the model appearing in a display.

A ray-tracing application generates a picture of the motif-model **P** as viewed from the learner's perspective.

2.2 Feature Parameters

The typical errors (E1)-(E8) are distinguished by some feature parameters. To convert the motif-model into the learner's erroneous model, the feature parameters are obtained by analyzing pictures of the motif and the learner's sketch. For example, a dish and glass motif requires feature parameters $F_1, F_2, \cdots, F_{15}$ as shown in Figure 6.

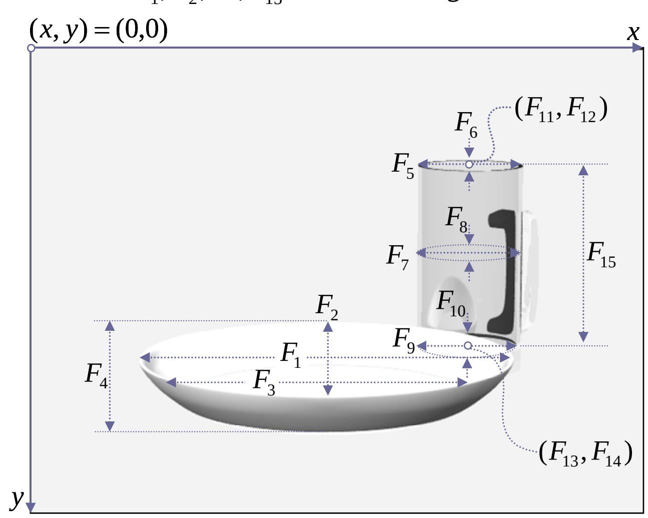


Fig. 6 Feature parameters of a picture of the subject of a drawing.

2.3 Extracting Feature Parameters

Feature parameters are obtained by thinning and binalization of a picture. The feature parameters $F_1, F_2, \cdots, F_{15}$ are analyzed from a picture of the motif. The feature parameters $F'_1, F'_2, \cdots, F'_{15}$ are analyzed from a picture of the learner's sketch.

2.4 Constructing the Erroneous 3D model

The erroneous 3D model is constructed by reflecting the feature parameters F' onto the motif model $\mathbf{P}$. To reflect an error, a scaling transformation for $\mathbf{P}$ is defined for each error. This section illustrates the construction of an erroneous 3D model regarding (E1).

Let us define the position-vector $\mathbf{P}_\mathrm{d}$ for the dish. To simplify the following explanation, $\mathbf{P}_\mathrm{d}$ has its own local origin. The vertical axis is the y axis, the learner's viewpoint is on the yz plane, and the x axis runs across an object.

(**E1**) **Too high drawing position of a dish.** So that the motif corresponds to the learner's sketch of the oval form around the top of the dish, $\mathbf{P}_\mathrm{d}$ is rotated about the x axis by θ, which expresses the difference of the ratio of width to height:

$$\mathbf{P}'_\mathrm{d} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta \\ 0 & \sin\theta & \cos\theta \end{bmatrix} \mathbf{P}_\mathrm{d}, \text{where} \theta = \arcsin(\frac{F'_2}{F'_1}) - \arcsin(\frac{F_2}{F_1}) .$$

Viewed from the side, the dish appears to be floating and inclined.

Figure 7 shows examples of displays from Error-Viz illustrating errors (E1)–(E8).

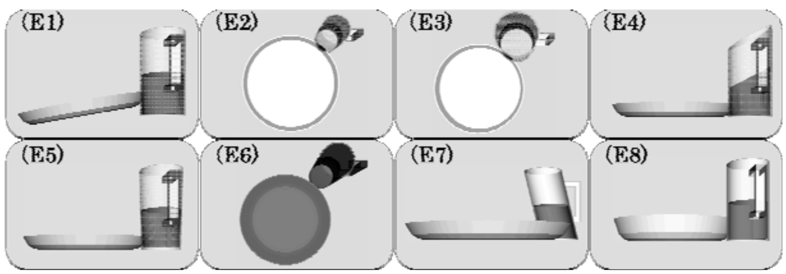


Fig. 7 Display examples of error visualization for the 8 kinds of errors.

3. Conclusion

Most novices cannot recognize the errors in their sketches, even though they may sense that something is wrong. A scaffold to understand the errors is important for learning from error. Differences between the subject of a drawing and an erroneous object that reflects the leaner's errors are obvious to the learner. This paper describes a technique to generate a 3D model from the learner's erroneous pencil drawing.

References

[1] Hirashima, T., Horiguchi, T., Kashihara, A., & Toyoda, J. (1998). Error-based simulation for error-visualization and its management: *International Journal of Artificial Intelligence in Education*, 9, 17–31.

[2] Matsuda, N., Takagai, S., Soga, M., Hirashima, T., Horiguchi, T., Taki, H., Shima, T. & Yoshimoto, F. (2003). Tutoring System for Pencil Drawing Discipline: *Proceedings of ICCE 2003*, 1163–1170.

[3] Perkinson, H. J. (1984). *Learning From Our Mistakes: Reinterpretation of Twentieth Century Educational Theory.* London, England, Greenwood Press.

[4] Reyna, R. D. (1970). *How to Drwa What You See.* New York: NY: Watson-Guptill Publications.

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Shared Virtual Presentation Board for e-Communication on the WebELS Platform

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Abstract: In this paper, a shared virtual presentation board (VPB) for e-Communication application on the Web-based e-Learning System (WebELS) platform is introduced. WebELS is a general-purpose e-Learning system to support flexibility and globalization of higher education in science and technology. In WebELS, the Meeting module consists of online slide presentation and video meeting, which the combination of both creates a so-called virtual room for e-Communication applications where meeting participants convene via the Internet. Online presentation features synchronized remote control for scrolling function, zooming function, cursor movement, shifting of slides back and forth, and even controlling the playback of video embedded on the slide. It also features online annotation to enhance the versatility and usefulness of online presentation. Online annotation allows the presenter to overwrite figures, draw objects or write mathematical equations to further elaborate what is being presented in a synchronized manner. This paper discusses the features of online presentation and the development of a virtual presentation board (VPB). VPB is a shared object that resides on the WebELS server system and is periodically accessed by WebELS client system in order that attendee's presentation viewer can replicate that of the presenter.

Keywords: e-Learning, e-Communication, online presentation, online annotation, cyber meeting, WebELS

Introduction

It has been a common knowledge that learning acquired in the universities become out-of-date in shorter years, and scientists and engineers are required to obtain new knowledge continuously after graduation. Lifelong education is definitely required from the point of views of both individual and the nation for sustainable technological growth and development [1]. However, employees who are working in industries have limited opportunities for learning advanced knowledge due to time and location limitations which traditional classroom-based education cannot provide answers to this kind of social demands. Internet-based e-Learning/e-Communication technology has great possibility to solve this problem, since it has a variety of benefits based on the recent progresses in the areas of advanced internetworking technologies, multimedia information processing technologies, and sophisticated software technologies, at higher quality and lower cost at a global scale [2].

In recent years, various online presentation tools for e-communications have become widely available. The most popular technology is based on screen-sharing [3], which gives the participants the opportunity to see the presenter's screen as it is. The advantage of screen-sharing technology is that presenter can show various applications on his computer and be seen by remote participants. Presenter, however, have to be careful that sensitive and confidential information is not displayed as it can be visible to the participants. Another drawback of screen-sharing technology is the reduced graphic quality that smaller text or objects cannot be clearly seen as it has no zooming function. Screen sharing technique also requires higher bandwidth for streaming encoded screen images.

On the other hand, content download technique, as employed in Web-based e-Learning System (WebELS), have a number of advantages. In this technique, contents are downloaded before the meeting starts by the participants from the server, and only the virtual presentation board (VPB) data is transferred between the client and the server during the presentation. VPB data is composed of control signals and annotation data in the order of tens of kilobytes, therefore this technique can be used even in low-speed network environment.

In this paper, we present the development of VPB for the online presentation on the WebELS platform. WebELS is a general purpose e-Learning platform to support flexibility and globalization of higher education in science and technology especially for PhD education by means of advanced information and communication technology [4,5]. WebELS consists of three modules, i.e., WebELS Learning for self-learning, WebELS Lecture for Internet-based online distance lecture and WebELS Meeting for Internet-based online meeting. In WebELS Meeting, the online presentation uses VPB to achieve remote synchronization of slide events between the presenter and the attendees. E-Communication on the WebELS platform is made possible by combining the online presentation and video conferencing functions to create a virtual room, where meeting participants convene via the Internet. This paper focuses on the online presentation that uses the shared VPB data.

1. **WebELS Meeting System Overview**

Figure 1 depicts WebELS Meeting as a web-based content-centered e-Communication system. The fundamental requirements for e-Communication system include online presentation, online annotation, video conferencing and chat messaging. With these features, users in remote location, i.e., presenter and attendees, that share the same virtual room over the Internet can experience real-time online meeting.

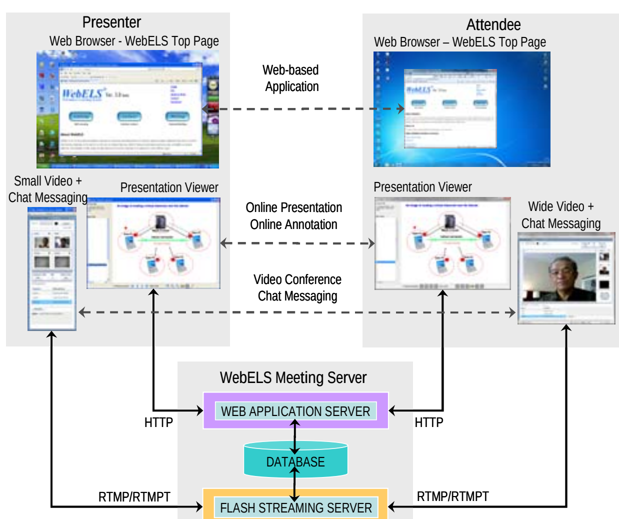

Figure 1. WebELS Meeting as an e-Communication System

The online presentation system implements the concept of a Virtual Presentation Board (VPB) which will be discussed in succeeding sections. This board is a data file stored at the server and updated by the presenter by sending all information in its presentation viewer every time there are slide events. Attendees of the same content retrieve the shared VPB data by polling the server, and thus attendees are able to reproduce in their display panel similar to what is in the presenter.

e-Communication is made possible by combining the video conferencing and online presentation in the same virtual room. Video conferencing and online presentation panels are designed to be independent with each other, because one video conferencing panel can be used with multiple presentation contents.

2. Synchronized Online Presentation

WebELS Online Presentation features the following important characteristics in implementing an effective e-Communication system:

- Slide Synchronization – The most important and basic requirement for online presentation is the remote slide synchronization. The presentation control panel is equipped with slide control buttons (next, back, first slide and last slide) that enables shifting of slides back and forth by the presenter.
- Cursor Synchronization – An effective presentation guides the attendees on which part of the slide is being presented. Conventionally, a laser pointer is used for this purpose. In WebELS, a bold red crosshair cursor is used as a pointer that appears when the presenter clicks at a certain position on the presentation display panel.
- Online Annotation – Aside from pointing to a particular point on the slide using a cursor, there would be a necessity to overwrite figures, draw objects or write mathematical equations to further elaborate what is being presented. Writing annotation on the presentation display panel is simply done like a freehand drawing. It is done by pressing the left-hand mouse, and holding it steadily while dragging the thin crosshair cursor to form the desired object. See Fig. 2 for online annotation example.
- Slide Zoom Function – Attendees sometimes use text documents for presentation. However, text document may not be easily readable or visible as a slide presentation. Slide zooming function would then be necessary in order to enlarge part of the slide that is of interest.
- Video Playback Function – Video content added to slide presentation enhances the interest of the attendees on the presentation. In WebELS system, various video content formats (MOV, AVI, MPG) can be embedded onto the slides. Video playback functions such as start, stop and pause are also made to synchronize remotely between the presenter and attendees.

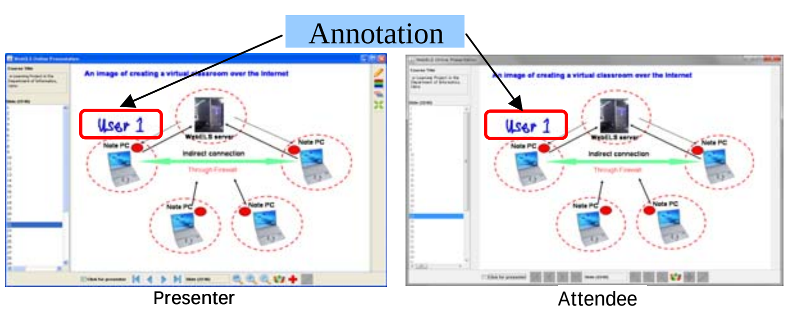

Figure 2. Presentation Viewer with Annotation

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3. Implementation and Data Structure

3.1 VPB Concept Implementation

Figure 3 shows the WebELS Meeting as a client-server system that implements the content download technique. Before the meetings starts, each participant downloads the viewer applet and the presentation content from the server. Virtual Presentation Board (VPB) data is shared among the participants as the meeting is undertaken. The implementation concept of VPB is to make copy of what is displayed on the presenter's presentation viewer, send this copy to the server, where every user can download this copy and reproduce on their presentation viewer. The presenter is the source of VPB data, wherein any slide events in its display panel, a new update of VPB data is sent to the server. Slide event objects include slide number, cursor position, slide zoom information, scrollbar position, video playback information, and annotation information. For the attendees to reproduce copy of the presenter's display panel in a synchronized fashion, the system pools the server and retrieves the VPB data file every one second. As the VPB data is in the order of tens of kilobytes, the online presentation works efficiently well even in narrow bandwidth network environment as opposed to screen sharing technology that requires higher bandwidth.

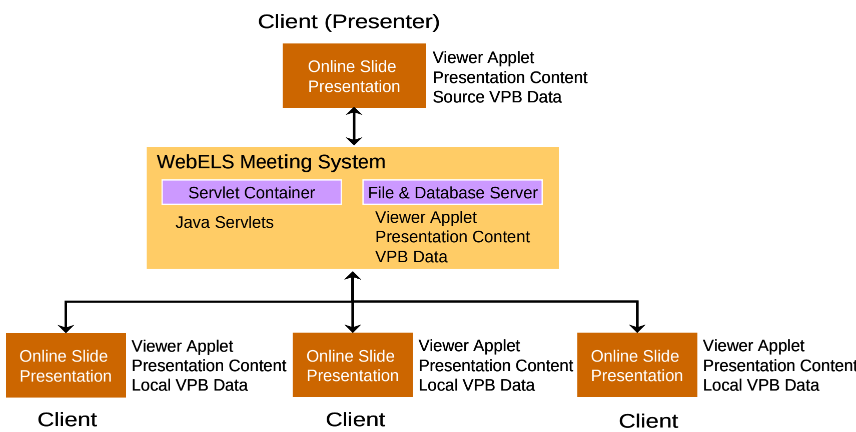

Figure 3. Virtual Presentation Board (VPB) Concept on WebELS Meeting System

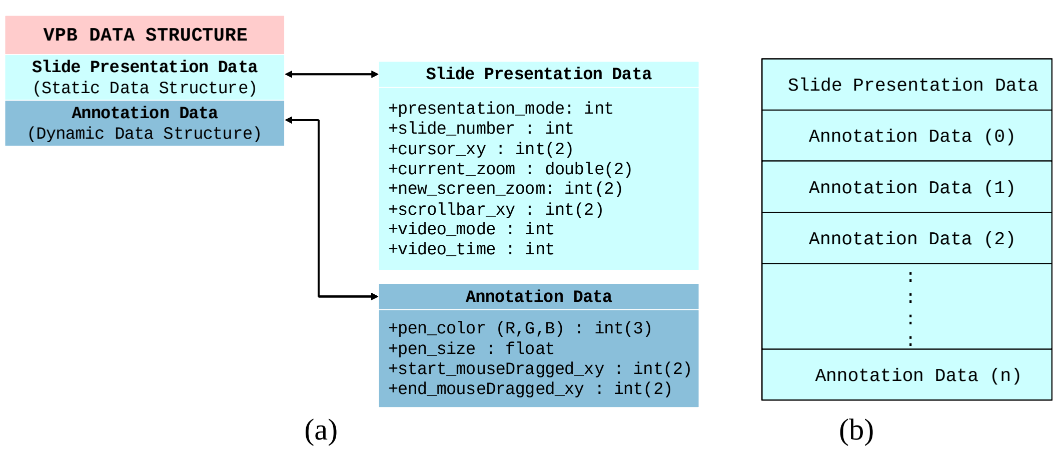

Figure 4. (a) VPB Data Structure, (b) VPB Data Stream

3.2 VPB Data Structure

Figure 4 (a) shows the Virtual Presentation Board (VPB) data structure that consists of static and dynamic data. Static data structure is used for slide presentation objects that include presentation mode, slide number, cursor position, zoom data, scrollbar data and video function. The part of the VPB data structure that has dynamic memory is used for the annotation data that represents pen color, pen size, and cursor xy position. It uses a vector type memory that is appropriate for growing array of objects. The data stream is shown in Figure 4 (b), where the slide presentation data comes first, and then the annotation data in a repeating pattern.

4. Practical Evaluation

WebELS has been used by a number of domestic and international organizations and universities for distance exchange lectures and meetings. Recent distance lecture was conducted between the National Institute and Informatics (Japan) and the Tsinghua University (China). The exchange lecture was successful using the online slide presentation and the video meeting functions. Furthermore, because of the multi-point access, and no firewall and proxy setting requirements, WebELS is considered to be an effective collaboration tool for higher education in international cooperation between universities and academic institutes.

5. Conclusion

This paper presented the WebELS Meeting System and the development of a shared virtual presentation board (VPB) for e-Communication on the WebELS platform. VPB is a data structure that defines several objects that represents how the presentation viewer displays the slide content. WebELS implements the content download technique, wherein presentation viewer and content are downloaded prior to starting a meeting, and the shared VPB data is only used to synchronize remote slide events during an online presentation. Because VPB data is in the order of tens of kilobytes, content download technique works efficiently well even in low bandwidth network environment, in contrast with screen sharing technology that requires high network bandwidth.

Acknowledgements

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References

[1] Ueno, H. (2002). Internet-Based Distance Learning for Lifelong Engineering Education - A Personal View and Issues, *Journal of Information and Systems in Education*, Vol.1, No.1, pp. 45-52.

[2] Blinco, K., Mason, J., McLean, N., and S. Wilson. (2004). Trends and Issues in E-Learning Infrastructure Development. DEST(Australia) and JISC-CETIS(UK).

[3] Tee, K., Greenberg, S. and Gutwin, C. (2006). Providing Artifact Awareness to a Distributed Group through Screen Sharing. *Proceedings of the 2006 20th Anniversary Conference on Computer Supported Cooperative Work*, ISBN:1-59593-249-6, pp. 99-108.

[4] Ueno, H., He, Z., Yue, J. (2009). WebELS: A Content-Centered E-Learning Platform for Postgraduate Education in Engineering. *Lecture Notes in Computer Science*, Volume 5613, pp. 246-255.

[5] Berena, A.J., Sriprasertsuk, P., He, Z., and Ueno, H. (2009). An Open Source Integrated e-Learning/e-Communication Platform for Postgraduate Education and Corporate Cyber Meeting. *IEICE Technical Report*, ET 109(193), pp.33-37.

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Recommendation and Diagnosis Services for Presentation Semantics

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Abstract: The main topic in this paper is how to effectively help research group members share and reuse presentation documents. The key idea is to propose a presentation semantics framework, which represents semantic roles of and relations among presentation slides with metadata. We then discuss a machine learning technique for analyzing the semantics roles and relationships automatically from the repository of the documents accumulated in the research group. This paper also demonstrates interactive Web services that recommend the metadata to be attached to the documents newly made, and that diagnose the presentation semantics of the documents.

Keywords: Presentation Semantics, Metadata Recommendation, Semantics Diagnosis

1. Introduction

In our daily research activities, a large volume of contents is generated and used by researchers and students in a research group. In particular, presentation documents are well-organized ones representing not only research findings but also presentation heuristics followed by the research group members [1]. Especially, novice researchers could promote developing their presentation skills by sharing such documents accumulated in the group.

However, the presentation documents are usually managed by their presenters and are not always shared by the research group. Moreover, information of presentation semantics to be shared and reused is implicitly embedded in objects like slides of the documents. It is accordingly difficult for the novices to select necessary slides for making new documents and to reflect on their own documents by means of semantic structures obtained from a large volume of past documents accumulated in the their group.

In order to resolve such issues, we have proposed a framework of the presentation semantics, which represents semantic information included in presentation documents with metadata [6]. On the other hand, it is complicated for the research group members to append suitable semantic metadata to the documents since such task often requires defining group standards for sharing them effectively. The main issue addressed in this paper is accordingly how to analyze the semantics roles and relationships automatically from the repository of the documents accumulated in the group, which is applied to metadata recommendation and to semantics diagnosis.

2. Presentation Documents with Metadata

In this paper, the presentation semantics framework provides a metadata model for representing semantic structures embedded in the presentation documents [7]. This framework consists of four types of metadata as shown in Figure 1.

Slide metadata represent the semantic roles of each slide included in a presentation document. Examples of the slide metadata are "*Cover*", "*Overview*", "*Purpose*", "*Architecture*", "*Results*", etc. Segment metadata also represent a sequence of the slide metadata in the document. We have defined four kinds of segment metadata, "*Introduction*", "*Theory & Idea*", "*System*", and "*Evaluation*", each of which includes related slide metadata. For example, the segment "*Theory & Idea*" includes "*Purpose*", "*Approach*", and "*Model*". Relation metadata represent sequential or hierarchical relationships among the slide metadata and segment metadata. An example of the sequential metadata is a sequence of "*Cover*", "*Overview*", "*Table of Contents*", and "*Background*", which often appears in the documents. The other example of the hierarchical metadata is a parent-child relationship between the slide metadata. For example, "*Background*" has two children metadata "*Research Targets*" and "*Issues Addressed*". File metadata represent some attributes about the presentation contexts such as "*Target*", "*Presentation Time*", etc..

In general, sharing the presentation documents is not so easy since such the presentation semantics are often embedded in the documents. Attaching the metadata to the documents is also a time-consuming and complicated task for the research group members as follows: (1) the same slide could be often attached with the different metadata that have the same meaning, (2) it is difficult to detect the slide metadata from the slide contents, and (3) it is also difficult to detect the segment and relation metadata from the slide sequence.

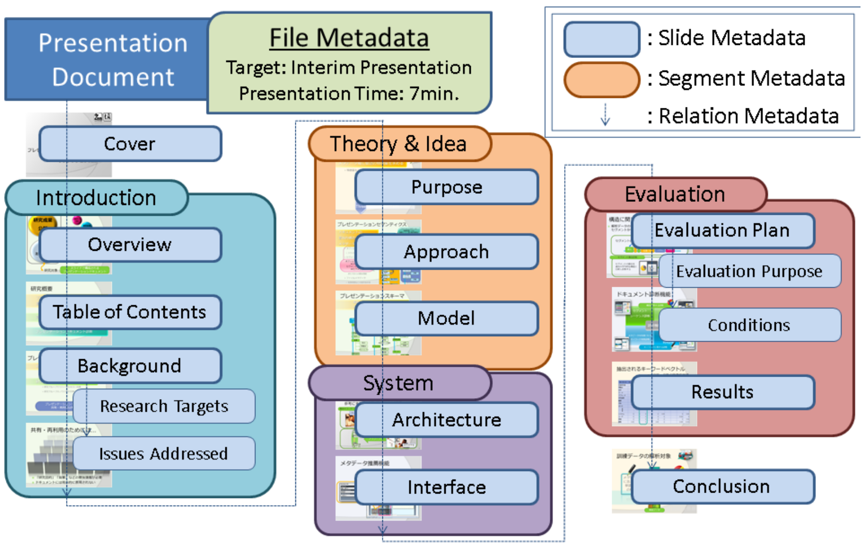

Figure 1. Presentation Semantics Framework

3. Web Services with Presentation Semantics Analysis

The essential requirement for resolving the above difficulties is to recommend the presentation semantics as the metadata. In this paper, we accordingly propose a machine learning technique to conduct semantic analysis of the presentation documents. We also describe two interactive Web services for metadata recommendation and semantics diagnosis, which have been implemented with ASP.NET 3.5 and Silverlight 3 [5] to run like desktop applications on the major web browsers such as Internet Explorer and FireFox.

3.1 Machine Learning for Semantic Structure Analysis

Presentation slides often include typical keywords that afford clues for identifying the metadata. It is accordingly possible to obtain the slide metadata from the typical keywords in the slides to analyze the presentation semantics. Considering such typical keywords, we use the machine learning technique to identify the relationships between the slide metadata and typical keywords included in the slides from the documents as training data that are attached in advance with the metadata and that are accumulated in our research group. Such relationships identified can be used to detect the presentation semantics of the documents produced in the group. Detail steps for the keyword vector calculation are as follows:

A) Noun words are extracted by using MeCab (Japanese language morphological analyzer) [3] from each slide of the presentation document with metadata in advance.
B) The keyword vector of the slide metadata is represented by the following formula,

$$V_i = \left(w_{i,1}, w_{i,2}, \cdots, w_{i,j}, \cdots, w_{i,m}\right) \quad (1)$$

where $w_{i,j}$ is the weight score of the word $j\ (1 \le j \le m)$ in the slide metadata $i\ (1 \le i \le l)$. Each $w_{i,j}$ is calculated by the following formula expanded tf - idf approach.

$$w_{i,j} = tf_{i,j} \cdot imf_j \qquad (2)$$

where $tf_{i,j}$ is summation of the score for the word j included in the slide metadata i of all the documents attached. imf_j is inverse metadata frequency of the word j as shown in the following formula.

$$imf_j = \log_{10} \frac{l}{mf_j} \qquad (3)$$

where l is the total number of the slide metadata, and mf_j is the number of the slide metadata including keyword j.

C) Each weight score in the keyword vector is normalized by each slide metadata.

D) This technique then calculates to what extent each metadata appears at the normalized position in the sequence of the metadata from the training data. It counts the number of the slides included in each segment metadata and calculates averages and standard deviations of the allocation rate of every segment metadata from the documents.

3.2 Recommendation Service for Slide Metadata

Using the results of the presentation semantics analysis described above, this Web service recommends the slide metadata to be attached to presentation documents. The aim of this service is to help the research group members attach the slide metadata to the documents they produce. The first step towards identifying appropriate slide metadata from the typical keywords included in the slide is to calculate the keyword vector of each slide in the same way as the machine learning technique does. The second step is to calculate degree of similarity between the target slide *k* and the slide metadata *i* by means of the following formula as inner product of each keyword vector.

$$Sim(k,i) = V_k \cdot V_i \qquad (4)$$

where V_k and V_i are the keyword vectors of the slide k and the slide metadata i, respectively. V_i is also calculated in the presentation semantics analysis. The next step is to calculate the normalized appearance position of each slide in the same way as the training data. The candidates of the slide metadata are ranked in a descending order of the normalized appearance frequency as shown in "Order of Normalized Appearance Frequency" in Figure 2. Following these orders, this service extracts common metadata candidates and sorts them by multiplying the keyword vector similarity and normalize appearance frequency, which are recommended as appropriate metadata of the target slide. The rests of the candidates are ordered behind the common metadata candidates.

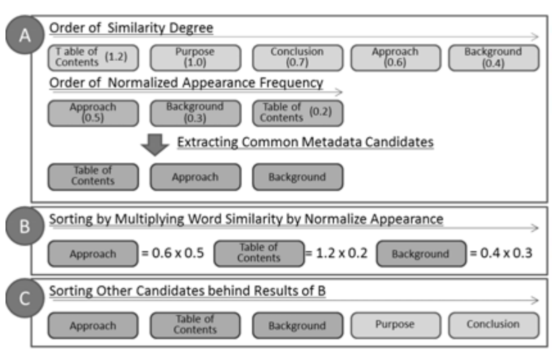

Figure 2. Recommendation Algorithm

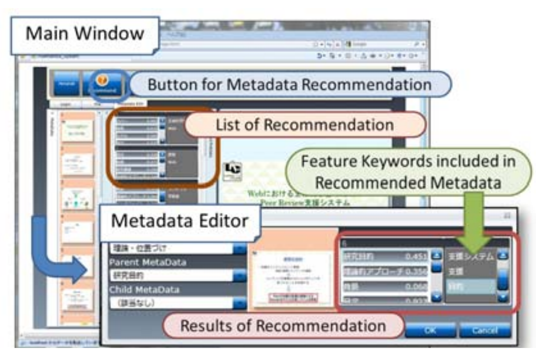

Figure 3. Recommendation Service

The service for the metadata recommendation estimates the slide metadata corresponding to the target slide as shown in Figure 3. After uploading PowerPoint 2007 format (.pptx) [3] file as the presentation document, a research group member can attach the slide metadata to each slide included in the document by means of the recommendation function. When he/she pushes the button for metadata recommendation, Metadata Editor shows the results of the recommendation at the right side of the slide thumbnail. The metadata selected are stored with the document to the Web server.

3.3 Diagnosis Service for Presentation Semantics and Keywords

This service uses the results of the presentation semantics analysis to diagnose the presentation semantics and keywords embedded in the presentation documents produced by the research group members. It provides four functions as shown in Figure 4: (1) Segment sequence checker detects fragmentations of the segments estimated from the slide metadata so that the group members can notice discontinuities of the presentation sequence easily. (2) Segment balance checker detects an allocation tendency of the segment metadata by comparing the target document to average and standard deviation of the allocation rate of the training data. (3) Metadata keyword checker evaluates whether typical keywords corresponding to certain slide metadata are used in each slide. (4) Title keyword checker evaluates whether keywords including the title of the presentation are used in each segment.

Figure 4. Semantics Diagnosis Services

4. Case Studies

This section describes case studies whose purpose was to investigate whether the services enabled suitable metadata recommendation and semantics diagnosis. In these studies, we used 12 presentation documents for the interim presentation (presentation time: 7 minutes) of our research group members as training data. The main domain of these presentations was to develop self-directed learning support systems. The slide metadata were attached to all the documents by a knowledgeable researcher as correct metadata in advance.

As the case study for the recommendation service, we first chose a certain presentation document from the 12 documents, which deleted the slide metadata attached as a recommendation target. Next, we registered the other documents on the service as training data for the semantics analysis and recommended the slide metadata for the target document from the results of the analysis. We repeated such recommendation process for every document and compared the slide metadata attached by the knowledgeable researcher to the ones attached by the service. Table 1 shows the results of the accuracy of the metadata recommended which were divided into two types, (a) accuracy of first place, which represented the rate of the metadata correctly recommended in the first place, (b) accuracy of top three places, which represented the rate of the metadata correctly recommended in the top three places. In addition, we made comparison among three recommendation approaches using (1) the keyword similarity, (2) the normalized appearance position, and (3) these combination.

Table 1 indicated that the results from the combined approach (3) were more suitable for the metadata recommendation than (1) and (2). The approach (1) got poor results since there are some words which have close relationships with several slide metadata. For example, the word "task" is associated with not only "Approach of Research (i.e. target tasks)" but also "Conclusion (i.e. future tasks)". The results from (3) seemed to be improved by combining

(1) and (2) because the approach (2) roughly complemented the order of the semantic structure in which the approach (1) lacks.

As the case study for the diagnosis service, we first registered the above 12 presentation documents with metadata on the service as the training data. Then we prepared paired documents different from the training data, which two novices in our research group made. These documents were the first and final versions for the interim presentation. Assuming that the final version was more refined than the first version, we investigated the differences in each diagnosis result. Comparing the diagnostic results of the first version to the final version, problems of the segment sequence, segment balance, and title keyword in the first version were resolved through the presentation refinements.

Table 1. Accuracy Rate of Metadata Recommendation

	(1)	(2)	(3)
(a)	40.6% (78/192)	42.7% (82/192)	53.1% (102/192)
(b)	62.0% (119/192)	74.0% (142/192)	77.1% (148/192)

5. Conclusion

This paper has described the presentation support Web services with the presentation semantics framework. The key future of our presentation semantics framework is to deal not with the domain knowledge of the document [2] but with the roles of and semantic relations among objects composing the documents. Such presentation schema consequently means a presentation philosophy to be used in the research group members. We have also demonstrated the recommendation service and the diagnosis service which utilize the results of the presentation semantics analysis with the machine learning technique. The results of preliminary case studies indicated that the services would make it possible to provide the research group members with the services which manage presentation semantics.

In the near future, it will be necessary to improve the recommendation accuracy and to facilitate developing skills in producing presentation documents. Furthermore, we will evaluate effectiveness of the diagnosis service for the refinement process in a more detail.

Acknowledgements

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References

[1] S. Hasegawa, A. Tanida, and A. Kashihara: A Presentation Support Service using Presentation Semantics, Proc. of the 8th IEEE International Conference on Advanced Learning Technology (ICALT2008), pp.104-105,(2008).

[2] A. Kohlhase: "Semantic PowerPoint: Content and Semantic Technology for Educational Added-Value Services in MS PowerPoint", Proc. of World Conference on Educational Multimedia, Hypermedia & Tele- communications (ED-MEDIA2007), 3576-3583, (2007).

[3] T. Kudo, K. Yamamoto, and Y. Matsumoto: Applying Conditional Random Fields to Japanese Morphological Analysis, Proc. of the 2004 Conference on Empirical Methods in Natural Language Processing (EMNLP-2004), pp.230-237, (2004).

[4] Microsoft Corporation: "PowerPoint Home Page - Microsoft Office Online" http://office.microsoft.com/en-us/powerpoint/FX100487761033.aspx

[5] Microsoft Corporation: "The Official Microsoft Silverlight Site", http://silverlight.net/

[6] K. Saito, A.Tanida, A. Kashihara, S. Hasegawa: An Interactive Learning System for Understanding Presentation Semantics. IEICE Technical Report Educational Technology, Vol. 109, No. 453, pp. 37-42 (2010) (in Japanese).

[7] A.Tanida, S.Hasegawa, A.Kashihara: Web 2.0 Services for Presentation Planning and Presentation Reflection. Asia-Pacific Society for Computers in Education, 2008. Proc. of The 16th International Conference on Computers in Education (ICCE2008), pp. 565-572. (2008).

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Kit-Build Concept Map and Its Preliminary Evaluation

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Abstract: In this paper, we have described Kit-Build method as an approach to realize automatic assessment of a concept map. In Kit-Build method, an ideal concept map (goal map) is prepared by an expert of a target domain at first, and parts are generated by decomposing the goal map. The parts are provided to a learner, and then the learner rebuilds a concept map (learner map) by connecting the parts. It would be easy to diagnose the maps by comparing the goal map and learner map because the same parts are used in them. We have already designed and developed a learning environment with the Kit-Build method. An experimental evaluation of the learning environment is also reported.

Keywords: Concept Map, Automatic Assessment, Kit-Build Method

Introduction

The concept map is a tool that helps to organize knowledge for meaningful learning [1]. By building concept maps, learners are promoted to confirm their knowledge by themselves and to comprehend the knowledge deeply. The concept maps built by learners are also useful for teachers to examine the students' understandings [2,3]. Assessment of concept maps built by learners, however, remains as a big issue to realize educational interaction through the concept map. A learner sometimes fails to build an adequate concept map and then it is often difficult for the learner to be aware of the incompleteness. Therefore it is necessary to support the learner to find and correct the errors. It is, however, almost impossible for a teacher to check several concept maps built by several learners at a time. Therefore, from the viewpoint of technology-enhanced learning, several investigations have already addressed the automatic assessment of learners' concept maps and providing appropriate feedback [4-7]. Basic approach to realize the assessment is to compare the learner's and the expert's concept maps. Most of the investigations have addressed the automatic assessment and paid special attention to handle the cases where learners have misspelled a concept or they have used a synonym or a concept related to the appropriate one based on natural language processing techniques.

In this paper, we have proposed "Kit-Build method" as an alternative approach to realize automatic assessment of concept maps. In the Kit-Build method, an ideal concept map (goal map) is prepared by an expert of a target domain at first, and parts are generated by decomposing the goal map. The parts are provided to a learner, and then the learner is required to rebuild a concept map (learner map) by connecting the parts. In this method, diagnosis the maps by comparing the goal map and learner map becomes very easy because the same parts are used among them. This method makes the following matters possible for a teacher and learners: (i) getting the differences between a goal map and a learner map, (ii) getting the differences between each of learner maps, and (iii) getting the concept map of a group which is generated by overlaying learner maps including the group. The group map can also be compared with other maps. The results of the diagnosis enable the environment to indicate inadequate portions in the concept map of individuals or group. Additionally, since it is possible to evaluate the similarity of the concept maps of each learner, the results are useful to formulate collaborative learning group.

We have already designed and developed a system where learners can build concept maps, the system diagnoses the built map, and the system gives feedback based on the diagnosis. In this paper, an implementation of Kit-Build method and an experimental use and evaluation of the implementation are reported.

1. Implementation of Kit-Build Method

We have designed a practical flow to build concept maps with the Kit-Build method. The flow is compose of four main phases 1) Goal map building, 2) Learner's map building, 3) Goal map modification, and 4) Learner's map modification (details of the flow is not described in this paper because of page limitation). We have already developed a system based on this flow. The system is called as "CmapSystem". It is a web application with two client systems ("CmapEditor" and "CmapAnalyzer") and a server system ("CmapDB"). Interfaces of CmapEditor and CmapAnalyzer are shown in Figures 1 and 2, respectively (because only Japanese version has been implemented, the words in figures are translated into English). CmapEditor has functions to make a goal map, a kit, and a learner's map. This system has been implemented by Java (version 1.6). CmapAnalyzer has functions to gather learner's maps, adjust a goal map, and revise a learner's map. This system has implemented by Flash and supports version Flash Player 10. CmapDB has a function to store and share maps. This system was developed by Ruby (version 1.8.6) on Rails (version 1.2.3) and MySQL (version 5.1.30). Experimental use of CmapSystem is reported in Section 2.

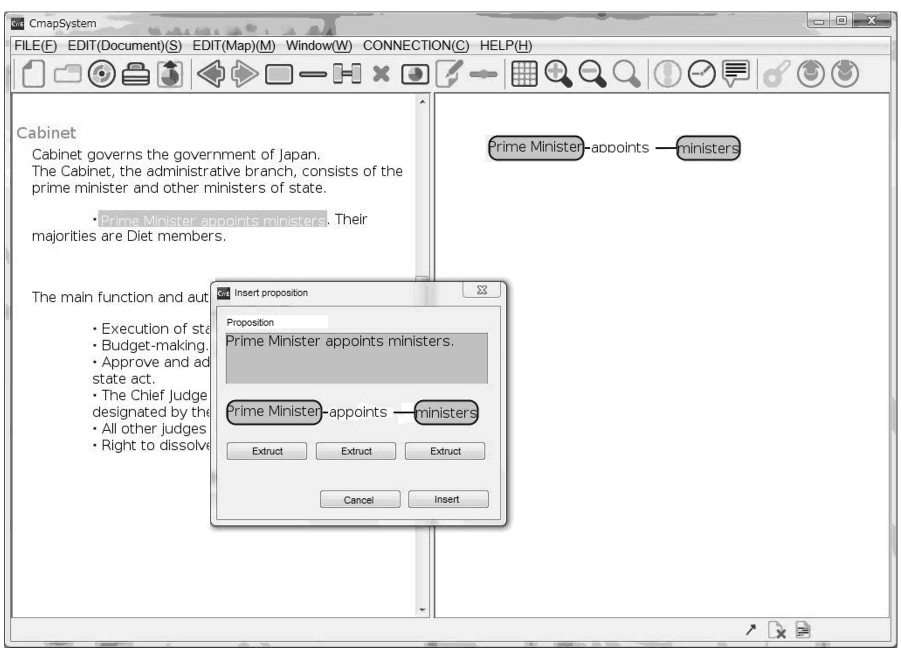

Figure 1: CmapEditor

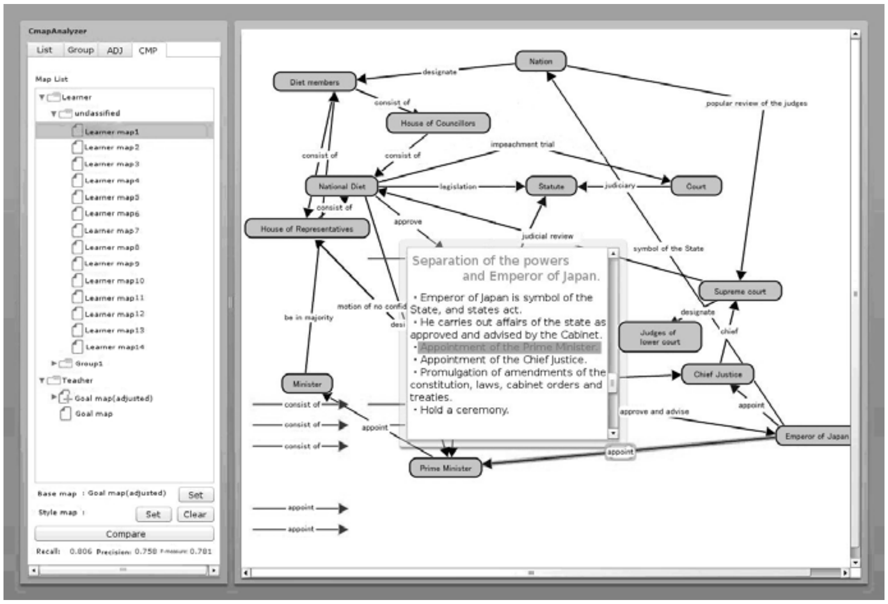

Figure 2. CmapAnalyzer

2. Experimental Evaluation

2.1 Purpose of the Experiment

The purpose of this experimental use of CmapSystem is to examine whether it is possible to interact between teachers and learners through the concept maps or not. In this experimental use, since learning materials are prepared by the authors of this paper, we (the authors) played the role of teachers. Practical use by teachers is one of our important future works. The interaction is composed of the following 4 phases: (1) Goal map building (2) Learner map building, (3) Goal map modification, and (4) Learner map modification. Because (1) is an activity only for the teachers, we tried to confirm (2)-(4).We have already carried out three experimental uses. In the first experiment, 12 university students used the system until the third phase. In the second, 15 teachers of K12 used the system in the role of learners until the third phase. In the third experiment, 30 university students used the system until the fourth phase. The results of these experiments are almost similar, only the third experiment is reported in this section.

2.2 Experiment Procedure

The experiment was conducted for two days. At the first day, the following procedures were carried out. At first, we provided the subjects with a learning material of "separation of powers under the Japanese Constitution", and requested them to read the content in twenty minutes. All subjects have learned the content at least once in high school or university. Next, we explained "concept map" and "method of making the concept map by the system" in ten minutes. Afterwards, concept map of the "separation of powers" was made by the subjects in twenty minutes with the system. During the phase of the learner map building, the learning material was available in the system. After that phase, the learner maps were gathered through online and analyzed by CmapAnalyzer. At first, by overlaying the learner maps, a group map was generated. By comparing the group map with the goal map, we checked and adjusted the goal map. At the second day, the differences between the adjusted goal map and each learner map were given to each learner. Then, each learner is required to improve their maps individually for 20 minutes. Afterwards, the subjects answered their questionnaires. In the second day, 26 subjects attended this experiment because four remaining subjects made a complete learner map.

Table 1. Results of the Questionnaires

	Questions	Strongly agree	Agree	Disagree	Strongly disagree
(1)	Building the concept map was useful to understand the learning material.	17	10	3	0
(2)	Kits were helpful to build the concept map.	19	8	3	0
(3)	There are enough kits to build the concept map.	4	16	8	1
(4)	Building the concept map that represent your understanding was easy	6	9	15	0
(5)	The concept map you built was appropriate.	3	16	10	1
(6)	The feedback for the concept map was appropriate.	14	9	1	2
(7)	Activity to improve the concept map was useful to understand the learning material.	11	14	1	0

2.3 Results of the Activities

The document of the "separation of powers" composed of 1101 Japanese characters and 6 paragraphs. The goal map consisted of 16 nodes and 33 links. Therefore, a subject was requested to build a learner map with 49 kits. Thirty learner maps were built by 30 subjects. CmapAnalyzer detected 63 excess links (2.1 links in average in a learner map), 70 deficient links (2.3 links in average) and 7 unconnected links (0.23 links in average) by comparing individual learner map with the goal map.

By overlaying the 30 learner maps, a group map was generated. In comparison of the group map and the goal map, CmapAnalyzer detected 61 differences, that is, 26 excess links (overlay degree is more than 0), 31 deficient links (overlay degree is less than 1) and 4 unconnected links (overlay degree is more than 0). We examined all of them and corresponding portions in the learning material, and then judged that 4 differences should be accepted as alternative interpretations of the learning material. The goal map then modified to accept those four excess links. The corresponding portions of the learning materials became the targets of modification of the learning material.

Since 61 differences were too much to check in short time, we tried to filter them by using the overlay degree of each difference that is a ratio of learner maps including the difference. When we set the overlay degree to detect the differences in the group map at 0.1 in the excess link (that is, 10% of learner maps included the excess link), 0.7 in the deficient link and 0.1 in the unconnected link respectively, 8 excess links, 2 deficient links and 1 unconnected link were detected. Then all links that caused the adjustment included were detected. Therefore, the filtering with the overlay degree might be a useful method to reduce the load to the adjustment.

In the phase of learner map modification, each learner map was compared with the (adjusted) goal map and detected differences were informed each subject. The subjects were promoted to improve their map for twenty minutes. For both the unconnected link and the excess link, sentences in the learning material corresponding to the links were informed the subjects. The deficient links were not indicated because the links were pointed out as the unconnected or excess links. Therefore, in the modification phase, the correct answers were not taught directly. In this experiment, 19 in 26 subjects corrected their learner maps completely and 6 subjects left one incorrect link. One subject gave up correcting his map soon and left 5 incorrect links.

Table 1 showed the results of the questionnaires. About 90% of the subjects agreed that building the concept map (with kits) was useful to understand the learning material and kits were helpful for them to build the concept maps. About 70% of the subjects then thought the provided kits were enough to describe their understandings. The results of questions (4) and

(5) suggested that the task to build concept map was not easy for the subjects. About 90% of the subjects answered that the feedback for the concept map was appropriate, and almost all subjects thought that the activity to improve the concept map was useful to understand the learning material.

In summary, in this experimental use, a subject built a concept map composed of 49 kits and that included only 2.1 excess links, 2.3 deficient links and 0.32 unconnected links in average. The subject then corrects most of the errors with the feedback. Besides, most of the subjects thought that building the concept maps with the system was useful for learning. Because the goal map was also adjusted based on the group map, it was confirmed through the contribution of the feedback to the authors. Based on these results, we judged that interaction between learners and authors through the concept map was realized in this experiment.

3. Conclusion

In this paper, Kit-Build method and CmapSystem as an implementation of the method are described. Through three experimental uses of CmapSystem, we have cofirmed that Kit-Build method and CmapSystem are a promising approach to promote interaction between learners and teachers with concept map. The method has the following two characteristics, (A) concept map building task is divided into segmentation task and construction task, and then the segmentation task can be replaced by recognition task of the kits provide beforehand, and (B) a correct concept map that a learner should build can be specified as a goal map. These characteristics restrict the applicable targets of the Kit-Build method and require additional functions for the learning environment. Therefore, to propose and implement several measures against these restrictions are our important future works. We are also planning a large-sized, long-term and more practical use of the environment as the next step of this research.

Acknowledgement

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References

[1] Novak, J. D., & Gowin, D. B. (1984). *Learning how to learn*. New York, NY: Cambridge University Press.
[2] Barenholz, H., & Tamir, P. (1992). A comprehensive use of concept mapping in design, instruction and assessment. *Science and Technological Education*, 10, 37–52.
[3] Ozdemir, A. (2005). Analyzing Concept Maps as an Assessment (Evaluation) Tool in Teaching Mathematics. *Journal of Social Sciences*, 1(3)141-149.
[4] Chang, K., Sung, T., & Chen, S. F. (2001). Learning through computer-based concept mapping with scaffolding aid. *Journal of Computer Assisted Learning*, 17(1), 21-33.
[5] Cimolino, L., & Kay, J. (2002). Verified Concept Mapping for Eliciting Conceptual Understanding. *Proceedings of ICCE2002*, 1561-1563.
[6] Kornilakis, H., Grigoriadou, M., Papanikolaou, K. A., & Gouli, E (2004). Using WordNet to Support Interactive Concept Map Construction. *Fourth IEEE International Conference on Advanced Learning Technologies*, 600-604.
[7] Gouli, E, Gogoulou, A., Papanikolaou, K. A., & Grigoriadou, M. (2005). Evaluating Learner's Knowledge Level on Concept Mapping Tasks. *Fifth IEEE International Conference on Advanced Learning Technologies*, 424-428.

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Development of Pipeline Time Chart Tool for Microprocessor Design Education

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Abstract: We developed a pipeline time chart tool to explore pipeline control for microprocessor design education. Since the developed tool is not signal level but instruction level, the user of this tool can visually understand the microprocessor pipeline control. The user can set and run the pipeline control. Since the user can also modify the pipeline control flexibly, the user can examine the influence of the pipeline control change. Therefore, the user can learn good pipeline control of the microprocessor visually and effectively, and could get the design skill for thinking of the specification of pipeline control. This developed tool is very useful for students and young engineers.

Keywords: microprocessor design education, pipeline control, time chart

1. Introduction

Microprocessor design education becomes substantial. The design education of pipeline microprocessor in university is also coming [1]. The students usually practice implementing processor there. However the students do not think about meaning and effect of specification, because the specification of microprocessor is given to the students in conventional design education. We believe that the design skill for thinking of the specification is very important for microprocessor design education [2] [3]. This paper describes a pipeline time chart tool to get the design skill that is focused on the specification.

2. Pipeline Time Chart Tool

We developed a pipeline time chart tool to explorer pipeline control for microprocessor design education. The pipeline time chart tool is a component of the MEIji University Microprocessor design Education System (MEIMES). Time chart tools are usually used in computer design education. However, they are too difficult for student to understand computer architecture, because they are based on signal level. An instruction level based time chart is expected, but it is only seen in text books of computer architecture. Any time chart diagram in the book is not enough to learn the architecture of pipeline processor. Therefore, we developed time chart tool in instruction level for pipeline processor. Our proposed pipeline time chart tool does not exist so far. By using our time chart tool, students can visually understand execution of pipeline stage of each instruction, and flexibly change pipeline control for thinking the specification of pipeline processor.

Figure 1 shows overview of the developed pipeline time chart tool. The instruction set is COMET's. The COMET is a very- known virtual simple educational processor defined by Information-Technology Promotion Agency, Japan. The processor of Fig.1 has five-stage pipeline. Five stages are instruction fetch (IF), instruction decode (ID), operand fetch (OF), memory access (MEM), and execution in ALU and write back result (ALU). The area of the pipeline where the processor runs is colored with a proper color of the instruction. The user can visually understand execution of the pipeline stage of each instruction by our tool.

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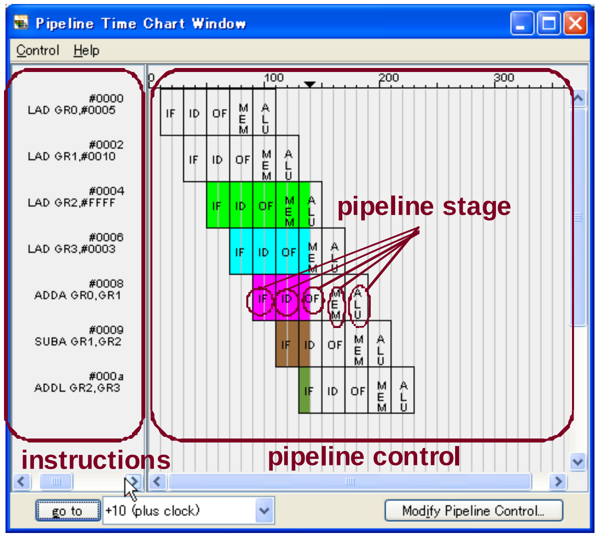

Figure 1 Pipeline time chart tool

The pipeline control of processor may cause three kinds of hazards. The pipeline time chart tool can indicate occurrence of all pipeline hazards. Figure 2 shows an example of structural hazard. The processor has only one memory and the LD instruction at address of #0000 accesses to the memory in MEM stage. Therefore, the SUBA instruction at #0005 cannot simultaneously accesses to the same memory in IF stage,. The pipeline hazard is displayed with a red arrow line between stages of the instruction where the problem occurs, and error or warning mark is attached with the instruction that does not give a correct result. When the user puts cursor on the mark, detail of the hazard is shown by tool tip. Figure 3 shows occurrence of data hazard. The ADDA instruction at #0004 cannot reads data of GR0 in OF stage, before the LD instruction at #0000 writes result to GR0 in ALU stage. Figure 4 shows the situation during executing branch instruction. Warning marks are attached at instructions after the branch instruction, because the processor does not know whether these instructions execute or not. If execution sequence of instruction is branched and branch hazard occurs, the warning marks are replaced with error marks as shown in Fig. 5. The pipeline time chart tool can also shows measures against pipeline hazards, such as data forwarding and pipeline flush, with blue arrow lines.

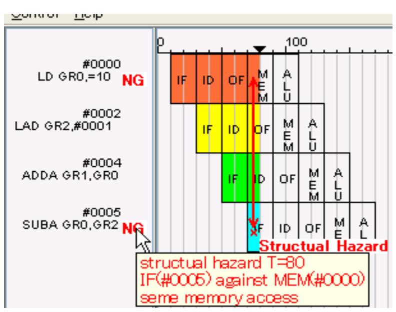

Figure 2 Structural hazard

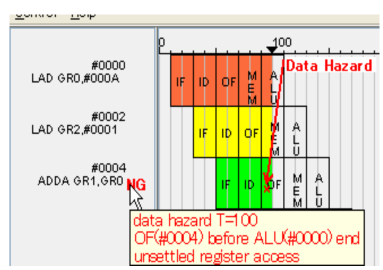

Figure 3 Data hazard

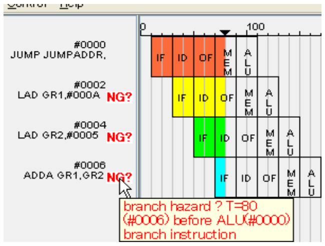

Figure 4 Executing branch instruction

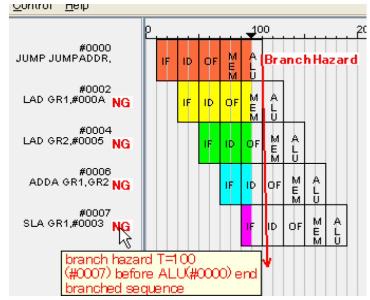

Figure 5 Branch hazard

The start time and processing time of each stage of the instruction are changeable with mouse dragging as shown in Fig. 6. The instruction which is specified with mouse is also cancelable. Therefore the users can flexibly modify the pipeline control, and then they can examine the influence of the pipeline control change. Figure 7 shows an example of avoidance of structural hazard of Fig.2. The structural hazard of Fig. 2 is resolved by waiting the IF stage of the SUBA instruction until memory access completion of the LD instruction in MEM stage.

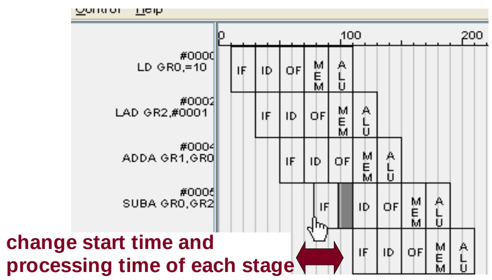

Figure 6 Modification of pipeline control

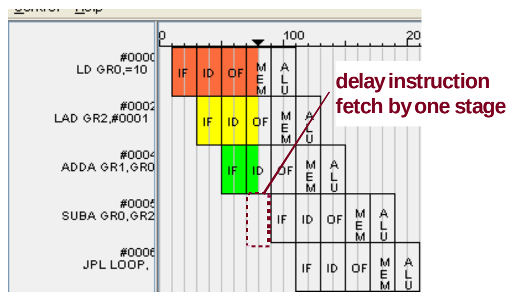

Figure 7 Avoidance of structural hazard

The users can explore combinations of instruction and stage with which the processor works correctly. They can learn good pipeline control of the microprocessor visually and effectively by using the pipeline time chart tool with a guide tool of MEIMES.

3. Conclusion

We developed the pipeline time chart tool to explore the pipeline control for microprocessor design education. The students and young engineers can learn meanings and effects of the specification in the pipeline control through examining the behavior of pipeline by using our tool. Therefore, the users could get the design skill for thinking about the specification of pipeline control architecture. This developed tool is very useful for students and young engineers. Learning using this tool is scheduled in computer architecture class of our university in 2010.

References

[1] Takahashi, R. & Ohiwa, H. (2003). Situated Learning on FPGA for Superscalar Microprocessor Design Education. Proc. SBCCI 2003 (pp.243-248). San Paulo, Brazil: IEEE Computer Society Press

[2] Morimoto, T & Tsutsumi, T.(2005). Early Development of Microprocessor Design Education System MEIMES-DESIGN. Proc. Forum on Information Technology 2005 (Vol.4 pp.353-354).Tokyo, Japan : ISPJ and IEICE (In Japanese)

[3] Morimoto, T & Tsutsumi, T. (2009). Development of Instruction Analysis Tool for Computer Design Education. Proc. The17th International Conference Computer In Education ICCE2009(pp.489-491). Hong Kong: APSCE

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A Modeling Language for Supporting Evidence-based Nursing Processes

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Abstract: In the past decade, evidence-based practices are attached importance to nursing care field. Evidence, such as randomized clinical trial, has presented the facts in a scientific way that offers people believable and referable guideline in clinical practices. In order to practice evidence-based nursing, practitioners must understand the concept of studies and know how to accurately evaluate these studies. However, currently the growing numbers of studies are almost published as a science article and written in English. This fact makes the evidence-based studies hard to readily understand by the nurses who work in non-spoken English countries. In this paper, we present a modeling language that based on graphical notations, called UeML, for representing the structures of nursing evidence and supporting evidence-based nursing processes. The main contribution in this proposed approach is artifact of nursing evidence represented in UeML provides a more concisely way for nurses to understand the context of evidence-based studies and apply it.
Keywords: Evidence-based nursing, unified modeling language, nursing knowledge modeling

1. Introduction

Clinical nursing care is mostly experience-based in the past. However, sometimes such experiences are not the best solution for patients. Evidence-Based Nursing or EBN is a type of evidence-based medicine that focuses on nursing field. EBN involves identifying solid research findings and implementing them in nursing practices. An underlying assumption of EBN is a science based on evidence will tell us what the most successful and cost-effective approaches to nursing care are [5]. In order to practice evidence-based nursing, practitioners must understand the concept of studies and know how to accurately evaluate these studies. However, the growing numbers of studies are almost published as a science article and written in English. This fact makes the evidence-based studies hard to readily understand by the nurses who work in non-spoken English countries. In addition to this challenge, such text-based documents are not readily available for searching and appraising, and further sharing with other colleagues. In this paper, we explored that using modeling language to address these difficulties.

2. Methods

The concept of modeling technique is wildly adopted in many science and engineering fields. A modeling is a process to simplify, represent, and visualize a complex target. Fowler [7] defines modeling language is a language to describe concepts and constructs in the problem domain. For examples, physiologist use body anatomy to introduce complex body organs; software engineer uses modeling language to specify, visualize, construct, and document a software system [16]. The objective of this study is to develop a generic modeling language for representing the structures of nursing evidence. The proposed nursing evidence modeling language, named UeML, adopts the notations in unified modeling language (UML) [14] who has features of easy use and unification, and has been widely used in many fields such as medicine, electronic engineering, civil engineering, and so on.

Researchers usually organize their research finds, i.e., evidence, in a text-based format and depend on the published style. Evidence-based nursing studies do not have a real unified structure in common use for representing at present, first of all, we have collected a set of published studies from related nursing care studies and carry on the analysis of evidence structures (see Fig.1). Next, UeML extracts the suitable notations and diagrams from UML and integrates into the nursing evidence processes (see Fig.2). Due to the limitation of space, The features and definitions of UeML diagrams could not show here.

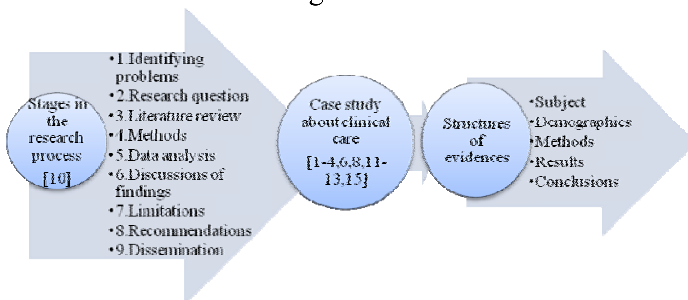

Fig. 1 Analyzing the structures from stages in the research process and case study.

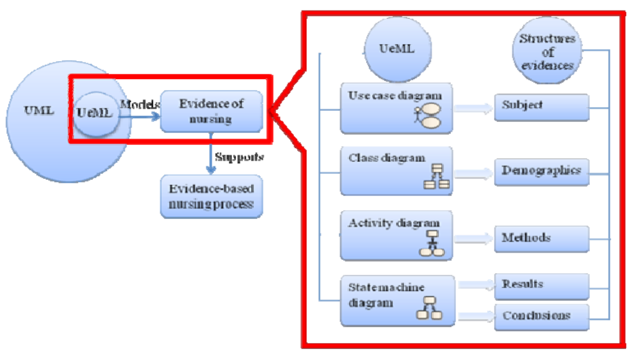

Fig. 2 Integrating UeML with evidence-based nursing processes.

3. Case study

Traditionally, literatures are text-based mostly (Left of Fig.3). Right of Fig.3 shows a UeML model we draw a literature manually based on definitions of UeML (Due to the limitation of space, only a shrink diagram).

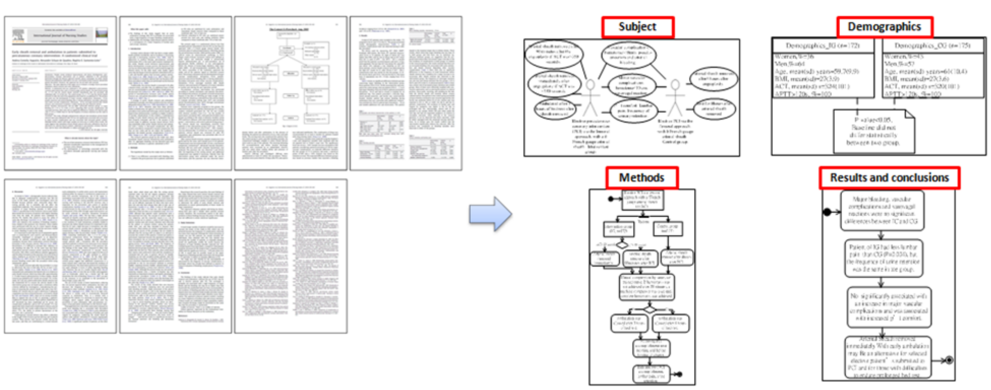

Fig. 3 Overall view of an evidence-based nursing study and UeML model.

4. Conclusions

Viewpoints from readers, researchers, and evidence-based nursing are discussed:

- UeML for readers: Graphic representation decreases the different of languages and fields. Readers can catch the architecture more easily and discuss with others through the process of drawing if the research doesn't have UeML diagrams.
- UeML for researchers: The purpose of writing studies is to share the knowledge, discuss, and apply it. Adding UeML diagrams will promote the interaction.
- UeML for development of evidence-based nursing: Knowledge translation (KT) is an iterative process that involves knowledge development, synthesis, contextualization, and adaptation, with the expressed purpose of moving the best evidence into practice that results in better health processes and outcomes for patients [9]. Optimization of the process requires engaged interaction between knowledge developers and knowledge users [9]. Researchers and readers will have a common language because UeML. Clinical nursing staffs have a clear concept from UeML model, and apply it.

References

[1] Augustin, A.C., de Quadros, A.S., & Sarmento-Leite, R.E. (2010) Early sheath removal and ambulation in patients submitted to percutaneous coronary intervention: a randomised clinical trial. *International Journal of Nursing Studies, 47* (8), 939–945.

[2] Borup, L., Wurlitzer, W., Hedegaard, M., Kesmodel, U. S., & Hvidman, L. (2009). Acupuncture as pain relief during delivery: A randomized controlled trial. *Birth, 36* (1), 5–12.

[3] Chang, L. Y., Katherine, K. W., & Chao, Y. F. (2008). Influence of physical restraint on unplanned extubation of adult intensive care patients: A case-control study. *American Journal of Critical Care, 17* (5), 408–415.

[4] Colonel, P., Houzé, M. H., Vert, H., Mateo, J., Mégarbane, B., Goldgran-Tolédano, D., et al. (2008). Swallowing disorders as a predictor of unsuccessful extubation: A clinical evaluation. *American Journal of Critical Care, 17* (6), 504–510.

[5] Closs, S.J., Cheater, F.M. (1999) Evidence for nursing practice: a clarification of the issues. *Journal of Advanced Nursing, 30* (1), 10–17.

[6] Dougherty, C. M., Jahnston, S. K., & Thompson, E. A. (2007). Reliability and validity of the self-efficacy expectations and outcome expectations after implantable cardioverter defibrillator implantation scales. *Applied nursing research, 20* (3), 116–124.

[7] Fowler, M. (1996). *Analysis patterns.* Reading, MA: Addison Wesley.

[8] Lu, S. H., Dai, Y. T., & Yen C. J. (2009). The effects of measurement site and ambient temperature on body temperature values in healthy older adults: A cross-sectional comparative study. *International Journal of Nursing Studies, 46* (11), 1415–1422.

[9] MacDermid, J. C., & Graham, I. D. (2009). Knowledge translation: putting the "practice" in evidence-based practice. *Hand clinics, 25* (1), 125–143.

[10] McSherry, R., Simmons, M., & Abbott, P. (2002). *Evidence-informed nursing.* London: Routledge.

[11] McGrath, S. K., & Kennell, J. H. (2008). A randomized controlled trial of continuous labor support for middle-class couples: Effect on cesarean delivery rates. *Birth, 35* (2), 92–97.

[12] Mollaoğlu, M., & Beyazit, E. (2009). Influence of diabetic education on patient metabolic control. *Applied nursing research, 22* (3), 183–190.

[13] Meng, Y., Qingjie, G., Xiangtong, Z., Shugang, S., Yaohua, W., Liweia Z., et al. (2009). Intensive insulin therapy on infection rate, days in NICU, in-hospital mortality and neurological outcome in severe traumatic brain injury patient's: A randomized controlled trial. *International Journal of Nursing Studies, 46* (6), 753–758.

[14] Object Management Group. (2009, February 2). *OMG Unified Modeling Language, Superstructure Version 2.2.* Retrieved October 28, 2009, from the World Wide Web: http://www.omg.org/spec/UML/2.2/Superstructure/PDF/

[15] Padmanabhan, A., Stern, M., Wishin, J., Mangino, M., Richey, K., DeSane, M., et al. (2009). Clinical evaluation of a flexible fecal incontinence management system. *American Journal of Critical Care, 16* (4), 384–393.

[16] Rumbaugh, J., Jacobson, I., & Booch, G. (1999). *The unified modeling language reference manual.* New York: Addison-Wesley.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Development of Streaming Contents Generation System for Rapid e-Learning

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Abstract: A streaming contents generation system for rapid e-Learning has been developed. PowerPoint with narration is converted to e-Learning contents, which is then published through a Web system, allowing researchers not familiar with information technology to easily create e-Learning contents. This system, called the Kumamoto Universal and Multipurpose Authoring system (KUMA), is useful for propagating rapid e-Learning.

Keywords: Authoring system, Rapid e-Learning, Streaming Technology, PowerPoint, Higher Education

1. Introduction

The development of Course Management System (CMS) [1] and authoring software [2-3] as well as the standardization of e-Learning contents [4] have driven e-Learning in higher education. However, the lack of professional staff to create e-Learning contents and maintain systems remains a problem. Creation of educational contents is a significant problem for researchers who are not familiar with information technology, particularly when teaching materials include narration and text which to date have required much time and technical skill [5]. In order to create effective e-Learning contents, many authoring software has been developed by researchers and vendors. Such authoring software makes possible creation of dynamic e-Learning contents, including multimedia. However, many researchers remain reluctant to create e-Learning contents due to the complexity of the authoring software. Rapid e-Learning has grown as an attractive method to diffuse e-Learning in higher education [6]. The purpose of rapid e-Learning is to perform quickly a series of executions from e-learning contents creation to distribution. With rapid e-Learning, a researcher is easily able to create e-Learning contents using the Kumamoto Universal and Multipurpose Authoring (KUMA) system. Our meaning of "rapid" is that whole time for making e-learning contents is evidently quick and easy way.

In this paper, a streaming contents generation system with which anyone can easily create e-Learning contents is introduced. This system, called the KUMA system, not only allows creation of e-Learning contents from PowerPoint with narration but also publishes e-Learning contents without the need for any other software, thus reducing researchers' burden. The KUMA system is expected to contribute to the further diffusion of e-Learning in higher education.

2. System Configuration

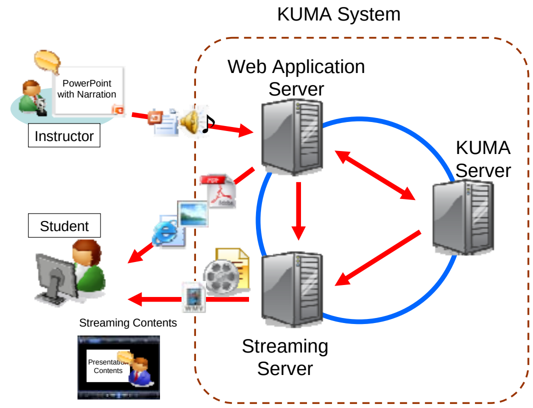

Figure 1. The KUMA system configuration

Figure 1 shows a conception diagram including the KUMA system configuration. The KUMA system consists of three servers: a Web application server on Cent OS 5.4; the KUMA server on Windows Server 2008; and a Windows Media service on Windows Server 2008. The Web application server acts as an interface between the KUMA system and users. One function is for searching and managing e-Learning contents via the interface window MYPAGE; the other is for students to access e-Learning contents via the Web application server. The KUMA server converts PowerPoint with narration to streaming contents automatically. The Windows Media Server delivers e-Learning contents generated by the KUMA server. There are similar systems developed. The authorSTREAM is one of convert system which can convert a PowerPoint with narration into Windows Media Video at the server side. However users have to install some software related to this system [7].

2.1 Web Application Server

The Web application server provides several services, including a registration and login function as well as MYPAGE for researchers and a delivery of e-Learning contents to students. In order to create e-Learning contents, a researcher the first registers via the Web application server in order to create a MYPAGE. After login to MYPAGE, a researcher can upload prepared educational materials including PowerPoint with narration, which is converted to streaming contents by the KUMA server as shown in figure 2. The compatibility with PowerPoint is crucial as more than 80 percent of higher education institutions use this presentation tool in order to create educational materials.

2.2 KUMA Server

The KUMA server is configured by Windows Server 2008 Standard edition as an operating system. Microsoft PowerPoint 2007 and Windows Media Encoder 9 run in the background and are controlled by the management program as the kernel of KUMA. The KUMA server plays a key role in the KUMA system as it converts PowerPoint with narration to Windows Media Video (WMV). Figure 2 shows the entire process of converting PowerPoint with narration to streaming contents.

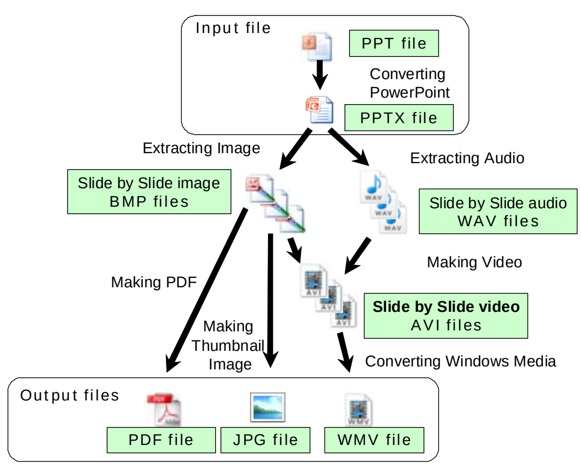

Figure 2. Flow chart of file conversion

2.3 Windows Media Streaming Server

Windows Media Service with the Microsoft Media Services (MMS) protocol is configured by Windows Server 2008 Standard edition as an operating system. E-Learning contents can be accessed via Windows Media Video Redirector (WVX), describing the location of the WMV using Windows Media Player. Windows Media Service delivers e-Learning contents at a bit rate suitable to the user's bandwidth. Two advantages of a typical streaming server are as follows: 1) protection of e-Learning contents is achieved by the Windows Media Service with MMS protocol; 2) Windows Media Player can stream the media without downloading.

3. Application of The KUMA System

The KUMA system has been applied to a series of streaming video lectures called "Streaming Book on Pulsed Power Engineering," produced by eminent researchers in the field of pulsed power engineering. The figure 3 shows the example of an application of KUMA system The "Streaming Book" is accessible over the Internet and thus can be used anytime and anyplace. The aim of this Website is to deepen understanding of pulsed power engineering by graduate students and young researchers. And this site opened to the world can become a good opportunity which makes a relation with a superior researcher and a student.

Figure 3. Web pages of Streaming Book

4. Conclusion

A streaming contents generation system for rapid e-Learning has been developed. PowerPoint with narration is converted to e-Learning contents, which is then published through a Web system. Researchers not familiar with information technology can easily create e-Learning contents. This system, called the Kumamoto Universal and Multipurpose Authoring system (KUMA), is useful for the diffusion of rapid e-Learning.

References

[1] Y. Vovides, S. Sanchez-Alonso, V. Mitropoulou, G. Nickmans (2007). "The use of e-learning course management systems to supportlearning strategies and to improve self-regulated learning", *Educational Research Review, Vol. 2*, pp.64-74.

[2] E. Reyes-Garcia and I. Saleh (2004). "HyperTectol: an assistant and authoring tool for using Multimedia in Learning Objects creation", *Fifth International Conference on Information Technology Based Higher Education and Training*, CD-ROM folder 190.

[3] K. Kozono, A. Teramoto and H. Akiyama (2005). "Development of Efficient Authoring Software for e-Learning Contents", *The transactions of the Institute of Electrical Engineers of Japan. A, A publication of Fundamentals and Materials Society 125*(8), pp.675-682.

[4] K. Nakabayashi (2007). "Technology Standardization and Open Movement in e-Learning", *Japan journal of educational technology Vol. 31*(3), pp.285-295.

[5] National Institute of Multimedia Education (2006). "Report on education using ICT including e-Learning, 2006", p.25.

[6] M. Andrew (2009). "Introduction of rapid e-learning development within an international geospatial company", *Joint ISPRS Workshop, E-Learning Tools, Techniques and Applications.*

[7] authorSTREAM Online PowerPoint Presentations and Slideshow Sharing,http://www.authorstream.com

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Design and Implementation of Synchronized data with e-Learning systems

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Abstract: There have been a lot of web systems in Higher Education (e.g. LMS, library system, registration system and so on). When several LMSs (e.g. Moodle) exist in each faculty (or each department), the student should access to any LMSs. Furthermore the web usage between universities extends. It is assumed that the students uses LMSs of any universities. When credit transfer system at other institutions is signed, student can take a course at other university's LMS. The student acquires the credits from other universities. It is necessary to check the recording history log. However, the log is distributed. The demands of interconnection of data of between systems arise when several Web systems exist. To solve the problem, we develop the synchronized environment that uses the web interface between web systems.

Keywords: LMS, e-Learning, data synchronize, script agent, web scraping

Introduction

In the 2000's, Japanese higher education introduced the web based information systems rapidly. Especially most universities built an e-Learning system. A student can download digital learning materials from LMS (Learning Management System). The number of contents increases and there is diversity. LMS is not an isolated system any more. There are a lot of web systems in the University. Some systems work alone. The user requests the cooperation between systems. One is implementation of single sign-on and other is data linkage. As for single sign-on, many methods are proposed and single sign-on is used at a lot of universities. Also, the federation that ties the organization based on SAML is operated. In our university, we can use SSO service by the Shibboleth that is the famous framework of federation. On the other hand, the frame of the data exchange is not maintained still enough.

The use of LMS in the class becomes common. The information of the student who takes a class is in both the registration system and LMS. The class name (information of teacher in charge and so on) is in both the electronic syllabus and LMS. In addition, when the user is using some LMSs, the teacher and the registrar staff will check the recording history log in each LMS. Under federation, it is natural for the student to use LMS of other universities. The learning history of one learner is distributed. It is necessary to construct a mechanism of data exchange between systems. The purpose of this research is to propose the frame of the data exchange.

There are various methods in the data exchange. We pay attention to the indirection approach. There is a data base in one of the components of the WEB system. There is a method of converting data directly between data bases. The realization of this method is easy. However, the database format changes in the meaning of an author of the web system. It is always exposed to the danger of the change. In many Web systems, import and the export function of data is implemented. This import and export function is useful for realization of the data exchange. Flexibility is high though this method is an indirection.

1. Web base information system

The concept named e-Learning covers wide areas. For example a video based distance education is a kind of e-Learning. We handle the LMS of the Web based information system like a Moodle as the typical e-Learning. A lot of universities have introduced a variety of WEB systems other than LMS, like an e-Registration, an e-Portfolio, a Portal, a Library, a grade management system, a student information database and so on. LMS has the functions, management of learning material (like PDF file), transfer of the homework, announcement, electric forum, minutes test and so, at each class. We use the open-source LMS "Moodle". The Moodle is unsuitable to large-scale use. So, we set up Moodles at each faculty (or department). Various information is necessary to operate LMS. The LMS has some databases previously. The LMS needs the information, like a student's attribute, a class name, a charge teacher, a list of registered students and so on. The LMS receives these data from other systems in some way or other. It is not a good method that a human staff enters registration information on the LMS's console while watching the sheet that is printed out from the e-Registration. The users and operation staffs want to exchange the data automatically between systems. It is necessary to design work to achieve this desire, taking out necessary information from the database, converting the data format, and putting in other database.

2. Agent based data exchange

We think over the solution that synchronizes the data between web based systems. We classify the method of the data synchronization in the following three kinds.

1. Direct synchronization from database to database

The LMS database of X University connects to the database of Y University. The information transfers from database to database directly. A smart copy program enables the copy of data. the copy program is necessary to know the database design. The programmer should analyze the database.

2. Database sharing between applications

Some applications share the database. It is not a big problem that the database is shared or not for the behavior of the Web system. The web system keeps usually processing only. The programmers of the application should agree the database sharing previously.

3. Agent script method

Data is converted by using broth import and export functions of the Web system. The Web system has the function to output data outside as the file and to read the file. Data is saved once as a file. Because the XML format has high flexibility, we use the XML format. The script operates the interface of the Web system on behalf of human. It is necessary to prepare the agent script.

The second method seemingly looks efficient. However, this hides a big problem of how to design the sharing database. The programmer of the web system does not consider the sharing database. According to circumstances, it is necessary to rewrite the system thoroughly. Furthermore it is difficult to share the database when you assume the web system beyond the organizations. Officials cannot decide where to put the database physically. The realization of second method is very difficult though it is a rational idea. The efficiency of the first method is high on the process of web system. We should analyze details of the database. There is a possibility that the design of the database changes when an author upgrades the web system. We should make the copy program every time the database format changes. The cost of system development is also high.

In this research, we adopt the third method. We should make the program for this method. This program is an agent script that operates the Web interface. This method is an indirect data exchange through the XML file. Because it is an indirection, flexibility to the change of the system is high. Moreover this method can correspond even if the number of relating systems increases. We think that flexibility is more important though the cost of the system development is large.

Conclusion

In this paper, we propose necessity and implementation federation between the web information systems. Many Web systems flood in the e-Learning environment of the present university and the teacher and the student are forced very complicated processing. There are many examples about SSO between systems. However, the problem of the synchronization of data is not solved yet. We propose about the indirect data synchronous method. The flexibility of the agent script method is high.

We are building the test environment for verification. We evaluate behavior of the agent and performance in the test environment.

Acknowledgements

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References

[1] Moodle : http://moodle.org/
[2] Mechanize library : http://mono.kmc.gr.jp/~yhara/ rubyscraping/?WWW%3A%3AMechanize
[3] Yuichi, S. & Hikofumi, S. (2008). Construction and management of Educational Infrastructure System on realization of a mutual use have a multi educational system and information sharing between systems. *JSiSE research report23(7)*, 118-123

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Augmenting LMS with Repository System to facilitate Content Sharing

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Abstract: While E-learning has been supported continually, it has not gained much popularity in Thailand. A major problem is the lack of quality, as well as the variety of the learning contents, especially in the rural area where the teachers are less experienced in creating the contents compared to that of the teachers in urban areas. This paper presents a method to distribute contents between two areas that have a different quality of education. Our LMS called LearnSquare is modified to support content sharing by connecting with Fedora repository system. The teachers who use LearnSquare can choose the contents they want from repository. The large amount of contents offers variety of choices for the students to choose from according to their teachers' learning conditions.

Keywords: Fedora Repository, Learning Management System, LMS, Content Sharing

Introduction

In Thailand, the effort to promote online learning has been made over the recent years. Initially, apart from the preparation of the infrastructure, the dissemination and installation of leaning management system have also been carried out. However, as time has passed, we realize that one of the major problems of using the online learning system is not because of the lacking essential infrastructure, but the lack of quality as well as variety in the learning contents. This problem is often found in the rural areas where the number of teachers is small, thus creation of online materials was overwhelming. In addition, most of the teachers are not equipped with a tool to produce contents that could hold students attention. Meanwhile, in urban areas where the number of teachers is usually more than that of the rural, the contribution of higher quality and more diverse contents from the teachers are expected. These richer contents are mostly available to the students in the city. To solve the problem, we believe that the contents should be created and shared among people at all places. By doing so, we certainly can help expand the opportunity in learning across the nation [1].
This paper presents a combination model between a learning management system and a digital object repository. Moreover, a navigation technique is proposed to support a condition of learning in each lesson.

1. System Component

This project has 2 main components; Learning Management System (LMS) and repository system. LearnSquare is a Thai open source LMS which provides educational opportunities in Thailand. In the latest version of LearnSquare, we develop the system to connect through the repository. Fedora is an open source digital repository system that manages rich content and delivers rich digital content [2]. It combines variety of data streams that reference content anywhere on the web. Fedora repository runs as a service within a web server. It is accessible through well-defined REST and SOAP interfaces that be easily integrated into a variety of application environments with different user interfaces. This paper represents Fedora as a content center. The contents in Fedora repository system will be shared but cannot be copied to the other site.

2. Navigation Techniques

Adaptive navigation technology is also a developed in this paper. Not only an instructor can use content from digital object repository but also assign conditions in each lesson for navigating a student. The navigation technique consists of direct guidance, sorting, hiding and annotation [3]. We concentrate on hiding (focus on link hiding) and annotation technique. Annotation technique can further inform students about the current state of the annotated links by using some forms of comments.

3. System Process

The system process is shown in Figure 1. The teachers (as shown here as Instructor A,B and C) create or import contents via LearnSquare. In the case that other teacher (as shown here as Instructor D and E) also uses LearnSquare, they could search the Fedora Repository System for those contents and use them to create their own course.

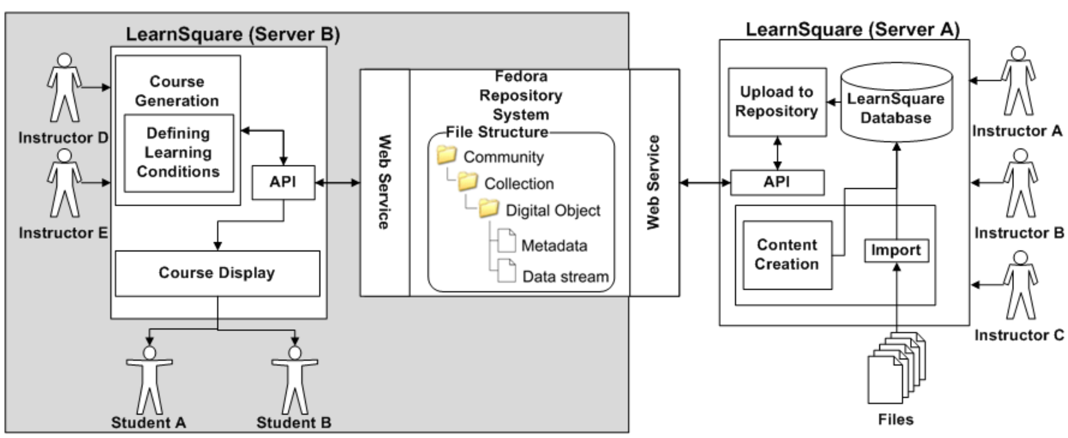

Figure 1. The system process.

3.1 Digital Object Collection

All contents are stored in content based of LearnSquare server. Whenever the instructors want to upload the contents, they have to fill an information will be used as the metadata of the contents. Contents are stored in Digital Object (DO) format. The DO should be a stand alone object since it would be easier to manipulate and retrieve [4]. Fedora Repository file structure is composed of 3 levels show in Figure 1. Community level and Collection level are used to categorize Digital Objects. Metadata in Digital Object is used for identifying DO while data stream is used for calling real contents.

3.2 Course construction and defining of learning condition

The process of LearnSquare course construction by using contents from Repository is shown in gray area of Figure 1. The example of the course structure is shown on the left in Figure 2. The Course structure consists of various lessons; each lesson is made of sub lessons. Folders sign represent parent lesson in which there are no contents stored inside, but are used to define learning conditions. Papers sign represent child lessons, which are the actual contents selected from repository.

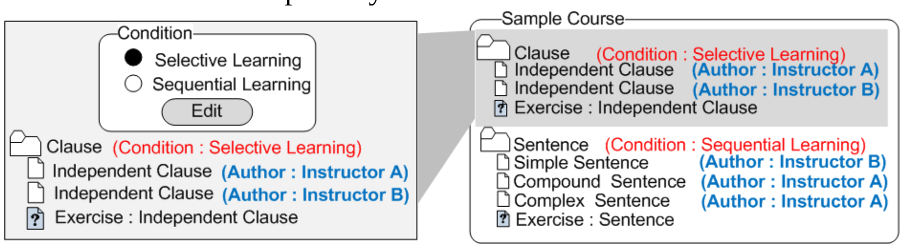

Figure 2. An example of content structure and UI of defining learning condition

Learning condition is separated into 2 parts. Selective learning means students can choose and study at least one child lesson. Sequential learning means students have to study all child lessons. The right side of figure 2 shows an example of user interface in defining learning condition. Lesson “Clause” is defined to “selective learning” so, a student can choose to study lesson “Independent Clause” of “Instructor A” or “Instructor B”. While lesson “Sentence” is defined to “Sequential Learning” so, a student has to study “Simple Sentence”, “Compound Sentence” and “Complex Sentence” respectively.

4. Conclusion and Future work

The main purpose of this project is to make quality contents available to all places including the rural areas where there are fewer teachers than in the city. Those teachers can gather the contents created by teachers in the city and create their own courses. We have modified our LMS so that LearnSquare can be connected to Fedora repository, content center. Furthermore, since contents in the Repository are significantly large, chances of finding duplicated contents are also high. This is considered to be an advantage because the teachers will have enormous choices of contents to choose from.

For future work, we will reinforce the making of high quality contents. Moreover, authoring tool will be developed for supporting content generation.

References

[1] Bhattarakosol, P. (2003). IT direction in Thailand: cultivating an e-society. *IT Professional*, Vol. 5, Issue 5, 16-20.

[2] Rafael P. (2008). Distributed Digital Content Access In a Virtual Community Based e-Learning Platform. In I. R. Salvador R., Roberto H., Timothy R., Manuel C., *38th ASEE/IEEE Frontiers in Education conference*, New York.

[3] Binglan H. (2001). Student Modeling and Adaptivity in Web Based Learning Systems. *Master's Thesis of Massy University*, New Zealand. 30-33.

[4] Fertalj, K. (2009). Analysis of e-learning repository systems and frameworks with prepositions for improvements. In I. R Bozic, N. Jerkovic, H., *Proceedings of the ITI 2009 31st International Conference on Information Technology Interfaces*. 487–492.

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Development of IR Tool for Tree-Structured MathML-based Mathematical Descriptions

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Abstract: The quantity of Web contents including math has skyrocketed in recent years. Some pieces of previous research have dealt with the development of IR systems targeting MathML-based math expressions. They are still developing in terms of lack of fuzzy search functions or low hit rates. One of the authors in ICCE2008 proposed the IR tool enjoying a fuzzy search function by adopting regular expressions. The objective of this study is to propose a "tree structure" algorithm for the fuzzy search function with better precision.

Keywords: IR system for math, MathML, fuzzy search, tree structure

Introduction

With the expansion of Web contents dealing with math expressions, the needs have increased for IR(Information Retrieval) systems treating math. Some pieces of previous research have worked on the development of IR systems targeting MathML-based math expressions. It has to be admitted, however, that none of them are complete in terms of availability for composite retrieval and fuzzy search. In [1], one of the authors reported on the IR tool implementing fuzzy search. The validity and usefulness of the tool were verified, but the limitation of the tool was also revealed. In this study, it is our objective to propose a "tree structure" algorithm for the fuzzy search function with better precision.

1. Previous Research

[2], [3], and [4] are similar to our study although the systems are not found completely satisfactory in either 1. math structure is not fully considered, 2. indexing tag information is too rigid to realize fuzzy searching, or 3. only partial implementation has been made.
[5] is unique in proposing an IR system by incorporating math expressions in "extended" MathML-formats for better grasping their (mathematical) meanings. Likewise, no results of implementation or experiments are shown.

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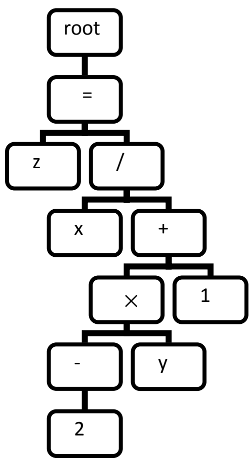
2. Retrieval with Tree Structure

(Presentation) MathML data need to be further hierarchized before retrieving process since parentheses, operators, variables and numbers are all treated as siblings. This doesn't help the system execute retrieval considering data structure. Another problem is that MathML allows degree of freedom in describing same math expressions. In order to solve these problems, MathML data is further hierarchized and for minimizing noises in retrieving. The tree structure for "z=x/(-2y+1)" is updated as Fig. 1 after processing hierarchization.



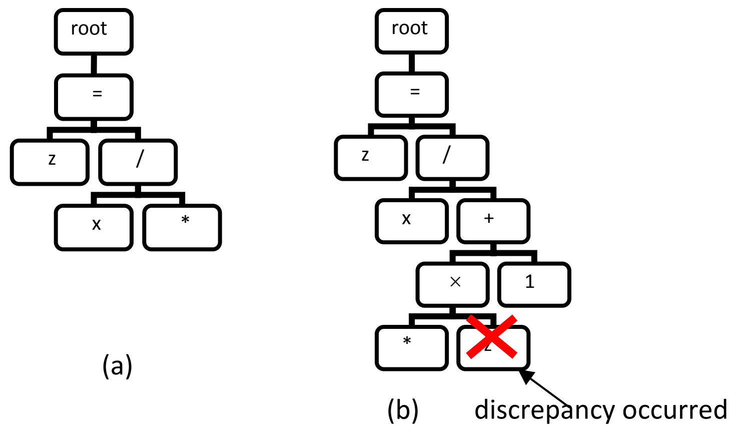


Fig. 1: Optimized Tree Structure

Fig. 2: Examples of Query Tree

A query tree is compared with target trees by the following retrieving algorithm (depicted by a pseudo-program style). Its implementation doesn't require lots of labor since operations for comparison are provided in line with the service for DOM.

Move(p) sets p to point to

1. p's child node
2. p's unvisited sibling node
3. p's parent node

, according to these priorities.

<< Retrieving Algorithm>>

```
Set t1 = pointer to root node of target tree;
Do
    Matched = True; Set t = t1; Set t1 = Move(t1);
    Set q = pointer to root node of query tree;
    Do
        Set q = Move(q);
        If (Node(q) < > "*" {
        If (corresponding node of target tree doesn't exist) { Matched = False; Exit Do;}
        Else {Set t = Move (t); If (Node(q) < > Node(t)) { Matched = False; Exit Do;}}}
    While (next unvisited node of query tree exists)
 While (not Matched Or next unvisited node of target tree exists)
```

If Matched = True holds true when the outer Do loop is exited. This represents that the query math expression matched the target expression in some way. It is verified that, for instance, the query tree of Fig. 2 (a) matches the target tree (Fig. 1) while that of (b) doesn't.

3. Experiments

3.1 Outline of Experiments

IRs were attempted for 1,000 MathML data sampled from Wolfram Functions Site (http://functions.wolfram.com/), with two algorithms separately. The results of the experiments are shown in Table 1. The numbers of math expressions hit by the selected algorithm are given in the table. The numbers in parentheses are the ones hit incorrectly.

Table 1: Results of Experiments ("*" is a wildcard)

Retrieval / Algorithm	IR1	IR2	IR3	IR4	IR5
Regular Expression	9	40(9)	18	1	231(215)
Tree Structure	9	37	18	1	16
Correct numbers	9	37	18	1	16

IR1: $\cos^2(z)$, IR2: $\frac{\sqrt{*}}{*}$, IR3: $\cos^2(*)$, IR4: $\frac{\sin(*)}{\cos(*)+*}$, and IR5: $\frac{*-*}{*+*}$

4. Summary and Future Plan

In this study, IR tool targeting MathML-based math expressions was implemented. Focusing on its feature, IR algorithm applying tree structure as well as hierarchization of presentation MathML were proposed. Our future plan is the implementation of IR tool with fuzzy search function, with no restrictive conditions. The augumentation of dataset is also strongly expected for more various search. Another constraint of the current tool is its interface, especially in terms of query-inputs in math expressions.

References

[1] Y. Miyazaki, Y. Iguchi, "Development of Information Retrieval Tool for MathML-based Math Expressions", ICCE2008, pp. 419-426 (2008).

[2] T. Nakanishi, et al., "An Implementation Method of Composite Association Retrieval System for Data of Mathematical Formulas", DBSJ Letters, Vol.4, No.1, pp. 29-32 (2005).

[3] H. Hashimoto, et al., "A Survey of index formats for the search of MathML objects", IPSJ SIG Notes 2007-DBS-142-(10), Vol.2007, No.54, pp. 55-59 (2007).

[4] K. Otagiri, T. Murata, "Search of Mathematical Formulas Using MathML", 22nd Annual Conference of the Japanese Society for Artificial Intelligence, (2008).

[5] B. R. Miller, A. Youssef, "Augmenting Presentation MathML for Search", Intelligent Computer Mathematics, AISC 2008, pp. 536-542 (2008).

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Web-based Teaching Practice System Design for Pre-service Teacher[1]

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Abstract: The policy of free education for normal university students issued by the Ministry of Education (MOE) has been implemented in 6 subordinate normal universities since 2007. The implementation of the policy requires pre-service teachers having practical abilities. Traditional education module couldn't solve the problems such as resources shortage, practice activities limited by space and time. However, the web-based teaching practice system could provide good environment for solving these problems. This paper is based on the project of "Application demonstration of innovation teaching practice system based on IPV6" which is supported by the national development and reform commission. We designed the practice system for pre-service teacher. The innovation of this paper is designing a practice system which could fulfill pre-service teachers' demands and offer excellent digital environment to improve the quality of teaching abilities.

Keywords: Pre-service teachers, Teaching Practice System, Design

1. Background

At present many graduates from normal universities and some teachers after being trained find it difficult to exercise advanced education ideas and methods into practical teaching. This phenomenon would depart teacher education idea from practice; moreover, teachers' professional level would also be greatly affected. So how to enhance teachers' pre-service practical knowledge becomes one of the most important educational goals of normal colleges[1].Web-based teaching practice system for pre-service teacher can effectively overcome the problems such as resources shortage, practice activities limited by space and time which exist in traditional practical model. Training teaching abilities in network environment can also improve the learning quality of practical process. So we designed a teaching practice support system to support pre-teacher education.

2. System division and design objectives

In China, teaching practice consists of three parts: virtual field study, microteaching and internship teaching. These three parts are arranged in hierarchical way. Virtual field study is the first step to cultivate pre-service teachers' practical ability. After grasping teaching theory, pre-service teachers are required to watch excellent teaching videos of other teachers or experts, analyze their teaching processes objectively, learn common teaching methods and strategies, try to turn teaching theory into practice in their minds. This will

[1] This paper is based on the project "teacher education innovation system for Pre-service Teacher" which is supported by State Development and Reform Commission （project number：121）

cultivate their practical knowledge. Microteaching is the second step to cultivate pre-service teachers' practical ability. Firstly, they need to teach in virtual teaching environment and their action will be record as videos. And then analyze their own teaching videos, find problems and try to solve problem. This would help students cultivate self-reflection ability and give objective teaching evaluation. Internship teaching is the third step to cultivate practical ability of pre-service teachers. They would get teaching experience in real, complicated environment .At the same time, they can check education theory from books and form their own practical knowledge[2]. The structure of this three-step subsystem is shown in Fig. 1.

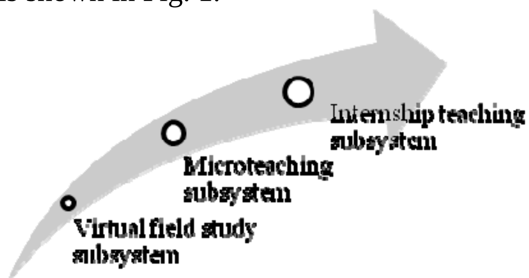

Fig. 1 relation of three subsystems

3. System design[3]

3.1 operation flows design

Each subsystem has some different functions and parts of same functions. When designing the system, we couple the same functions. The unique features of each subsystem will be designed and developed independently. In this way, the development costs can be reduced and the system usability can be improved. Users can use the subsystems easily when they are familiar with one of the subsystems. Key operation flows of three subsystems are shown in Fig. 2.

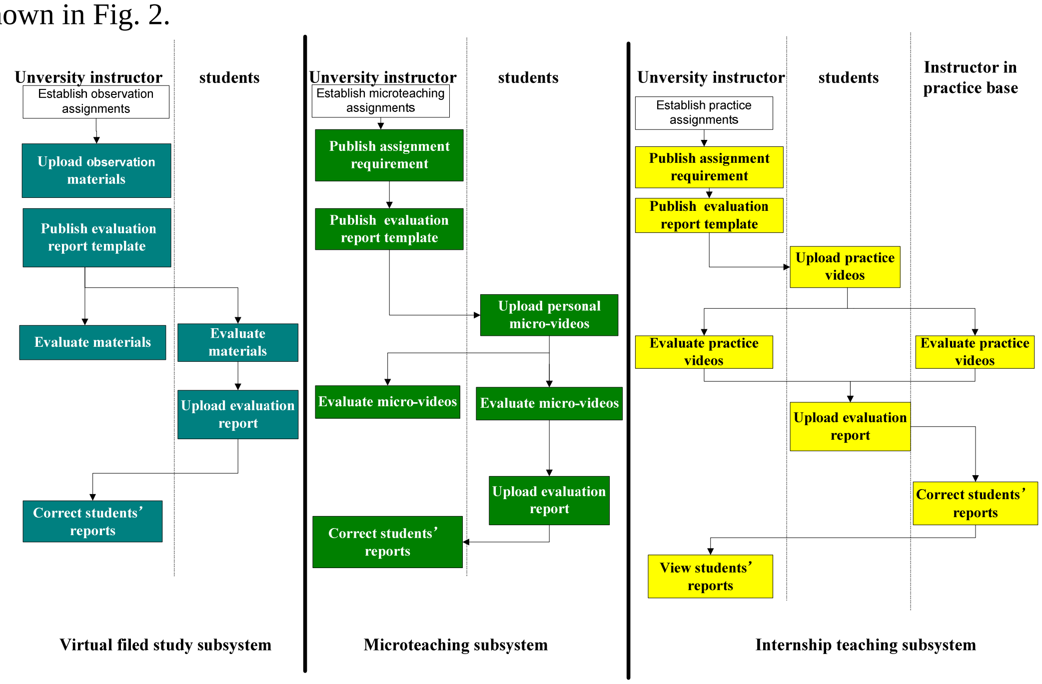

Fig. 2 Key operation flows

3.2 Function module design[4]

Each subsystem includes two main function modules: teaching module and teaching tools. The design is shown in Fig. 3.

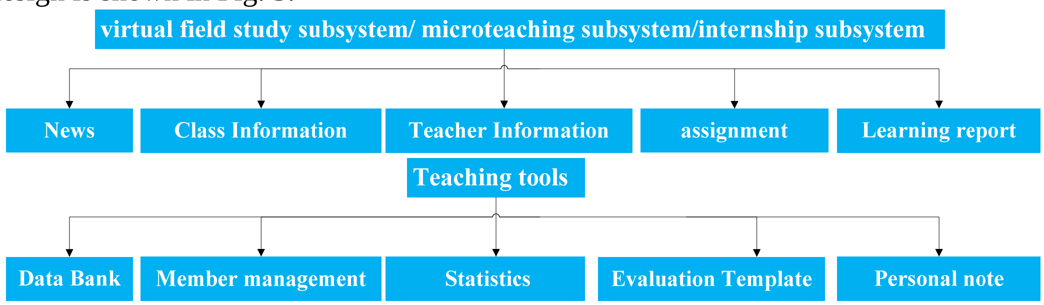

Fig. 3 Function modules

4. Development environment

The architecture of practice system for pre-service teachers is B/S. we use java as the development language and use SSH (Spring + Hibernate + Struts2) and JDK6.0 as the technology architecture. The system database is Oracle 10i. The system server is based on Linux/Windows 2000 Server operating system, and the middleware software is Tomcat 6.0 or above version which provide web services.

5. Summary

After being published, the system will be able to support 5 million users. 2,000 users can visit the platform at the same time.1, 000 users can play video at the same time. The number of courses is expected to reach 300 or above, and the number of observation course 450 per time. The number of data is expected to reach 6 TB or above. The system has already achieved Secure Single Sign-on and the resource and data can be shared and exchanged with other systems. Our next research will focus on the key technologies including copyright protection of resource, video broadcast, and system interface. Meanwhile, we will try to achieve the goal of covering the National Normal University and secondary school, supporting normal students, educational masters and teachers studying online. We will try our best to promote the reform and innovation of teacher training model in China

Reference

[1] Wu Qiufen. Thinking of ways to strengthen students' practice ability[J].Journal of Huaibei Coal Industry Teachers College(philosophy and social science)，2008，(6):156-160

[2] Zhang Lizhi, Qin Haozheng. Practical Knowledge in Teacher Education Revisited. Modern University Education,2009, (3):19-2

[3] Liu Lei, Fu Weili. Practice Ability: Meaning, structure and Training Strategy [J].Education Science, 2005,（4）：1-5

[4] Kuang Shanyun. Implications of WISE inquiry learning platform [J]. China Educational Technology, 2010,（1）：78-81

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Development and Practical Use of Assignment Report Grading System on Economics courses

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Abstract: It is well known that an assignment report has positive effect for learning. However, a great deal of work is required to evaluate and give feedback to it, because it is difficult to reach agreement on grading standards among setters (instructors), graders (teaching assistants), and participants in the course (students). Therefore, in this research, we have been developing an evaluation support system of the assignment reports that is used by the teaching assistants. The system provides a report format that the students are able to follow to complete the report. The format allows the teaching assistants to insert their comments in a more visualized form that is easier to be understood by the students. This paper shows how the results generated from this correction support system are different from those generated by the conventional ways of report checking.

Keywords: assignment report, marking, collecting support, writing support

Introduction

Instructors realized that they could promote student learning by assigning assignment report. Many educational institutions rely on assignment report. Kumagai et ai.[1] developed a system for students' laboratory assignment report in engineering as a means to check the order of submission and organizing, for both first submissions and resubmissions. They shortened the time for arranging assignment report. Sumiya et al.[2] proposed the lightweight and maneuverability system, including only the arrangement function of assignment report without a large-scale support system such as Moodle or WebCT. They support the five submission measures: e-mail, e-file, text in a browser, URL, and off-line activity. It is very interesting that the systems by Kumagai and Sumiya provide a specialized arrangement function for assignment report and save time in submitting assignment report for both instructors and students. On the other hand, Takano et al.[3] practiced the automatic checking system by an analytic technology for sentence structure over the issue of object orient programming. However, only a few studies so far have analyzed the effects of correcting and returning student assignment report with individual comments in order to improving writing ability in large sections of social science courses.
We are concerned with measures of effective correction of assignment report, improvement in writing ability, and encouragement of continuous interest Okuda et al.[5]. This paper describes the system targeting essay assignment report in economics departments.

1. Practice of correction of assignment report

1.1 A scale of practice and changes in the system

Table 1 shows a number of students and rate of submission of their assignment report. We piloted our research in an International Finance course until 2008 and expanded three courses of International Economics in 2009. The changes in the system were in five stages. The goal was to improve ease of use for students and teaching assistants, as they moved from paper base (Stage I) to G-mail and Excel (Stage V).

Stage I(Paper base): 2001, Stage II(WebCT): 2002～2007(2nd)
Stage III(WebCT- Partition): 2007(3rd),
Stage IV(WebCT and Acrobat): 2007(4th)～2008(b)
Stage V(G-mail and Excel): 2009(c)～

Table 1 : A number of students and rate of submission of their assignment report

	2001	2002	2003	2004	2005	2006	2007
number of students	475	203	347	91	186	216	170
rate of submission	―	―-	―	―	―	80%	79%
	2008(a)	2008(b)	2009(c)	2009(d)	2009(e)		
number of students	169	63	206	63	100		
rate of submission	80%	78%	93%	84%	84%		

This research aimed at various ways from Stage I to Stage V. The conditions we use for our system are (1) students do not bear the expense (2) usable by only web browser and reliable (3) easy to operate.

1.2 The way to set up the problem and the learning effects

The research reports in this study are essays of roughly six hundred characters each. The questions are “Explain/ consider with concrete examples ~” which is a major essay style in schools of social science. To develop students’ writing ability, our system provides “enunciation style,” adding guidance to assist students in answering the questions. This guidance recognizes factors that students are likely to miss, and it does not restrict students from discussing freely. Figure 2 shows the interface of this system.
For instance, the guideline of “Consider an opportunity cost concretely” in 2009(a) is to: (1) explain the definition of an opportunity cost (in roughly 100 characters), (2) show more than three specific examples of an opportunity

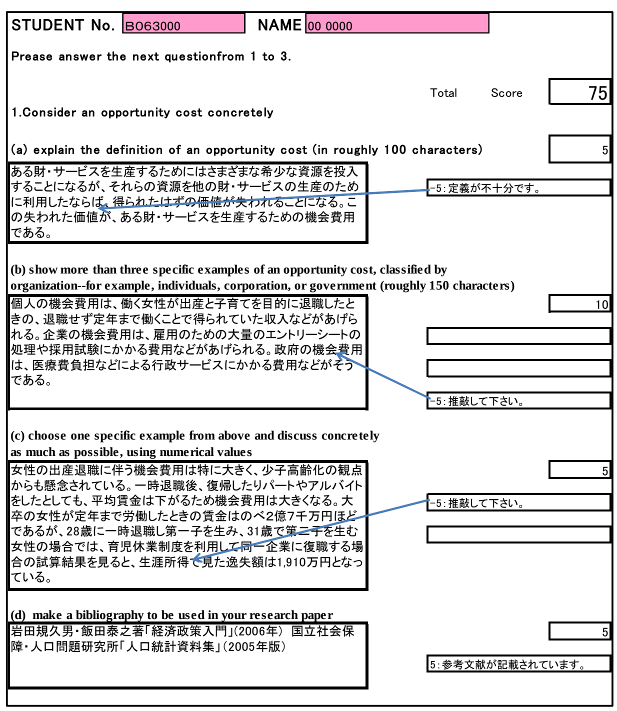

Figure 1 The interface of this report system. (In this system, Students answer in Japanese.)

cost, classified by organization for example,individuals, corporation, or government (roughly 150 characters), and (3) choose one specific example from above and discuss concretely as much as possible, using numerical values, (4) make a bibliography to be used in your research paper. Students prepare elements and fill in answer sheets. In this research several teaching assistants worked on corrections of numerous students' papers. Since we set up the appropriate guideline, the grading standard was shared among an exam setter (instructor), graders (teaching assistants), and participants in the course (students). Figure 1 shows guidelines of the answering sheet and its answer. Figure 2 shows the changes of scoring five groups.

When students were assigned multiple research reports every year, the percentage of 'A' and 'B' grades were increased in proportion to the number of reports. Those receiving 'D' and 'E' grades also improved over time as a result of the correction of their assignment report.

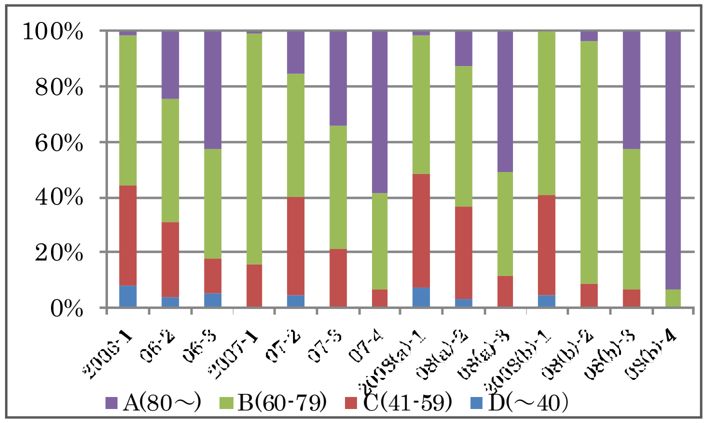

Figure2: The changes of scoring from 2006 to 2008. (A: 100-81％、B：80-61％、C:60-41%、D:40-21%、E:20-0%）from 2006 to2008(b)

2. Conclusion

The purpose of this study was to save time in correcting and submitting assignment report, as well as achieving a shared grading standard. We put this system into practice in an actual course and found it to be successful in a class of roughly two hundred students. We saved labor by using the web for distribution, collection, and return. Since this system achieved consensus in grading and evaluating among instructors, graders (teaching assistants), and participants in the course (students), instructors hardly had to do any grading. By using the guidelines to put students' arguments into shape and in precise sentences, graders were able to grade without little actual knowledge of the subject. By examining ways to set up assignment report and achieve consensus in grading, this study helps students improve their writing ability while saving time in grading.

References

[1] Narimoto, S., Li, X. Deguchi, H., Ohta, T., & Sakai, S. (2007). Analysis of Turnaround Time in On-line Report Correction Support System. *IPSJ MAGAZINE, 48*, 2781-2790 (in Japanese).

[2] Sumiya, T., Nagato, Y., Inagaki, T., & Nakamura, J. (2007). On an assignment management system using WWW and e-mail. *IPSJ SIG Technical Reports, 2007*(101), 109-112 (in Japanese).

[3] Takano, T., Miyakawa, O., & Kohama, T. (2008). Development and Evaluation of a Scoring Support System for Object-Oriented Programming Education. *IPSJ SIG Technical Reports,2008*(103), 41-45 (in Japanese).

[4] Okuda, M., Ishida, M., Ochi, Y., & Hirashima, T.(2008). A Supporting system to write report and its learning effects. *IPSJ SIG Technical Reports, 2008*(128), 75-80 (in Japanese).

[5] Okuda, M., Ishida, M., Hirashima, T., & Ochi, Y.(2009). Designing a writing assistance system by using ICT. *IPSJ Symposium Series, 2009*(6), 109-116.

[6] Ogata, H., Yano, Y., & Wakita, R.(1998). CCML:Exchanging Marked-up Documents in a Networked Writing Classroom. *Computer Assisted Language Learning, 11*(2), 201-214.

[7] Burstein,J., Kukich, K., Wolff, S., Lu, C., Chodorow, M., Braden-Harder, L., & Harris, M.D. (1998). Automated scoring usinga hybrid feature identification technique. *Proceedings of the COLING/ACL*, 206-210.

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Development of Multimedia Terminal that Uses Personal Tempo

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Abstract: In this paper, we propose a novel multimedia terminal in which the presentation tempo of the contents, such as videos, slideshows, and animation, are determined by the user's personal tempo. We examined the relationship between the user's personal tempo and a presentation tempo that the user prefers. The results showed that there was a correlation between the personal tempo and the presentation tempo. We then developed a multimedia terminal by using Flash. The terminal has two new functions: a personal-tempo measuring function and a display-speed control function that changes the presentation tempo of the contents. This tempo is determined by the user's personal tempo.

Keywords: personal tempo, multimedia terminal, presentation

Introduction

Animation and slideshows that are included in multimedia contents, such as information terminals and learning materials, are generally presented at a speed that has been decided by the content producer beforehand. There can be large individual differences in the presentation tempo that users prefer [1, 2]. A multimedia terminal has been developed in which the user can freely change the display speed or tempo; however, the user must operate the keyboard or mouse to adjust the speed. The speed that the user prefers can change if the contents change. Therefore, it is necessary to adjust the speed whenever the contents change, and this adjustment can be troublesome for users.

We propose a new multimedia display terminal that can present animation and images, such as slideshows, at an appropriate speed determined by the user's personal tempo. A personal tempo is the tempo that is observed in activities such as walking, speech, and other actions in everyday life. Intra-individual variation in the personal tempo is low, while inter-individual variation is high. A high correlation of the tempo is found across similar actions [3].

1. Relationship between Personal Tempo and Presentation Tempo

1.1 Experiment

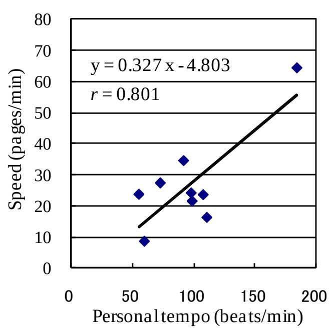
The presentation tempo that a user prefers was measured using a slideshow designed for college introduction. The personal tempo was also measured before and after this measurement, and the average of the two measurements was used as a personal tempo. The participants in this experiment were nine college students.

The number of beats during 1 min of a tapping task was measured as the personal tempo. The participants were asked to click the left mouse button at the speed at which they felt most comfortable.

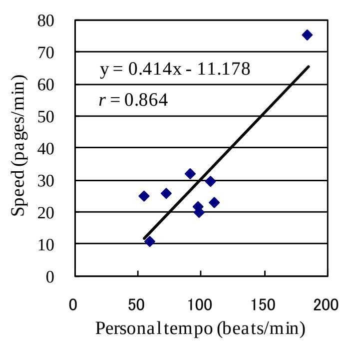
The presentation tempo that the user prefers was measured using a slideshow that displayed pictures of rooms and buildings, as an introduction to the college. The participants were asked to move the mouse to the right and to the left in order to adjust the interval time of the slideshow. A total of four titles of the slideshow were used: "Rooms, large image (1280 × 1024 pixels)," "Rooms, small image (640 × 480 pixels)," "Buildings, large image (1280 × 1024 pixels)," and "Buildings, small image (640 × 480 pixels)."

1.2 Results and Discussion

Figure 1 shows the relationship between the slideshow speed that a user prefers and his personal tempo, as well as the Pearson product-moment correlation coefficient for the association between the slideshow speed and the personal tempo for the nine participants. The correlation coefficient r ranged from 0.801 to 0.866. The results showed that there is a correlation between them.
The difference in the speed between the participants was very large; however, each individual participant consistently displayed the same difference. Furthermore, the difference in the speed between the titles was smaller than that among the participants.
As a result, when the multimedia contents are presented, it is desirable to consider not only the difference in the contents, but also in the user's favorite tempo.



(1) Title: Rooms, Size: large



(2) Title: Rooms, Size: small

Fig. 1 Example of relationship between personal tempo and slideshow speed.

2. Development of Multimedia Terminal

2.1 General

The experimental results showed that the presentation tempo that the user prefers was different among the various users; however, there was a correlation between the personal tempo and the presentation speed. We then developed a multimedia terminal by using Flash to introduce the college. In this terminal, the presentation tempo is determined by calculating the user's personal tempo. The top page of the contents is shown in Figure 2. A user can obtain information about the college, such as videos, slideshows, pictures, and text, by touching the screen. In addition to these basic functions, the terminal has two new functions: a personal-tempo measuring function and a display-speed control function.
The personal-tempo measuring function measures the user's personal tempo. The user who uses this terminal for the first time is asked to click the left button of the mouse for 30 s at a speed at which the user feels most comfortable.

Fig. 2 Top page of the college guide.

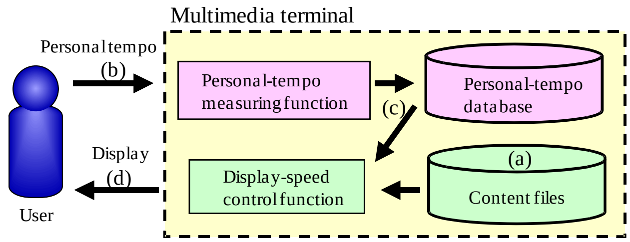


Fig. 3 System configuration.

The display-speed control function adjusts the presentation tempo automatically, such as the slideshow interval time. The speed is calculated using the user's personal tempo and the prediction formula, which is obtained by examination beforehand. The slideshow interval time is extended for a user whose personal tempo is low.

2.2 System Configuration and Process Flow

The system configuration and process flow are shown in Figure 3, as follows:

(a) The relationship between the personal tempo and the presentation tempo is examined, and the prediction formula is obtained for all contents. The formulae are stored along with the content files.
(b) The user's personal tempo is measured.
(c) The measured personal tempo is stored in a personal-tempo database with the user's name or user ID, and this value will be reused the next time.
(d) The contents in the tempo that the user prefers is displayed, which is determined using the personal tempo and the prediction formula.

3. Conclusion

We examined the relationship between the user's personal tempo and the presentation tempo that the user prefers by conducting experiments. The results of the experiments showed that the presentation tempo that the user prefers differs among users; however, there is a correlation between the personal tempo and the presentation speed.
We then developed a multimedia terminal for college introduction, in which the presentation tempo is determined by calculating the user's personal tempo. The terminal has two new functions: a personal-tempo measuring function and a display-speed control function that changes the presentation tempo of the contents. When the user's personal tempo is low, the terminal display slows down. This terminal can also be introduced into an e-learning system, in which the learning materials are presented automatically in a tempo that is appropriate for the learner.
Further study will evaluate the proposed system in terms of its educational effect for the presentation of learning materials.

References

[1] Yasui, K., & Shigeta, K. (2009). A Study of Three Dimensional CG Animation Speed. *IEICE report ET2008-119*, 151-156 (in Japanese).
[2] Shigeta, K., Nakayama, M., & Shimizu, Y. (2001). An Estimation of the Suitable Presentation Speed of Rotation for a 3D Object. *IEICE report ET2000-122*, 69-74 (in Japanese).
[3] Rimoldi, H.J.A. (1951). Personal Tempo. *Journal of Abnormal and Social*, *46*, 283-303.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Everyone Wants Web 2.0

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Abstract: The interactive nature of Information and Communication Technologies (ICT) is the impetus for the adoption of digital technologies by students for socialising and communicating in new ways. In particular these new ways of communication have embraced web 2.0 technologies such as Facebook© ©, however, teaching practices within educational institutions have remained relatively unchanged. This paper explores the use of the web 2.0 technology Facebook© in a Higher Educational setting to support undergraduate students. It further highlights how students in a developing country currently use this technology and their expectations for the future use of this web 2.0 technology.

Keywords: Web 2.0, Facebook© , Developing Countries, ICT

Introduction

Facebook©, a web 2.0 tool with over 400 million users (Facebook© , 2010), is an example of one of the most popular web 2.0 tools for socializing and communicating online. This is the tool of choice for online interaction for many people across the world in developing and developed countries. This tool cannot be ignored when its active user base is so large and it is used for socializing and communicating by such a diverse group of people. In fact, socialising through the use of interactive digital technologies, was identified in over 81% of students in an American study by the National School Boards Association (NSBA, 2007). In other developed countries such as Australia, similar research also suggests that the youth are spending at least half of their discretionary time using digital media and communicating (ACMA, 2008). Thus, socialisation through the use of these interactive technologies is a well-learned habit of these students and is at the forefront of their dally activities.

Similarly, students in some developing countries also have access to these digital technologies. There is no statistical data available to show how many students or young people use these digital technologies for socialising and interacting in these countries, however, during the previous elections in Malaysia, the blogging community became such an influential and powerful political voice that the government had to listen, and final election results were heavily influenced by the social interactions of this community (Kaufman, 2008). This alone, would support the fact that a large percentage of the Malaysian population have access to, and are capable users of these interactive technologies for socialising. It is also one of the driving factors that influenced the following study of the Web 2.0 technology, Facebook© , amongst an undergraduate group (n=60) of students in a Malaysian based university education degree.

1. Background and Approach to Study

Within this collaborative capacity building program a range of common ICT tools were used to facilitate communication between the university and the students in the Malaysian Institutes Tools such as email, group lists and Blackboard, the universities preferred learning management system (LMS), were used, however, informal feedback, low page visits and comments within Blackboard, and the lack of response to emails indicated that students were not using these tools. The limited access to reliable Internet facilities was initially indicated as the reason for this, however, through small focus groups with the students it was soon realised that many of them used the Web 2.0 technology Facebook© in their social lives. Consequently, the students invited their lecturers into their online social lives, thus prompting the use of Facebook© as an additional tool to support them as they undertook their 20 weeks of practicum in schools throughout Malaysia.

The study focused on the last 12 months of the course that included a total of 20 weeks of practicum. A large groups of students (n=60) invited lecturers to be a part of their online social community where they were supported by each other, and the lecturers. The student postings were recorded on the students Facebook© ‘Wall’, a place similar to a forum that allows students to post short statements for comment by others. Students also participated in a survey based on ICT and web 2.0 technologies in learning and teaching.

2. Findings and Discussion

Students (n=60) from the area of science, physical education and mathematics were the focus of this study with n=53 students actively posting on Facebook© and responding to the survey. The survey allowed students to provide feedback on their experiences with Internet tools and in particular the web 2.0 environment Facebook© which was used extensively to support students in their final year of study. Initial findings from the study identify the habits of students using these Internet tools in a developing country and further highlight the impetus for the need to change traditional didactic modes of teaching often found within higher education settings. Through an analysis of the data, two main themes emerged on how students used Facebook©. The first theme was that of socialization (general communication, the sharing of photos, letting other students know what they do and arranging meetings), while the second theme that emerged was that of a community that supported each other (e.g. students encouraging each other after a bad day of teaching in their practicum).

When students were asked about which Internet technology they prefer to communicate with, 61% indicated that they preferred Facebook© over other technologies such as Instant messaging (9%) and email (30%). When the students were asked to substantiate their initial response to using these technologies, the responses were indicative that the social nature of communication and collaboration was important to them.

While the study had as its aim to identify how students in a developing country used this technology, it also aimed to understand how students viewed the future of Web 2.0 technologies in their future teaching and learning experiences. Students were asked if they would use Facebook© with their students if they had access to it in their future teaching schools. In their responses, 74% of the respondents said that they would use Facebook©. This high response rate indicates the desire for these education students to connect with their future students and provide a different type of learning experience for them. In this context, when the students were asked if a system like Facebook© should be used in place of the Blackboard LMS that they used, 63% indicated that a system like Facebook© would be a better tool, while 26% were unsure and 11% did not think it would be a better system.

3. Conclusion

Student use of web 2.0 technologies, and in particular, tools such as Facebook© can not be ignored, given their want for these tools to be included within all parts of their lives, including their education. Students want this social community around them where they can support each other and communicate and interact in different ways. Facebook©, within the realms of this study can be seen as a type of white list email system where students know that messages in this environment are from someone they know. The messages are not spam or junk and all their activities occur within a safe walled garden of possibilities with people who they want to be part of their community. The implications of this need for web 2.0 technologies by students, even those from developing countries, reinforces the need for higher education institutions to move away from the more didactic approaches that exist and to re-examine new ways of teaching and learning.

The study is conducted within a collaborative, international capacity building project between two countries, and consequently further research is needed to explore the possibilities of these web 2.0 technologies in other contexts. Some technologies cannot be just added to current practices. The technologies need to be at the forefront of any new course creations and revisions. This study acts as a pilot study for a much larger project, to further explore the benefits of web 2.0 technologies and digital medias within the classroom.

References

[1] Abbitt, J. (2007). *Exploring the Educational Possibilities for a User-Driven Social Content System in an Undergraduate Course*. MERLOT Journal of Online Learning and Teaching, 3 (*4*) 437-447. Retrieved 10 February, 2010 from http://jolt.merlot.org/Vol3_No4.htm

[2] Alexander, B. (2006). *Web 2.0: A new wave of innovation for teaching and learning?* EDUCAUSE Review, 41(2), pp. 33-34, 36, 38, 40, 42, 44.

[3] ACMA (Australian Communication and Media Authority). (2008). *Australian families with children are 'media-rich', research finds.* Retrieved January 14, 2008, from http://www.acma.gov.au/WEB/STANDARD/pc=PC_310897

[4] Barnes, C. and Tynam, B. (2007). *The adventures of Miranda in the brave new world: learning in a Web 2.0 millennium. ALT-J, Research in Learning Technology Vol. 15, No. 3, September 2007, pp. 189–200.*

[5] Facebook Press Room Statistics (2010), Retrieved February 21, 2008, from http://www.facebook.com/press/info.php?statistics

[6] Harris, C. (2006). *School library 2.0: Say good-bye to your mother's school library. The web is all about new possibilities.* School Library Journal, 52(5), 50.

[7] Kaufman, S. (2008).*Malaysia's alternative media become decisive political factor*. Retrieved 21 February, 2010 from http://www.america.gov/st/democracy-english/2008/April/20080403175441esnamfuak0.1705591.html.

[8] Kirkup, G. and Kirkwood, A. (2005) *Information and communications technologies (ICT) in higher education teaching—a tale of gradualism rather than revolution*, Learning Media and Technology, 30(2), 185–199.

[9] Maloney, E. J. (2007). *What Web 2.0 can teach us about learning*. Chronicle of Higher Education, 53(18), 26.

[10] New Media Consortium. (2007). *The Horizon Report 2007*. Retrieved January 3, 2008, from http://www.nmc.org/pdf/2007_Horizon_Report.pdf

[11] NSBA (National School Boards Association). (2007). *Creating & connecting: Research and guidelines on online social - and educational – networking*. Retrieved August 10, 2007, from http://files.nsba.org/creatingandconnecting.pdf

[12] Warlick, D. (2006). *A day in the life of Web 2.0*. Technology & Learning, 27(3), 20-26.

[13] Yang, J. (2006). *The Charlie Rose show: TechNet innovation summit*. Retrieved December 30, 2006, from http://www.technet.org/transcript1

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Evaluating an ontology-based e-Learning data model using the TAM model

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Abstract: E-Learning is more flexible than traditional learning in course development and delivery. It offers more interactions between learners and contents that correspond to learners' knowledge level and learning objectives in a self-paced, self-directed mode. Bloom's cognitive taxonomy has often been used to determine the knowledge level. However, there is little said about incorporating Gardner's theory on Multiple Intelligence and ontology with Bloom's taxonomy. In this model, OWL and LOM are used to build an ontological network of contents with several relations between contents. To test the usefulness and ease of use of our prototype, we used the Technology Acceptance Model (TAM) to evaluate the system. Results are promising.

Keywords: OWL, LOM, e-Learning, Bloom's taxonomy, Multiple Intelligence, TAM

1. Introduction

1.1 Learning Objects

E-Learning systems need to be flexible in content and course delivery and consequently, create meaningful interactions between the user and the system. Contents or learning objects should have direct pedagogical value to the learning goal. Furthermore, they should be referable (contributing to added reusability) and self-contained (contributing to their modular use or reuse) in different learning contexts. In this paper, we describe learning objects using LOM (Learning Object Metadata), an approved standard on technical aspects of e-learning, created and supported by IEEE Learning Technologies Standards Committee (IEEE LTSC). LOM is almost identical to the IMS metadata specification and compatible with the Dublin Core (DC) metadata. In future work, we will extend LOM to SCORM metadata.

1.2 Semantic

Semantic E-Learning defines and links contents in a way that enables more effective discovery, automation and integration to support reuse and interoperability. We have used OWL (Ontology Web Language) [2] to design the ontological relations between contents. We use these ontological relations to enable interchange of resources and the inference of knowledge while querying them.

1.3 Problem statement and objective

There are some object-oriented data models in e-Learning systems. However, we need a more flexible data model that can network the contents based on their learning attributes. In this study, we test our ontology-based e-learning data model (as described below) using the Technology Acceptance Model (TAM) [3] in terms of ease of use and perceived usefulness.

2. Data Model

2.1 Architecture

Fig. 1 shows the data model‘s architecture. At the first layer, learning content has a unique IRI (International Resource Identifier). At second layer, LOM metadata provides data specifications for the contents. The third layer is the semantic layer. We add the objective and Intelligence properties for the contents and create the network of contents. At the top layer, we use SPARQL to search OWL to find proper learning contents.

Query	API	
	SPARQL	
Semantic Rules	OWL Ontology	
	Objective	Intelligency
Metadata	LOM	
	RDF	RDF Schema
Content	IRI (International Resource Identifier)	

Fig. 1 Ontology-based e-learning data model

2.2 Cognitive objective

Learning materials are usually matched to different levels of understanding and educational objectives based on Bloom’s Taxonomy [4]. These materials should be delivered to the learner in a sequential hierarchy to obtain better results in knowledge acquisition. The Objective property is used at the ontological level to categorize contents based on their objective to help learners to choose proper contents.

2.3 Multiple intelligence

Howard Gardner [5] proposed the Multiple Intelligences theory that people use at least seven relatively intellectual capacities (linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, interpersonal and intrapersonal) to approach problems. We have tagged our contents with linguistic/verbal, musical/rhythmic, logical-mathematical and spatial/visual. Hence, a learner may filter or select the contents based on the types of Intelligence which is more suitable for him to learn.

2.4 Semantic contents

We have also captured the relations among contents using ontology. The ontological level adds Pre-, Post- and Similar-content as relations to refer to other contents. This creates the semantic network of contents, which are automatically linked based on LOM properties.

3. User acceptance

A prototype was developed based on the ontology-based e-Learning data model to help us evaluate our model’s usefulness and ease of use. We present 2 hypotheses:
H1: An adaptable data model which categorizes the contents based on educational objective and Intelligence of the contents can deliver useful contents to Learners more efficiently and improve their attitude and increase their intention to use the system.

H2: An extensible data model, which creates a network of logical relations between contents based on Interactivity Level, Difficulty and Semantic Density will provide an easy-to-use sequence of contents for learners and improve their perceived usefulness of the system.

3.2 Methodology

We chose 30 people with IT background (10 tutors and 20 students) to use the system and answer the questionnaire based on the TAM model. There are 5 main factors in our system (cognitive objective, Multiple intelligence, Interactivity level, Semantic density and Difficulty). The questionnaire had 20 questions (4 questions for each factor) to evaluate the effect of them on ease of use, usefulness, attitude and intention to use the system.

3.3 Results

Cronbach's alpha was obtained for the test results reliability and Hypotheses were tested by Chi-square test method. The results are in Fig 2.

Hypothesis	P-Value	Result
H1	0.01 < 0.05	Proved
• Objective	0.011 < 0.05	Proved
• Intelligency	0.01 < 0.05	Proved
H2	0.015 < 0.05	Proved

Fig. 2 test Results

Cronbach's alpha exceeded the recommended level of 0.70 (Nunnally, 1978). Thus the result was reliable and has high internal consistency. Since P-Values are less than the significant level (0.05), we conclude that the data architecture typified in our prototype is easy to use. Furthermore, users are positive towards using it in the future.

4. Conclusion

E-learning systems require content-based data model that is flexible and easy to search. By including metadata and specifying ontological relations, it makes the learning contents shareable to provide knowledge sharing between E-learning systems. Our user testing shows that adopting contents with Objective and Intelligence properties can be easy to use and useful for tutors and students to deliver the proper contents based on their suitable Intelligence type and learning objective.

References

[1] Barker, P. (2005). What is IEEE Learning Object Metadata / IMS Learning Resource Metadata? CETIS standards briefings series, *the Centre for Educational Technology Interoperability Standards*, May 2005.
[2] van Harmelen, F. (2004). The Semantic Web: What, Why, How, *IEEE Distributed Systems Online*, 5(3),4.
[3] Davis, F., Bagozzi, R.P., & Warshaw, P.R. (1989). User acceptance of computer technology: a comparison of two theory models. *Management Science*, 35 (8), 982-1003.
[4] Bloom, B. S. (ed) (1956). *Taxonomy of Educational Objectives. Handbook I: Cognitive Domain*. London: Longman Group.
[5] Gardner, H (2000). *Intelligence Reframed: Multiple Intelligences for the 21st Century*. New York: Basic.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Lecture Improvement based on Twitter Logs and Lecture Video using p-HInT

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Abstract: We have developed an interactive function named “student voice” on p-HInT system. The p-HInT is an educational environment including game terminals in order to improving large-scale lectures. The “student voice” function consists of three element functions; a sending messages function like twitter tools, “OK-understand!” and “?-Not understand!” buttons, and a red-card function. The “student voice” function was adapted to lectures of 10 subjects. In addition, we have also developed an analysis tool based on twitter logs (student voice logs) and lecture video. We tried to improve lectures of System Development theory subject based on results of analysis in the tool. As a result, teacher was able to communicate interactively with students, and the number of pushing “?-Not understand!” button decreased. 68% students felt more motivation and more interests in lectures.

Keywords: Lecture improvement, game terminal, twitter, student voice

Introduction

From April of 2008, Hannan University has used a p-HInT(portable Hannan Internet Education Tool) in order to improve large-scale lecture with 200 or more students. The p-HInT is an interactive education environment for large-scale lectures with NINTEDO DS(R)(we say it “DS” in this paper) [1] , Sony PSP[2], iPod, or various portable terminals. The basic functions of the p-HInT are interactive test, attendees’ list with seating location, and attendance management. We evaluated educational effectiveness of the p-HInT with comparing examination results in two classrooms; one used the p-HInT, another did not use the p-HInT. The educational effectiveness of the p-HInT was clarified[3][4].

In addition, we have developed a new interactive function for improving lectures on the p-HInT. The new function is “student voice”. The new function consists of three element functions; “OK-Understand!” button and “?-Not Understand!” button, sending messages like a twitter tool, and sending red-card. These new functions are to increase interactive actions between students and a teacher. Students can always send their impressions to teachers through DS during lectures. A teacher can quickly grasp students’ thinking while a teacher gives speech. The function of the sending impressions is like a twitter tool. The quick improvement of lecture is available using these new functions. Moreover, the student voice function like a twitter tool records logs including data such as who sends, what impression, when they send. Therefore, we developed an analysis tool of reviewing lectures with twitter logs and lecture videos. A teacher can review past lectures. For example, a teacher can check lecture contents when negative impressions of students increased. Teachers see what students were not able to understand. Next lecture, the teacher will explain again the lecture contents.

In this paper, we show examples of lecture improvement using the new functions of the p-HInT. Importance of the interactive education in large-scale lecture is shown. In addition, we describe usefulness of the new functions named “student voice”. Section 1 shows related works, section 2 explains an outline of the p-HInT system and the new functions. Examples of usage of the "student voice" functions are shown at section 3, section 4 shows an analysis tool based on twitter logs and lecture videos, then, lecture improvement using the results of analysis. Section 5 shows summary and future works.

1. Related works

At first, we show studies of usage of mobile terminal in education. Cisic et al. have proposed Mobile Game Based Learning environment called "mGBL system" [2]. The environment includes server computers and client computers and mobile computers. Game software for learning is installed to the mobile computers. Students with the mobile computers can learn at anywhere, anytime. Hamid proposed a mobile game called Skattjakt (Treasure Hunt in Swedish) for kids [3]. Children learn environmental awareness while children play the mobile game on mobile computers, or mobile phone. Spikol developed mobile edutainment games for acquiring C++ programming knowledge [4]. These games are for self-study sake. Our p-HInT and a new interaction function "student voice" are for interactive education between teachers and students in large-scale lectures.

Next, we show practices of twitter usage in education. Unfortunately, because twitter is a new tool in this year, the basic theory of interactive education using twitter has not been proposed yet. Then, we show practices of education using twitter. Grosseck et al. developed a platform of twitter for learning[5]. Based on commercial twitter tool, they made an original twitter tool that has been customized to their curriculum. Dickens also proposed a MicroBlogging in DigitaLang for language learners [6]. Although these tools are useful specific learning scenes, evaluation and effectiveness of the platforms and environments are not clear. Parry used a twitter tool in his classroom [7]. 13 impacts of the twitter in his classroom were clear. For example, student conversations continue inside and out side of classroom, and development of classroom community. However, he did not mention impacts on lecture improvement. Based on analysis results of data of the student voice like twitter, teacher can improve their lectures. Therefore the student voice function is different from these educational twitter tools in a viewpoint of lecture improvement.

2. p-HInT system

2.1 Outline

Figure 1 shows a usage image of the p-HInT at a large-scale lecture. Each attendee brings DS to a lecture. At the beginning of a lecture, attendee does log-in to the p-HInT through DS. The p-HInT records the attendee names and seating locations in the classroom. The p-HInT generates an attendees' list with seating locations (See "Display of an attendees' list" of Figure 1). Because a teacher can see each name of attendee with a seating location, the teacher can match a attendee's face with his/her name. The teacher can keep attendees' names in mind even if the number of attendees is two hundreds or more. In addition, through DSs, a teacher can do tests at lectures. After attendees answer tests on DSs, the teacher can show results of the answers as bar charts (See "Results of test" of Figure 1). The teacher can review the tests and the answers while seeing the bar charts. In addition, students can privately send messages to a teacher at any time though DSs, like twitter tool. The message are "Agreement", "not-understanding", or "difficult seeing characters on blackboard". Of course, the p-HInT is useful at non-computer classroom. Especially, the p-HInT is valuable when the scale of classroom is large like a hall.

Effectiveness of the p-HInT was evaluated by comparing examination results between two classrooms; one used the p-HInT, another did not use the p-HInT. In essay-type tests, examination results of the classroom using the p-HInT were better than examination results

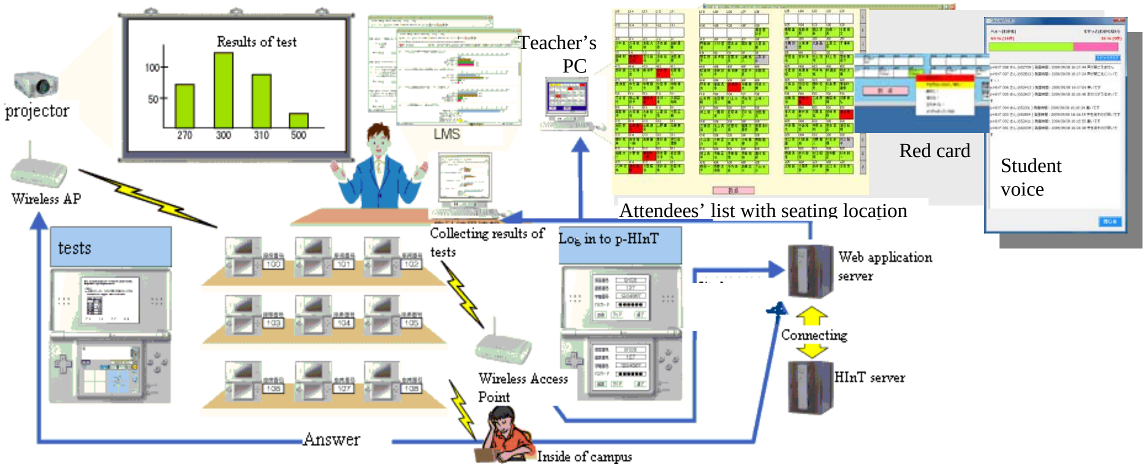

Figure 1 An outline of the p-HInT system at a large-scale lecture

of the classroom without the p-HInT. The gaps of the examination results were tested by t-test. Because other conditions such as a teacher and materials, lecture speech were same, the p-HInT system might influence to the examination results (significant difference 5% by t-test). In addition, we confirmed that students' private talk during lectures decreased, and teachers' explanation time during lectures increased because of decreasing miscellaneous tasks such as distributing materials.

In addition, we did questionnaires to students who attended lectures using the p-HInT system when all lectures finished. The number of valid responses was 753. The 70 % students answered that their understandings increased by the p-HInT. The 63 % students felt that they were able to review lecture contents by the p-HInT. The 52 % students were able to concentrate more to lectures. In short, the students thought that the p-HInT system was useful, and their understandings improved by the p-HInT system. The details of the p-HInT and the evaluation are described at [3][4]

2.2 New function "student voice"

We have added a new function named "student voice" to the basic function of the p-HInT. The "student voice" function is consists three element functions. First one is "OK-Understand!" button and "?- Not Understand!" button. Second one is sending message like twitter tools. Third one is to send red-card for warning.

2.2.1 "OK-Understand!" button and "?-Not Understand!" button

We developed two buttons on DS (See Figure2). In Japan, "Heh.." button is a very famous toy (See Figure 2). Japanese people often say "Heh.." when they are convinced. For example, when a person was convinced with the other person's speech, the person says "Heh..". The "Heh.." button toy is used in such situation. If you are convinced, you push the "Heh.." button. The button beeps "Heh.." like person pronunciation "Heh..". Students

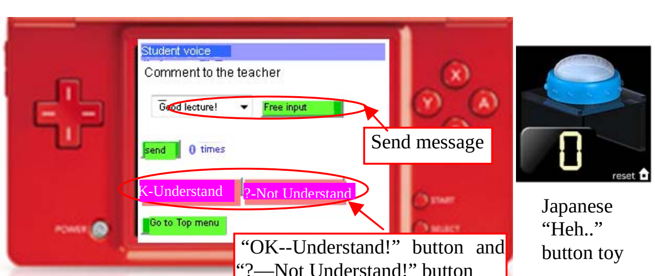

Figure 2 Student voice screen on DS and Japanese "Heh.." button toy

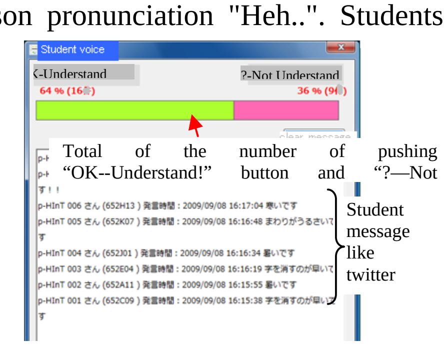

Figure 3 Teacher's screen of student voice

repeatedly push "OK-Understand!" button on DS when the students are convinced with teachers' speech during lecture. The pushing the button is always available during lectures. Teachers do not control students' pushing. Similarly, students repeatedly push the "?-Not Understand!" button when students can not be convinced with teacher's speech.

Teachers are able to see the number of pushing "OK-Understand!" button and "?-Not Understand!" button. Figure 3 shows a student voice window on a teacher's computer. A bar-chart of the number of pushing "OK-Understand!" button and "?-Not Understand!" button is shown at upper side of the window. Because the student voice window is always displayed on a teacher's computer, teachers can always see changes of the bar-chart.

2.2.2 Sending messages like twitter

Students can send messages to a teacher at anytime during lectures. In Figure 2, "send message" area is the send message function. Several messages are prepared on DS. For example, "Good lecture", "Please speak full voice", "Please write bigger characters on the blackboard", "Please repeat the explanation", "Please speak slowly", "Thanks". These messages are decided based on results of interviews to students. Of course, if students want to send the other message, students can input free sentences. Mainly, students send their impression of lectures at anytime. Teachers can quickly see the students' messages on the student voice window (See Figure 3). If a teacher confirms a message "Please write more big characters", the teacher will quickly rewrite bigger characters on the blackboard. Teachers can quickly put into practice of easy improvement such as rewriting characters on blackboard through the "student voice" function

2.2.3 Red card

Red card function is to send warning messages to a specific student. Figure 4 shows the red card function. The red card means a final warning to students who are not serious. For example, a student plays a game during a lecture. Although a teacher says "Don't play" many times, the student does not stop playing. The teacher sends a final warning message to the student's DS. The screen of DS suddenly changes a warning screen (See Figure 4).

3. Usage of the "student voice" function

3.1 Usage of the p-HInT and the "student voice" function in regular curriculum

The p-HInT system has been running from April of 2008. Until now, 26 teachers used the p-HInT system, a series of 14 or 28 lectures of 28 subjects (34 classes) used the p-HInT. Total number of lecture using the p-HInT is 614 (one lecture spends 90 minutes), total number of students who used the p-HInT is 3511. The number of calling the roll by the p-HInT is 446, the number of doing tests by the p-HInT is716. Fields of the subjects are various; Information Technology, social science, financial theory, economics, and psychology. Especially, the maximum number of attendees of a lecture is 234. The subject is "Introduction of IT" for freshmen. 234 students accessed at once the p-HInT system through their DSs in a lecture room (See Figure 5).

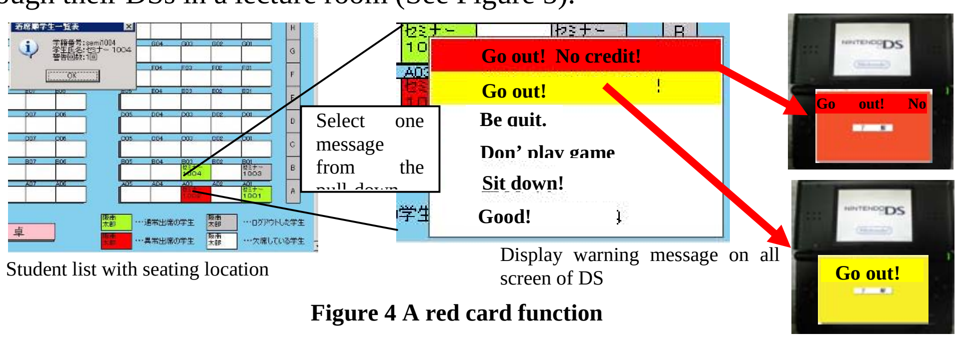

Figure 4 A red card function

Figure 5 Lectures using p-HInT at IT Introduction

The new function "student voice" has been running from October of 2009. The new function has been used in lectures of 10 subjects. Total number of pushing the "OK-Understand!" and "?-Not Understand!" button is 18,990. Total number of sending messages in the student voice function is 2,047, the number of sending red-card is 154.

3.2 An example of usage of the "student voice"

We focus on usage of the new function at System Development theory subject. The number of attendees is 64, a series of lecture consists of 14 lectures. 2 lectures were guest speakers' presentations. The attendees are the second degree students of Information Management faculty. The students freely pushed "OK-Understand!" button and "?- Not Understand!" button at anytime. The students freely sent messages at anytime. The teacher did not control the students according to the student voice function.

Total number of messages and pushing the two buttons is 2997. Total number of sending the red card is 2. An average of the number of student messages a lecture is 214. A student sends 4 messages at one lecture in average. Typical messages are "Can not see characters on the blackboard", "I understand.", "Has the software been already released?". Several messages were not related to lecture contents, for example, "Today is beautiful", "Now sleepy", "It's hot". The student messages were certainly twitter tool. Their impressions during lectures send to a teacher through DS.

On the other hand, lectures of Multi Media theory used the p-HInT and the new function. The teacher of Multi Media theory subject controlled the student voice function. The teacher did not arrow that students sent messages at anytime. The teacher always used the student voice function when the teacher asked an ease question. Therefore, the teacher asked three questions per a lecture in average. The students answered through the student voice function. For example, the question was "Do you understand GIF format?". The GIF format was a main theme of the lecture. To grasp percentage of students' understanding, the teacher used the student voice function. There were few free-send-messages in the lecture of the Multi Media subject.

Figure 6 shows an example of changes of the number of pushing the two buttons in the two subjects; System Development theory, and Multi Media theory. In System Development theory subject, the students freely pushed the two buttons at any times. Therefore, students' actions of pushing the buttons ware scattering during the lecture. However, around at 17:50 and 18:00, the number of pushing "?- Not Understand!" button increased. What the teacher spoke at 17:50 and 18:00 were about "Von neumann" and "EDVAC, EDSAC". In short, it was difficult for the students to understand "Von neumann" and "EDVAC, EDSAC" in the lecture. In contrast, at the lecture of Multi Media theory subject, actions of pushing the buttons were concentrated to two points; around at 17:20 and 17:50 (See Figure 6). At 17:20, the teacher asked "Do you feel that red is cooler than blue?". The question is a cue of lecturing color impression. Of course, almost students pushed "?-Not Understand!" button, that is, they said "No". At 17:50, the teacher asked "Do you understand PARA language?". Just before, the teacher spoke about PARA language. The teacher wanted to confirm

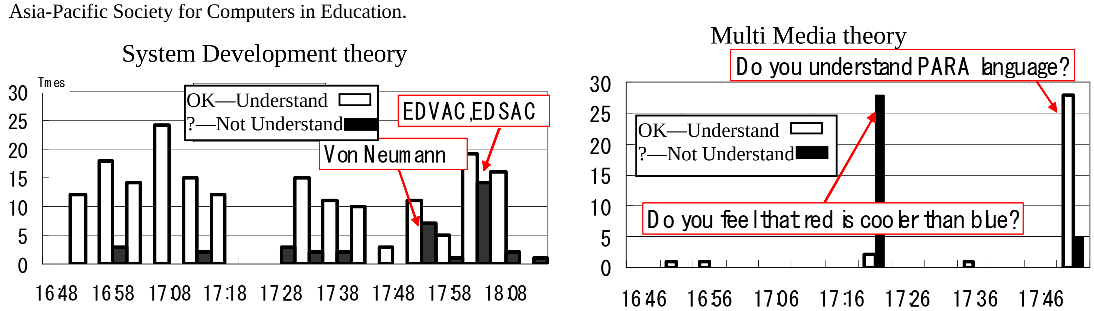

Figure 6 Graphs of the number of pushing "OK—Understand!" and "?—Not understand!" buttons

percentage of the students' understanding. About 85% students pushed "OK-Understand!" button, that is, almost students understood. In this way, the two buttons; "OK- Understand!" and "?-Not Understand!" were used in the lectures.

4. Discussion

4.1 An Analysis tool using the twitter logs and lecture video

We have developed a tool for analyzing lectures based on logs of the student voice and lecture videos (See Figure 7). The tool consists of three parts; slide show area for materials such as PowerPoint, teacher speech images of replaying lecture video, and a graph of the number of pushing the "OK-Understand!" button and "?-Not Understand" button on time series. The tool was based on commercial tool named "UB Point!"[8]. The UB Point is a kind of recording and replaying tool for lectures video. The replaying of lecture video can be synchronized with slide show of PowerPoint materials. We added a graph area of student voice to the "UB Point!". The graph shows changes of the number of pushing the "OK-Understand!" and "?-Not Understand" button on time series. If a user clicks a point of the graph, the replaying scene smoothly change to a scene of the clicked point of the user.

4.2 Results of analyzing by the tool

Using the tool, we analyzed how students push the "OK-Understand!" button and "?-Not Understand!" button in 12 lectures of the System Development theory subject. Figure 8 shows the results of the analysis. The tool totals up the numbers of pushing the two buttons every 5 minutes. White bars mean the number of pushing "OK-Understand!" button, black bars mean the number of pushing "?- Not Understand!" button. In addition, by clicking the graph area of the tool, the lecture contents were investigated. In Figure 8, the lecture contents are added to the graph in manual. For example, on 10/5, from around at 17:06 to

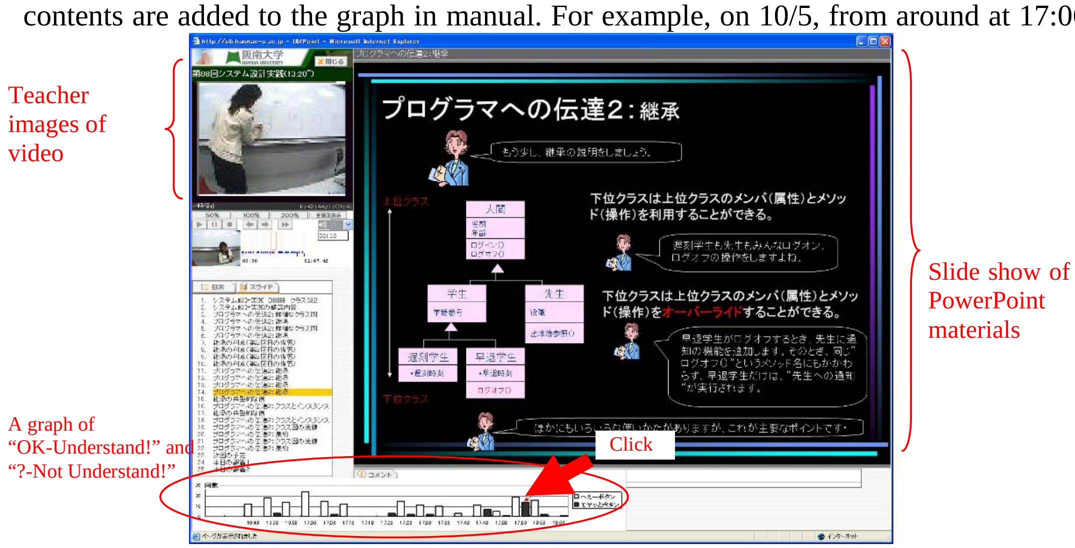

Figure 7 An analysis tool for lecture improvement using twitter logs and lecture video

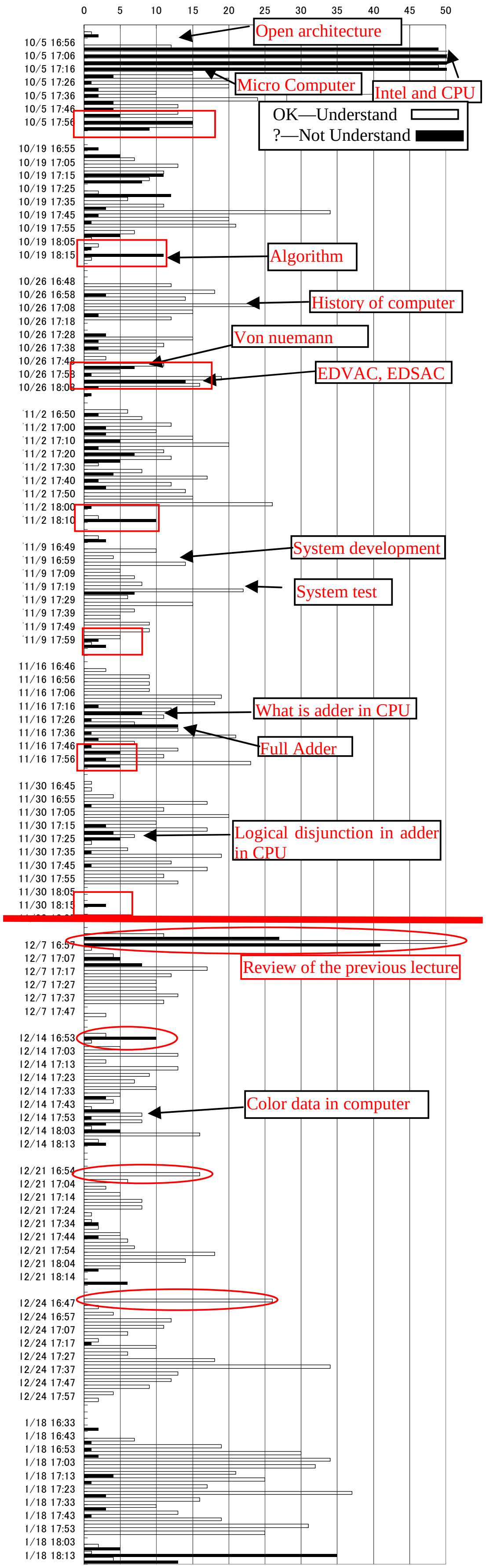

Figure 8 Change of pushing the two buttons

17:16, the students frequently pushed the both buttons. The teacher spoke about "Open Architecture", "Intel and CPU", and "Micro computer". On 10/26, from 17:58 to 18:08, when the teacher explained about "Von neumann" and "EDVAC, EDSAC", the students frequently pushed "?- Not Understand!" button. In contrast, at a first half of the lecture on 10/26, the teacher spoke about "History of computer". The students frequently pushed "OK-Understand!" button. Therefore, teachers can review their speech and materials after lectures. Contents that students did not understand easily were clear, contents that students understand easily were also clear. In the same way, we can easily judge good speech or bad speech of teachers.

4.3 Lecture improvement using the logs

Using the tool, we tried to improve lectures of the System Development theory subject. On 11/30, the teacher reviewed the past lectures. The review was based on graphs such as Figure 8 and student messages of the student voice function. The teacher knew two points of lecture characteristics. One point is that the number of pushing "?- Not Understand!" button increased at near the end of a lecture. For example, on 10/26, students frequently pushed the "?-Not Understand" button from 17:56 to 18:06 (finish time of the lecture is 18:10). In Figure 8, red rectangles means the increment of pushing the "?- Not Understand!" button. In short, at near the end of a lecture, students did not understand easily. A reason was clear when the teacher repeatedly replayed the videos of the lectures. At near the end of a lecture, the teacher hurriedly spoke in order to finish all lecture contents that were scheduled in the lecture plans. The hurry speaking leads the difficulty of understanding for the students.

The second point is about review of the previous lecture. The teacher always starts speaking today's lecture contents at the beginning of a lecture. However, there were some students' messages about the previous lecture contents. Moreover, the students were disappointed because the teacher did not reply to their messages of the previous lecture. The

non-reply leads decrement of the students' motivation.
Therefore, the teacher improved two points of lectures. The first is improvement of hurry speaking at near the end of a lecture. Even if the teacher was not able to finish all lecture contents, the speech speed does not change. Second is to set time for reviewing the previous lecture at the beginning of a lecture. In the reviewing time, the teacher presents students' messages at the previous lecture. At the same time, the teacher replies to each message even if the messages were not related to the contents of lectures. In Figure 8, red circles means the reviewing times of the previous lecture.
As results of the improvement, the number of pushing "?- Not Understand!" button decreased from 12/7 to 1/18 (See Figure 8). Especially, at review time at the beginning of a lecture, students frequently pushed "OK-Understand!" button. The review time was value time to communicate between the teacher and the students. In addition, as a result of student quaternaries, 68% students answered that the student voice was useful, and their interests and motivation increased.

5. Summary

We have developed an interactive function named "student voice" on the p-HInT system. The student voice function consists of three element functions; a sending messages function like twitter, "OK-Understand!" button and "-Not Understand!" button, and a red card function. 10 subjects (196 lectures) were used the student voice function of the p-HInT. In addition, we have also developed an analysis tool based on twitter logs (student voice logs) and lecture video. In System Development theory subject, using the tool, the lectures were able to be improved based on twitter logs. In future, the analysis tool will be adapted to various lectures. Then, a general improvement way will be proposed using the analysis tool. After that, we will quantitatively evaluate usefulness of the "student voice" function.

Acknowledgements

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References

[1] http://www.nintendo.co.jp/ds/
[2] http://www.jp.playstation.com/psp/
[3] Hanakawa, N., Yamamoto,G., Tashiro, K., Tagami,H., Hamada, S.,"p-HInT: Interactive Educational environment for improving large-scale lecture with mobile game terminals", the 16th International Conference on Computers in Education (ICCE2008), pp.629-634, Oct. 2008.
[4] Hanakawa,N.,Obana, M., "MOBILE GAME TERMINAL BASED INTERACTIVE EDUCATION ENVIRONMENT FOR LARGE-SCALE LECTURES", The Proceeding of the Eighth IASTED International Conference on Web-based Education (WBE2010), Mar. 2010.
[2] Cisic,D, Tijan,E., & Kurek, A., "Mobile Game Based Learning - Taxonomy and Student Experience", Proceeding of the 29th International Conference Information Technology Interfaces ,pp.299-305, 2007 .
[3] Hamid, S. H. A., Fung, L. Y., Learn Programming by Using Mobile Edutainment Game Approach, Proceedings of the First IEEE International Workshop Digital Game and Intelligent Toy Enhanced Learning DIGITEL '07, pp.170-172, 2007.
[4] Spikol, D., Milrad, M., "Combining Physical Activities and Mobile Games to Promote Novel Learning Practices", Proceedings of Fifth IEEE International Conference Wireless, Mobile, and Ubiquitous Technology in Education WMUTE 2008, pp.31-38, 2008.
[5] Grosseck, G, Holotesku, C., "Can we use Twitter for educational activities?", Proceeding of the 4th Scientific Conference eLSE elearning and Software for Education, Apr. 2008.
[6] http://www.digitalang.com/2008/04/twitter-microblogging/
[7] http://academhack.outsidethetext.com/home/2008/twitter-for-academia/
[8] http://www.hokkaido.fujitsu.com/service/ubpoint/index.html

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Development of a Game Type Food Education System Using a Cell Phone Camera

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Abstract: This paper describes the development of a food education system that utilizes a cell phone camera. As eating habits have become rich, a lot of consequent problems have been pointed out. To overcome them, people need to monitor their eating habits and learn how to improve eating habits. The distinctive features of our system are as follows: (1) accumulation and understanding of meal records using photos and comments, (2) learning by reflecting on one's eating histories, (3) learning by comparing one's history with those of others, (4) knowledge acquisition by quizzes and explanations, and (5) increasing motivation by a point-based game system. The results of our experiment have confirmed that our system works as we expected and that participants could improve their eating habits by learning about food and meals, and by reflecting on their own eating habits through the learning activities in our system.

Keywords: Food education, Eating habit, Nutrition, Diet, Cell phone camera

Introduction

The ubiquity of accessible information through computer networks can be utilized in new ways to support everyday life. On the other hand, while eating habits have become rich, a lot of consequent problems have been pointed out, such as relying too much on eating out, overeating, nutritional imbalances and excessive dieting[1][2]. In many cases, health problems originate in eating habits. In order to live a healthy life, people need to learn good eating habits. In Japan, the National Basic Law on Food Education was enacted in 2005, and food education activities have been undertaken nationally[1][2]. Food education is also called nutrition education or dietary education.

In this context, we have developed a food education system that utilizes a cell phone camera[3]. Our system is designed to teach people about nutrition and meals in daily life in the form of a game. This paper describes the design and implementation of our food education system, along with an experiment to measure its effectiveness.

1. Related works and purpose

As concern about food and meals has arisen, studies on food education have utilized the cell phone and commercial services. Some systems help people to improve their eating habits by giving them expert nutritional instruction in response to meal photos taken by cell phone cameras[4]. Hands-on educational programs for parents and children using cell phones have been reported[5]. Other systems help people improve their eating habits as a cell phone

servicing[6][7][8][9]. In addition, there are researches of the system which focuses on collaboration in a community[10].
In our system, users can learn about food and meals in their daily lives as a game. Our system enables users to self-evaluate and improve their eating habits through activities in which they document their daily meals with photographs and comments via a cell phone camera, referring their own and other users' histories of meals and the results of other activities. Our system also helps people obtain and enhance their knowledge of food and meals through quizzes and explanations of the basics of food and meals. The purpose of our system is to help people enjoy learning about food and meals and to motivate people to improve their own eating habits through their daily life game activities.

2. Learning design

In this section, we describe the learning design and related functions of our system. They are summarized in Table 1

2.1 Self-recognition of eating habits by record

In our system, the user takes photos of his or her meals with a cell phone camera and uploads the photos, along with comments about the meals, and stores them in the server. We expect that this practice requires the user to pay attention to the daily meals, whereas ordinarily this would not be the case. This triggers reflection and improvement of the user's eating habits. Although many cell phones come equipped with a camera and the ability to upload data to a computer, we built these functions into our client program (i-appli[11]) in order to realize smooth and seamless operation.

2.2 Learning by reflecting on one's own history

The user can take a look back on his or her meal history with comments, all of which are stored in the server, whenever desired. In addition to motivating users to continue recording their meals by photos and comments, looking back upon meal histories encourages a deeper self-cognition of eating habits and thus to self-improvement of them.

2.3 Learning by contrast with others' histories

In our system, the user can refer to others' eating histories. Through comparison, they can see what's missing from his or her diet.

Table 1: Learning design and related functions of our system

Learning design	Functions
Self-recognition	Meal records (photos, comments)
Learning by reflection	Referring to own history
Learning by contrast	Referring to others' histories
Knowledge acquisition	Quizzes and explanations
Motivation increase	Point-based game

2.4 Knowledge acquisition by quiz and explanation

Our system helps users learn about food and meals continuously in daily life through sets of quizzes and explanations three times in a day (morning, daytime and evening). Through these activities, we expect that users will enrich their knowledge about food and meals. We believe this also motivates users to improve their eating habits.

2.5 Increase motivation by point-based game

Most of the learning activities we mentioned above can be done alone. In activities performed alone, however, the user tends to lose interest easily. We are anxious about this. In order to prevent a drop in interest, we have introduced a point-game system, in which all participants compete for points. These points, which are specified beforehand, are given for such activities as taking photos of meals, reading explanations and free comment descriptions, when these are done in a predetermined period. The points given for correct answers in quizzes fluctuate. We believe the point-game design contributes to increased motivation in daily learning activities.

3. Outline of our system

Our system consists of a client program that works on a cell phone (an i-appli program[9]) and a server program for processing and storing data (Figure 1).
The client program downloaded from the server runs on the user's cell phone. It includes required data for daily tasks, such as directions for the user, questions and answers, specified points and explanations (text and images). The results of the activities are recorded on the cell phone and then uploaded to the server for storage. The data directory is divided for every user. Not only does the user have access to his or her data, but other users do as well.
The server is also equipped with an administration function. The administrator can manage users and tasks using a specialized Web-based managing screen. Table 2 shows the development environment of our system. Java2SDK, i-appli Development Kit for DoJa, and Eclipse were used to develop the i-appli of a client. Perl was used to develop the server.

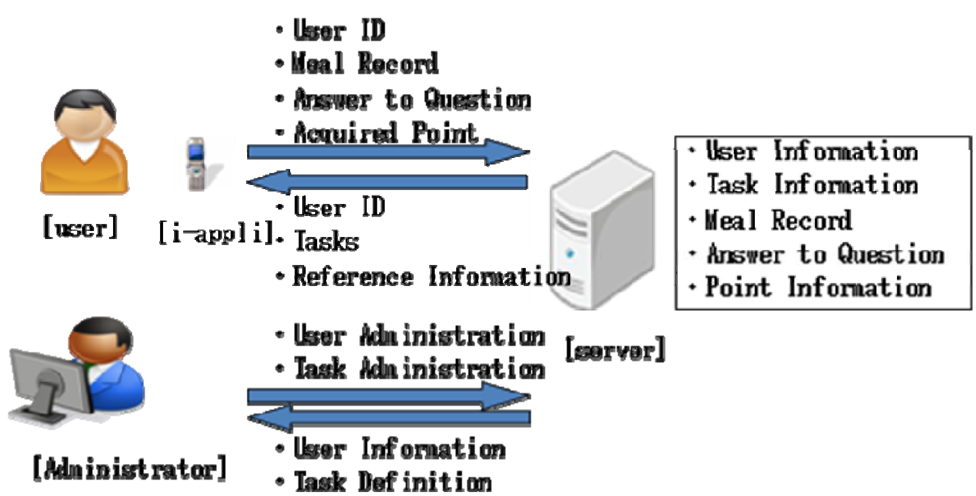

Figure 1: System outline

Table 2: Development environment

Development of i-appli	Windows XP Professional SP2 Java2SDK 1.4.2 i α ppli Development Kit for DoJa5.1 Eclipse3.3
Development of server	FreeBSD 5.4-RELEASE Perl 5.8.8

4. Client program (i-appli)

The client program (i-appli [11]) consists of three modules: a communication module, a task module, and a history module.

4.1 Communication module

The communication module controls communication between the client program and the server program, and between the client program and the scratchpad. The data transmitted and received include the user identifier, directions to the user, questions and answers, specified points and explanations (text and images).
The scratchpad saves the history of the questions, the answers and acquired points, etc. These data are useful and effective when the client program is terminated and started again. The user can immediately begin from the continuation at the terminated point.

4.2 Task module

The task module provides learning activities. They are a record of daily meals by a cell phone camera with comments, selection-type quizzes, free comment descriptions, and explanations of food and meals with text and images (Figure 2).
Nine tasks for one day are arranged in three rows of three lines on the screen. The image of a bird named Katti-kun, which is the official mascot of Saga University, is moved to choose a task. The first line includes tasks for morning, the second for daytime and the third for evening. The first row consists of the tasks of recording meals by a cell phone camera with comments. The second row is for quizzes (selection-type or free description-type) and the third is for explanations of food and meals. All tasks are associated with points.
All tasks except for selection-type quizzes have pre-determined points. In quizzes, if the user makes a mistake, a point is subtracted. The user can continue answering until he or she gives the correct answer. After every task, the user can read comments and confirm acquired points in the results display. We expect that this point-game system will help users stay motivated and interested in the activities.

Figure 2: An example of task selection

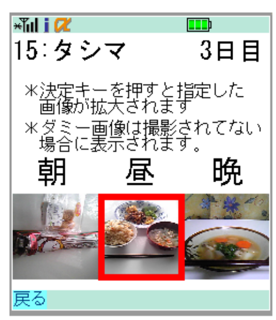

Figure 3:Examples of others' meals record reference

4.3 History module

The history module enables users to check and review not only their own activity histories but those of others as well. Contrasting one's own eating habits with other users' creates an opportunity to reevaluate those habits. Moreover, users can enjoy activities by watching other users' points being updated and by emulating each other. Figure 3 shows an example of a user checking other users' meal records.

5. Server program

In addition to communicating with the client program and managing data, the server program provides task administration and user administration functions.

5.1 Task administration function

The administrator can create new tasks and confirm or modify existing tasks. A task pattern, such as a meal record by a photo with a comment, a quiz, a free description or an explanation, is chosen from a pull- down menu to create a new task. An input form according to it is presented and a task can be created by inputting the necessary information there.

5.2 User administration function

In user administration, the administrator can watch the learning status of all users in real time. The administrator can also check more detailed records of the activities of specific users. In addition, the administrator can delete users and modify user information (user registration is performed at the request of a client).

6. Experiment

6.1 Outline of the experiment

Table 3 shows a schedule of the experiment. We conducted an evaluation of the developed system for seven days from December 15 through 21, 2009. Ten cell-phone SH905i were prepared for the experiment. Ten students (six males, four females) of Saga University participated in the experiment.

Table 3:Schedule of the experiment

Day	Experiment description
Day 1 (December 15, 2009)	● Operation instruction and practice ● Check of eating habits ● Pretest
Day 2-Day 6 (December 16-20, 2009)	● Food education with our system A) Meal record (breakfast lunch, dinner) B) Quiz or free comment（three per day） C) Bits of knowledge（three per day）
Day 7 (December 21, 2009)	● Posttest ● Questionnaire on system ● Questionnaire on food, meals and eating habits

One the first day, each participant was given a cell phone. The participants were instructed on how to operate the phone and practiced operating it. Furthermore, they checked their eating habits and pretested food and meals. From the second to sixth days, they performed the specified tasks every day. On the last (seventh) day, they took a posttest, which was exactly the same as the posttest and questionnaire for system operability, function and consciousness about food and meals.
These tests and questionnaires follow the Learning Materials on Eating Habits published by MEXT (Ministry of Education, Culture, Sports, Science and Technology)[12], The Well-balanced Diet Guide published by MAFF (Ministry of Agriculture, Forestry and Fisheries)[13] and the Dietary Reference Intakes for Japanese (2010 edition) published by MHLW (Ministry of Health, Labour and Welfare)[14].

6.2 Results and discussion

In comparing pretest and posttest scores, 9 of the 10 participants scored better in the posttest (Figure 4). The average percentage of correct answers improved by 15 points, from 72% to 87%. The tests asked users about the roles of nutrients and about their knowledge of food color groups and so on. The test consisted of 31 questions and a perfect score was 31 points. The average pretest and posttest scores were 22.4 and 27.0, respectively. After the pretest, the participants are not told their scores or the correct answers.
We investigated which items were improved from the pretest to the posttest. We found that users improved their scores on questions about food color groups. We believe that this improvement stems from the users learning about food and meals by using the cell phone system, specifically by acquiring information about nutrition, such as from receipts obtained from the dining room of a university co-op.

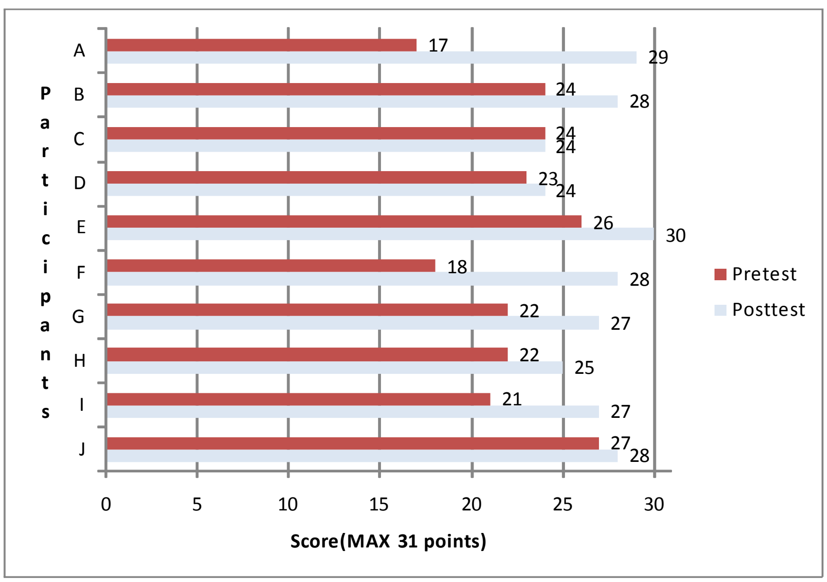

Figure 4: Comparison of scores between pretest and posttest

On the questionnaire about the operability of our system, the average score was 4.5 out of a total of 5(Figure 5). Although the operability of task selection and the history screen were evaluated slightly poorly, all the items received a score of 4 or higher. This is a result of our improvements to the interface design and implementation.

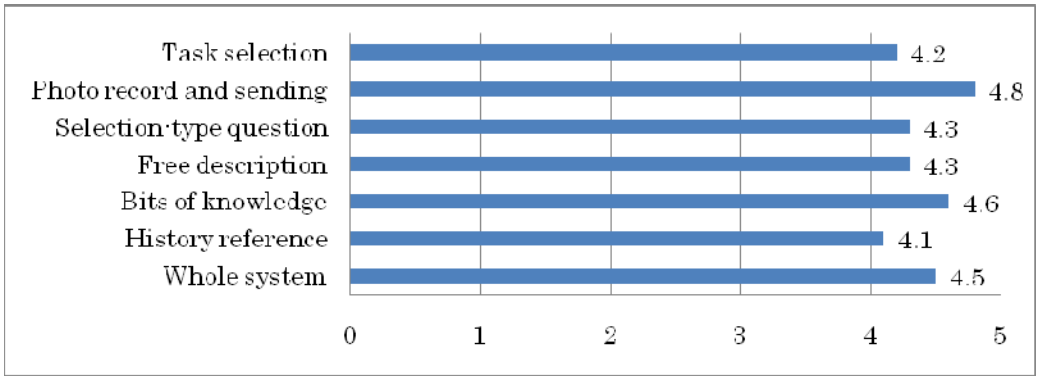

Figure 5: Evaluation results of operability on a five-point scale

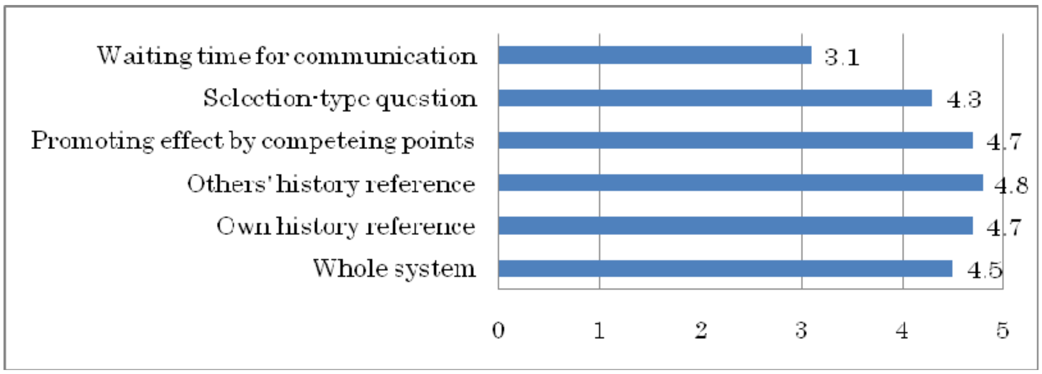

Figure 6: Evaluation results of functionality on a five-point scale

The results of the questionnaire confirmed changes in consciousness about food and meals. Some participants said, “I came to understand the necessity of balance in my daily meals.”, “My consciousness about diet changed after I saw photos of friends who had adopted a well-balanced diet.”, and so on. Through this experiment, many participants looked back upon their eating habits, noticed the importance of balance in their meals, and strove to improve their eating habits.

In the questionnaire about the function of our system, participants gave very high scores (4.5 out of 5) to the function of competing for points and to the function in which users could see their own histories as well as those of other participants(Figure 6).

Also from the results of the description-type questionnaire, we confirmed that motivation is increased by checking other users' information. These results demonstrate that the participants were motivated and enjoyed learning by competing for points. This is an effect of the game-based feature introduced in the system.

At the same time, issues were also found. One is forgetting to photograph meals. Another is the amount of time required to communicate with the server. There were some cases where communication was slow. The former issue can be solved with a sort of reminder function. The latter can be solved by optimizing the transmission and reception of data. The data processing algorithm in a server will be improved. The waiting time for communication will also be improved.

Furthermore, we received a request to add functions to the system, specifically the ability to attach comments to other users' histories for discussion rather than the mere ability to view those histories. We expect that such a function will increase mutual evaluation in addition to self-evaluation.

7. Summary and future works

In this paper, we have developed and evaluated a game-type food education system utilizing a cell phone camera. The system has five main features. (1) Users can recognize and be conscious of their own eating habits. (2) Users can acquire and enrich their knowledge of food and meals. (3) Users can reflect on and improve their eating habits by monitoring and recording their meals. (4) Users can reevaluate their eating habits by comparing those habits with others'. (5) These activities can be performed as a game, so that users enjoy learning.
Through the experiment, we have demonstrated that our system is helpful for food education. Nine of the 10 participants improved their scores on the basics of food and meals. The average percentage of correct answers improved by 15 points, from 72% to 87%. Changes in consciousness about food and meals were confirmed by the questionnaire. The results of the questionnaire about the operability and the functions of our system showed that the system was easy to use and helpful. Furthermore, we found that playing together with other members and competing against one another increase motivation to learn.
Adding a communication function between users for mutual evaluation and discussion, along with improvements in the data processing and administration functions in the server, remain as issues to be resolved. After such improvements are made, we will verify the usefulness and effectiveness of our system over periods of several months.

References

[1] Cabinet Office, Government of Japan. Basic Program for Shokuiku Promotion. http://www8.cao.go.jp/syokuiku/about/pdf/plan_ol_eng.pdf.
[2] Ministry of Agriculture, Forestry and Fisheries. What is "Shokuiku (Food Education)"? http://www.maff.go.jp/e/pdf/shokuiku.pdf.
[3] Okazaki,Y., Iwahashi, Y., Tanaka, .H., Watanabe, K., Takenaka, M. (2010). Development of a Game Type Dietary Education System Using a Cell Phone Camera, *Forum on Information Technology 2010(FIT2010)*, 3, 603-608.
[4] Hasegawa, S., Yoshida, T., Egami, I., Yokota, M., Murakami,Y. (2006). Dietetic Education Using a Nutrition Management System with Camera Phones. *Computer & Education*, 21,107-113.
[5] Nakahara,J., Yamaguchi, E., Nishimori, T., Mochizuki, T., Nakano, M., Furuta,Y., Sekine, S., Ofusa, J., Takigawa, Y., Yamauchi, Y. (2007). Learning about science with parents : Development of the hands-on educational program for children and parents that allows them to do science experiments using cell phones. *Transactions of Japanese Society for Information and Systems in Education*, 24(3), 155-166.
[6] Libra Plus Corp. refla. http://www.libra-plus.co.jp/business/refla.html.
[7] Mobile Diet Inc. motile diet. http://www.mobadai.jp/.
[8] Hymena&Co. HYMENA'S NUTRITION ANALYSIS SERVICE. http://hymena.jp/shopping/.
[9] United System Supply. Food Balance. http://www.united-ff.co.jp/ff/keitai/index.htm.
[10] Grimes, A., Landry, B. M., Grinter, R.E. (2010) . Characteristics of Shared Health Reflections in a Local Community. *Proceedings of the 2010 ACM conference on Computer supported cooperative work(CSCW2010)*, 435-444.
[11] NTT DOCOMO. i-mode. http://www.nttdocomo.com/glossary/i/i-appli.html.
[12] Ministry of Education, Culture, Sports, Science and Technology. the Learning Materials on Eating Habits. http://www.mext.go.jp/a_menu/shotou/eiyou/syokuseikatsu.htm.
[13] Ministry of Agriculture, Forestry and Fisheries. The Well-balanced Diet Guide. http://www.maff.go.jp/j/balance_guide/index.html.
[14] Ministry of Health, Labour and Welfare. the Dietary Reference Intakes for Japanese (2010 edition). http://www.mhlw.go.jp/bunya/kenkou/sessyu-kijun.html.

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Development and Evaluation of the Flower Identification Database for Mobile with a Geo-tagged Picture Map

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Abstract: We developed a system for creating geo-tagged observational picture maps that makes use of a GPS logger that is equipped with a database of flowers that can be used for the identification of these flowers. This database includes 961 color photographs of 220 varieties of flowers that are commonly found in Japan. The system has the following functionalities: the ability to search and identify flowers by season, color, and name; the ability to view high-resolution video clips showing scenes that are difficult to observe, such as the dispersal of seeds; detailed explanations on the method of identifying similar flowers that are hard to distinguish; and the ability to assist in the creation of an observational picture map by automatically showing photographs together with observational comments on a Google Maps based on GPS signal data. The system was trialed with 208 sophomore university students as part of a fieldwork involving the observation of wild flowers. As a result of the trial, the effectiveness of the system was validated in the following four domains: (1) interest, motivation, and attitude; (2) thinking and decision making; (3) technique and expression; and (4) knowledge and understanding.

Keywords: Automatic Generation of Geo-tagged Picture Map, Assistive System in Science Education, Mobile Phone, Mobile Devices for Students, Use of ICT in Education

Introduction

Through its “New Strategy for IT Revolution (2006) in Japan,” the Japanese Ministry of Education promotes the use of information technology in school education, identifies the active use of information and communication technology (ICT) to enhance learning, and advances the improvement of the teaching skills that leverage ICT as key challenges. Further, the fact that the use of ICT leads to enhanced scholastic performances has been objectively proven in various studies including “Research to assist in the promotion of informatization in Education” [1]. In practice, however, the outcome from the “Survey on Information Education and use of ICT” showed that among the 256 primary and junior high schools surveyed in K City, the average achievement index reflecting a teacher’s ability to leverage ICT was only 67.1 points (“partially achieved”). Moreover, the proportion of schools that utilized ICT in classrooms remained at 73.3%. Some of the reasons for ICT not being utilized despite its proven effectiveness included “lack of skills in collecting and developing content” and the claim that such tasks were “too laborious.” At the same time, it was noted that there was an increasing number of newly-employed primary school teachers who were conscious of the deficiency in their flower-identifying skills, which led to the inclusion of an assignment in the teacher training program that involved the creation of a flower observation picture map. We have thus decided to develop a flower identification and picture map system as a joint research project with the university.

Field studies are led in various places, in order to improve the concern for science education. However, in such field studies, as the studies are often done in places which are geographically remote one from the other, the documents which can be carried have to be limited, and the instructions about the contents of the study have to be modified according to the situation, as we experience various restrictions. Therefore, it is often the case that the study is only lead as an experience. In that case, the object of the children's interest is deeply involved, but their interests are not stimulated at all. In some cases their experience of a particular instant cannot be sustained anymore, then we have the problem that the study cannot be deeply understood by them. On the other hands, many education support systems with using mobile information devices have been developed as the advance of mobile device technologies [2][3][4]. In such situations, some researches have been using mobile information devices for field studies in order to solve this problem; they have accomplished remarkable development in recent years and have therefore flourished significantly.

These researches are divided roughly into two themes: (1) studies where mobile devices were applied to the material presentation of the field study, (2) records of learners' activities using mobile devices in the field study. The examples for the first theme (1) are utilization of a mobile phone in a zoo for the presentation of each animal's information [5][6]. In these two researches, the function of contents display has been achieved by reading GPS and QR code in correspondence to the place of the study. However, in order to promote the children's interest, we can think that the contents display according to each study situation is effective, but has not been achieved. As an example of the second theme (2), we have the example of the information gathering in the outdoor activity using PDA [7][8], and the example where camera and e-mail function of the cellular phone were used [9], however, the function of the first theme (1) was not realized in this case. As an example of the combination of two themes, we have the example of the cellular phone with GPS based learning support system for field studies at zoo. The system can display dynamically the contents that were suitable for study based on a learners' position information and his past activity history, and conducted by using a cellular phone with a GPS function [10]. However, teachers must prepare lots of contents about animals before the field work.

In this paper, we have described how we have used cellular phones with a GPS Logger as mobile computing devices. By acquiring and saving information about a user's position and the history of his past activities, we have developed a system and contents of flowers for a field study support. We have attempted to deal with some parts of the second theme (record of the study history) by recording the learners' comments with a cellular phone in the student's study history, for every user and we could thus suggest a solution for the problem mentioned in theme (1). Furthermore, we have evaluated this system by taking up fields outside the school, developing the contents about flowers for field study as an object of field study, and conducting an evaluation experiment.

1. Research Objectives

There are two objectives to this research. The first is to develop a system for assisting in the identification of flowers and creation of picture maps during field observation learning. The second is to trial the system with sophomore university students who are studying to become teachers in order to validate the effectiveness of the system. Specifically, the following four domains will be analyzed in order to measure the effectiveness of the developed system.

(1) "Interest, motivation, and attitude" – whether the students were able to feel an affinity with nature and further enhance their motivation for exploring it through the field observation of flowers using the mobile information terminal.

(2) "Thinking and decision making" – Whether the students' breadth of observation and research activities increased on completion of the flower observation fieldwork that

involved utilizing the multimedia contents on the information terminal, as opposed to relying exclusively on library resources.

(3) "Technique and expression" – Whether the students became proficient at utilizing various tools and equipment to fulfill particular needs and create picture maps efficiently through the use of creative techniques following their completion of the field observation utilizing a mobile information terminal and a GPS logger.

(4) "Knowledge and understanding" – Whether the students were able to identify flowers accurately and comprehend phenomena that are hard to observe directly, such as seed dispersal, by using the multimedia field guide during the fieldwork observation.

2. Research Methodology

In June 2008, an inquiry was made regarding the current flower observation learning being imparted in primary schools, and interviews were held with twelve primary school teachers and one curriculum director to discover the requirements with respect to the enhancement of this curriculum.

In order to validate the effectiveness of the system, a paper-based survey regarding the learning content was administered to the participants. Each question in the survey belonged to one of the following three domains: (1) interest, motivation, and attitude; (2) thinking and decision making; and (3) technique and expression. In addition, a short objective test was conducted to measure the knowledge and understanding of the students. Further, we investigated motivation, feeling of participation, satisfaction, and confidence as overall elements in relation to the learning activities using the present system. Finally, the flower observation map and the learning portfolio created by the students were analyzed.

3. The content and functionality of the flower identification and picture map system

On the basis of the results of the prior inquiry, it was decided that the system would comprise the following contents and features: (1) 961 color images, showing 220 flower varieties that are commonly observed in the Kansai region, equipped with the facility to search on the basis of each flower's season, color, and name so as to facilitate its identification (Figure 1); (2) the ability to view high-resolution video clips of difficult-to-observe scenes such as dispersal of seeds; (3) detailed explanations on how to identify flowers that are difficult to distinguish from each other (Figure 2); and (4) a picture map creation system whereby observation records and photographs would automatically be

Figure 1 A screen showing flower search results

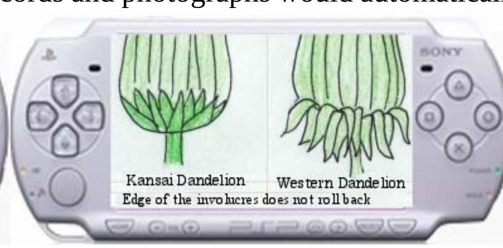

Figure 2 A screen containing an explanation on the method of distinguishing between flowers

shown on a Google Map using GPS data (Figure 3). Observation records would be stored on the server, which could then be used for collaborative learning.

Figure 3 A flower picture map created using this developed system

4. System Configuration and Architecture

The Flower Identification Database System for Mobile Devices with a Geo-tagged Picture Map developed for this research is a client-server system that comprises (1) the mobile phones owned by the students for sending picture and text messages; (2) the client PC used by the lecturer; and (3) the server running a SQL database server for storing the submitted pictures and comments and a Web server for displaying the submitted information. The client interface for the learners' use was developed using Ajax and the Google Maps API, and it can run on Windows NT 4.0, 2000, XP, and Vista. The comments submitted from the students' mobile phones are dynamically processed using Asynchronous JavaScript and XML, stored on the database server, and outputted as XML or CSV files. CentOS version 5 (Redhat Linux compatible), My SQL version 5, and PHP version 5 were used for the server. Figure 4 shows the Flower Identification Database System for Mobile Devices with a Geo-tagged Picture Map. KML (Keyhole Markup Language) is a file format used to display geographic data in an Earth browser such as Google Earth, Google Maps, and Google Maps for mobile. KML uses a tag-based structure with nested elements and attributes and is based on the XML standard. The most common way to embed geo-data into an image file is using

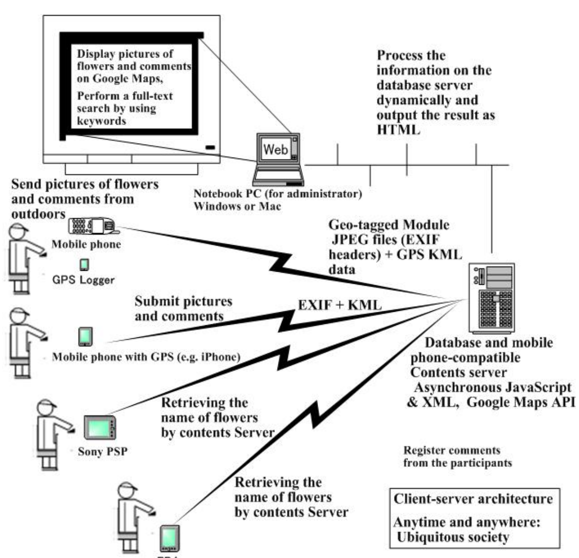

Figure 4 the Flower Identification Database System for Mobile Devices with a Geo-tagged Picture Map

the Exchangeable Image File Format (EXIF). The data is stored in binary form in the EXIF headers in a standard way. We developed the library for reading the headers of JPEG files.

5. Educational Practice utilizing the system at outside fields work

The educational practice at outside fields work were undertaken with a total of 208 students (78 male and 130 female) comprising 36 sophomore students training to become teachers at S University and taking the course entitled "Multimedia and Classroom Enhancement" and 172 students from B University taking the "General Studies" course (across three classes). The flower observation fieldwork was undertaken in pairs. Each pair was given a Sony PSP and GPS logger, and the students were asked to bring along mobile phones equipped with cameras. For those pairs that could not bring mobile phones, a USB camera was attached to the PSP provided. The students observed flowers as they walked on the university campus, took pictures with the cameras on their mobile phones, and sent emails to the system server comprising the name of the flowers observed, any related observation notes taken, and photographs of the flowers in the form of an attachment. When the students were unable to identify the name of a particular flower, the multimedia field guide for PSP was used to assist in its identification. The GPS logger automatically recorded the position information in its internal memory every five seconds. After the observation was complete, students returned to the lecture room and connected the GPS logger to a PC. The position data were then sent automatically to the system, geo-tagged (i.e., the position data were added for referencing), and an observation map such as the one shown in Figure 3 was generated.

In order to comparatively investigate the effectiveness of the system, the 208 students were divided into two equal groups: Group A (104 students) and Group B (104 students). The system was then utilized according to the execution schedule shown in Table 1. Since the students were enrolled in three classes, the maximum number of students at any one session was 36.

Table 1 Execution Schedule for the Observation Activities of Each Group

First Week (flower observation fieldwork on campus)	
Group A (104 students)	Group B (104 students)
Collection and identification of flowers without this system, taking of pictures and creation of a picture map on the paper not by using this system	Collection and identification of flowers with PSP system, taking of pictures and creation of a picture map on the web by using this system, GPS Logger
Attitude survey taken, self assessment sheet filled, and short test completed	
Second Week (flower observation fieldwork at the school where the students had undertaken internship)	
Group A (104 students)	Group B (104 students)
Collection and identification of flowers with PSP system, taking of pictures and creation of a picture map on the web by using this system, GPS Logger	Collection and identification of flowers without this system, taking of pictures and creation of a picture map on the paper not by using this system
Attitude survey taken, self assessment sheet filled, and short test completed	

6. Results and Discussion

6.1 Evaluation of the system by the students

The results of the students' survey regarding their assessment of the developed flower observation assistive system's ease of use, clarity of flower photographs, and flower identification method are summarized in Figure 5. Many students responded positively in the above context regarding the ease of use, clarity of photographs and video clips, and display size with respect to the flower field guide. Moreover, while many students also responded positively regarding the function whereby one could search for a flower by name, season, and color, some students commented that the function through which the observation record was submitted to the server was slightly cumbersome. It thus became clear that the developed system required further enhancements that would enhance its usability.

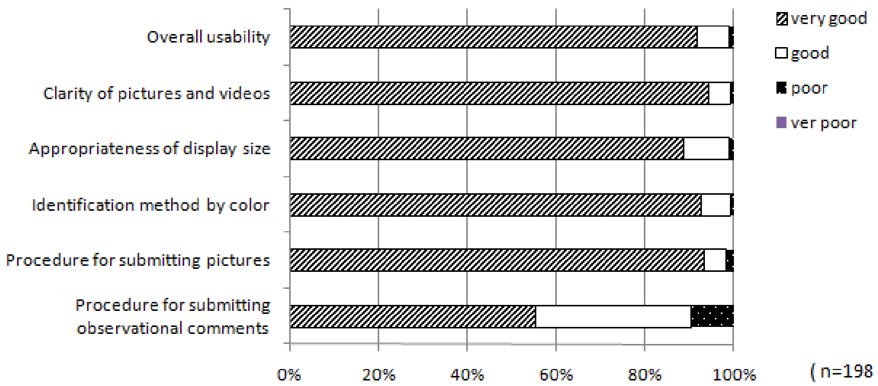

Figure 5 Evaluation of the system by the students

6.2 Validation of the system's effectiveness

The result of the test to objectively measure the students' knowledge and understanding of the developed system that was administered following the completion of fieldwork is summarized in Table 2. There were four types of questions in the test: (1) those related to identifying and naming a flower given its picture (8 questions); (2) those connected to looking at illustrations of seed dispersal and choosing the correct one (4 questions); (3) those concerned with reading the explanations and illustrations on the method by which to distinguish between similar flowers and choosing the correct explanation (4 questions); and (4) those inviting free-form comments on the observational study of flowers.

Table 2 Score results of the objective test on knowledge and understanding

	Group A	Group B	Inter- Group
1st Week	46.1	69.9	*p<.05
2nd Week	75.8	60.2	ns
Intra-Group	**p<.01	ns	

(n=200)

An analysis of variance was performed in order to compare four factors: 2 (intra-group) × 2 (inter-group). As a result, a significant interaction with 1% standard was detected, and the LSD method was used to perform multiple comparisons on the mean score. This resulted in a statistically significant difference being confirmed within Group A between week 1 (when photo identification sheets were utilized) and week 2 (when the present system was utilized). Furthermore, there was a statistically significant difference between Group A in week 1 (where photo sheet identification sheets were utilized) and Group B in week 1 (when the present system was utilized). On the other hand, there was no statistically significant difference in the mean scores of weeks 1 and 2 within Group B. This outcome can be interpreted as follows. The reason for Group A having a lower test score f in week 1—wherein learning took place based on photo sheets of flowers—was that, as shown in Figure 6, their mean scores for the questions related to flower identification, seed dispersal, and flower identification method were consistently lower than Group B, with 32% of the

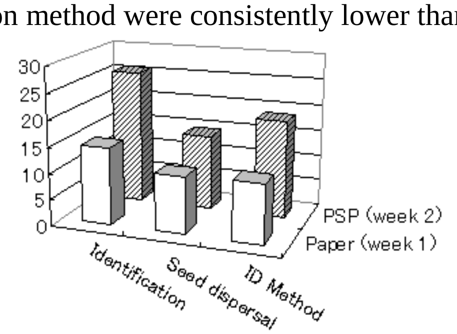

Figure 6 Analysis of the test results for Group A

students leaving more than one question on the identification of flowers unanswered.

While color photo sheets were used for looking up and identifying the name of the flowers, these sheets only included 24 representative spring and summer flowers, resulting in the students responding with “other flowers” when they were unable to identify the name. In addition, as in the photographs used in textbooks, the photo sheets only showed photographs taken from an angle that was optimal for capturing the characteristics of each flower. When the students observed the same flowers in the field, there were many instances whereby they saw the flower from angles other than those shown in the textbook, making identification problematic.

In contrast, the number of Group A students leaving questions related to flower identification unanswered was reduced to 8% in the second week, thereby causing the mean score to rise. Using the present system, students began the identification process on the basis of the current season and color of the flower. After the relevant candidate flowers are shown, photographs could be seen of not just the flower but also of its stem and leaves taken from various angles, thus aiding identification as well as boosting the retention of knowledge. This fact was backed up by the students’ free form comments such as follows: “it was easy to search for flowers by their color” and “identification was possible as photographs of not just the flowers but close-up photographs of the stems and leaves as well were provided.” Further, while a significant difference was not detected in the questions related to seed dispersal and those related to the identification method between weeks 1 and 2, there was an increase in the mean score for these questions. From the free form comments such as: “looking at the seed dispersal video stimulated my interest” and “I was able to understand the explanation clearly after looking at the slow-motion video of seed dispersal,” it can be deduced that the video clips were able to supplement areas that were difficult to grasp based exclusively on photo sheets.

Next, the result of the self-assessment questionnaire comprising 4-scale multiple-choice questions is shown in Figure 7 for Group A and in Figure 8 for Group B. The analysis of variance performed resulted in a significant interaction with 5% standard being confirmed between the two groups. The LSD method was used to perform multiple comparisons on the mean value. As a result, it became clear that scores for questions related to “thinking and decision making” (e.g., “Did you understand how to differentiate between the Kansai Dandelion and Western Dandelion?” and “Have you been able to formulate your own opinion based on information gained through investigation?”) were significantly higher in Group A when the present system was used for the concerned study.

The fact that the scores for questions related to “interest and motivation” were high for both groups with or without the use of the present system and did not show a significant difference is attributed to the incorporation of the outdoor fieldwork activity, which served to increase the interest and motivation of the students. Further, scores for questions related to “technique and expression” also improved when the present system was utilized. Free form responses included the following: “it was easy to create the picture map automatically, so more time could be spent on discussions related to the problem on flower identification”; “even when I uploaded an erroneous response due to the incorrect identification of a particular flower, I was able to discover the error during our discussions by comparing our map with maps created by other groups;” “an observation map was created and uploaded during the second week at the school where I undertook my internship; this enabled me to compare the mountainside and city regions;” and “I have endeavored to describe the identification method in the observation comment.” These comments reflected signs of the students’ creativity in the course of learning as well as their proactive attitude. Based on the outcome and observations stated above, the effectiveness of the system has been validated in the domains of “knowledge and comprehension,” “thinking and decision-making,” and “interest and motivation.”

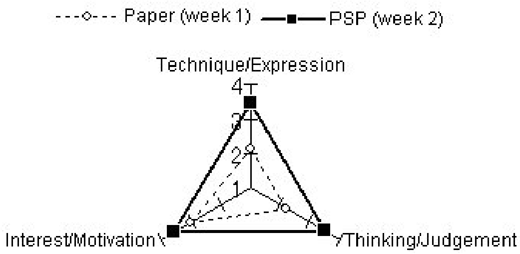

Figure 7 the average scores of Group A

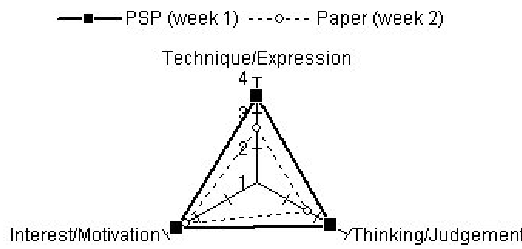

Figure 8 the average scores of Group B

7. Conclusion and Future Work

This article describes the development and the evaluation of the Flower Identification Database System for Mobile Devices with a Geo-tagged Picture Map. Learners can create the geo-tagged observational picture map with observational comments of flower on the Google maps by this system. This database of flowers includes 961 color photographs. Learners can search and identify flowers by season, color, and name, can watch high-resolution video clips showing scenes that are difficult to observe, such as the dispersal of seeds. Learners can read the detailed explanations on the method of identifying similar flowers that are hard to distinguish. The system was trialed with 208 university students as part of a fieldwork involving the observation of wild flowers. As a result of the evaluation, the effectiveness of the system was validated in the following four domains: (1) interest, motivation, and attitude; (2) thinking and decision making; (3) technique and expression; and (4) knowledge and understanding. In the future, we plan to undertake field trials with primary school students using PSP with GPS and a camera connected via USB.

References

[1] Shimizu, Y. (2008). Research to assist in the promotion of informatization in Education, Annual Report of School Education in Japan, Japanese Parties of Educational Technology, 11-20.

[2] Hsi, S. (2004). I-Guides in progress Two prototype applications for museum educators, and visitors using wireless technologies to support informal science learning, Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'04), 187-191.

[3] Roschelle L., & Pera, R. (2002). A walk on the WILD side: How wireless handhelds may change computer supported collaborative learning, International Journal of Cognitive Technology, 1(1), 145-168.

[4] Miyata, H., & Ishigami, M. (2007). Effects of Using Digital Contents Designed for PDA as a Teaching Aid in an Observational Learning of Planktons for Fieldworks on a Ship, International Journal on Advanced Technology for Learning, 4 (3), ACTA Press, 146-154.

[5] Chou, L., Lee, C., & Chang C., (2004). A Tour Guide System for Learning in Museums, Proceedings of the 2nd IEEE International Workshop on Wireless and Mobile Technologies in Education(WMTE'04), IEEE Computer Society, 195-196.

[6] O'hara, K., Kindberg T., Glacy, M., Baptista, L., Sukumaran, B., Kahana, G., & Rowbotham J., (2007). Social Practices in Location-Based Collecting, Proceedings CHI 2007.

[7] Haapala, O., Sääskilathi, K., Luimula, M., Yli-Hemminki, J., & Partala, T., (2007). Parallel Learning between the Classroom and the Field using Location-Based Communication Techniques, Proceedings of ED-Media 2007, Vancouver, Canada.

[8] Yoden, Y., Yamanoi, K., Kakihana, K., Araki, T., Mouri, Y., Kubota, Y., & Ichimura, T., (2005). Teaching practice for promoting scientific creativity using the mobile learning system "STUDYNOTE POCKET" on PDA., Proceedings of the 29th Annual Conference of Japan Society for Science Education, August (in Japanese).

[9] Takenaka, M., Inagaki, S., Kuroda, H., Deguchi, A., & Ohkubo, M., (2006). Fieldwork Support System Using Mobile Phones: Evaluations of Information Sharing in the Second Grade's Life Environment Study, Proceedings of ED-Media 2006, Orlando FL, USA, 1325-1331.

[10] Ogino, T., Suzuki, M., Kusunoki, F., & Hatono, I., (2008). Cellular Phone with GPS Based Learning Support System for Field Studies, Proceedings of ED-Media, Vienna, Austria, 2008, 1812-1817.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Analysis of the Learner Content Creation Process in a 1:1 Seamless Idiom Learning Environment

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Abstract: This paper reports a pilot study on mobile-assisted language learning that focused on both creative learner output and seamless learning. In learning Chinese idioms, students proactively used smartphones on a 1:1 basis to take photos in their daily lives, subsequently in-class or online sharing and discussions took place, enhancing the students' understanding in the proper usage of the idioms. Our analysis of the student artefacts in both product- and process-oriented aspects reveals the students' cognitive process and learning strategies during the course of content creation. The students' ongoing, open-ended, personal-to-social meaning making process and learner-created authentic content have indeed shown some indicators of seamless language learning and induction-based peer learning that has the potential of transforming language learning into an authentic learning experience.

Keywords: Mobile assisted language learning, Seamless learning, Meaning making, Learner created content

1. Introduction

In language learning, "closed" exercises that restrict information to only standard answers are unlikely to remain in permanent memory [1] whereas meaningful and communicative activities build on classroom learning experience, and link them with the learners' wider knowledge [2]. Bringing in student-generated materials is also a time-tested method that may actively demonstrate informed participation to explore large problem spaces, learn from their peers and create new understandings [3].
This paper reports on a study of Mobile Assisted Language Learning (MALL) in Nan Chiau Primary School, Singapore. In the study, we facilitated a Primary 5 (11-year-old) class to study and apply 29 common Chinese idioms. Apart from in-class idiom lessons, the students were assigned with a smartphone each which they were allowed to access 24x7 throughout the study. They used their smartphones to take photos in their daily lives, make sentences with the learnt idioms, and post them onto a wiki space for peer review.
In this paper, we focus on analysing the student artefacts in both product- and process-oriented aspects, to unveil the students' cognitive process when participating in the learning activity. Such a learning design could be attributed to the process of multimodal, learner-created-content-focused, ongoing, open-ended meaning making in the context of vocabulary learning. Due to the space constraint, only a brief description of the peer learning process is given in section 4.4. Interested readers may refer to [4] for more details.

2. Literature Review

2.1 Constructivist Approach in Vocabulary (Idiom) Learning

In recent decades, there is a paradigm shift in language learning theories from behaviorism to a communicative approach [5]. Under the emerging paradigm, learning is seen not as a passive activity that requires learners to accept pre-packaged information, but as an active process by which learners create their own understanding. In addition, researchers have raised the importance of the negotiation of meaning, also known as social meaning making, in second language development [6]. Such pedagogical strategies are particularly applicable to the learning of context-dependent vocabularies. Context-dependent vocabularies are certain types of compound vocabulary such as idioms whose complex nature may result in highly context-dependent appropriateness of their usage [7]. In other words, there are many possible real-life contexts where such vocabulary could suitably (or unsuitably but often mistakenly) be used. Just as scholars argue that language teachers should create the right conditions for students to "uncover" grammar [8] through students' active meaning making, we envisage a similar principle for vocabulary learning.

Over the years, vocabulary learning theorists have advocated productive learning [9], inductive meaning making [10], and contextual learning [11], among others. This points to the trend of emphasizing students' self-construction of understanding in vocabulary usage, and this is done likely through learning in the authentic context.

2.2 Mobile/Seamless Learning and Language Learning

As authentic learning comes into the picture of language learning, MALL becomes a viable solution to the blending of the language learners' learning environment into their real-life contexts. Prior research has shown that the mobility and connectivity of the devices enable students to become an active participant, not a passive receiver, in mobile learning activities [12]. The recent development of MALL demonstrates a similar tendency.

The notion of seamless learning may be the answer. The handhelds which could function as a personal *learning hub* [13] creates the potential for an evolution of ICT-enhanced learning, which is characterised by *seamless learning spaces* and marked by continuity of the learning experience across different environments, and emerging from the availability of one device per student (1:1) for 24x7 access [14]. The integration of individual and social learning could be enhanced by blending mobile and Web 2.0 technologies to bring to the students the situated mobile learning experiences that take into account both the students' everyday tasks and socio-constructivism [15]. Such an integration can be expected to balance and bring out the best of both individual and social learning.

3. Study Description

Our pilot study of "Move, Idioms!" took place during July-September 2009. We adopted the *design research* methodology [16] that involved identifying a problem and through rigorous research to provide solutions, which are then improved upon over a number of iterations of testing and implementations. We designed a customisable learning process to engage students in ongoing Chinese idiom learning and writing (sentence making) activities. A class of 40 11-year-old Primary 5 students, with mixed abilities in Chinese, participated in the pilot study. Each of them was assigned a HTC TyTN II smartphone running MS Windows Mobile 6, with built-in camera, Wi-Fi access, internet browser and English/Chinese text input. Furthermore, we adopted PBWorks (http://www.pbworks.com/) to create the wiki space for photo/sentence sharing and peer reviews. Apart from standard wiki features such as multi-user content editor and page history, an online forum-style comment tool is also incorporated on each wiki page. In addition, mobile-optimised comic animations that depict the meanings of idioms can be assessed by the students anytime, anywhere. The animations are sponsored by our research partner, a Taiwan-based digital content developer. Twenty-nine idioms were selected from the students' Chinese textbooks for Primary 3-5 as the target idioms to learn. The students had encountered most of these idioms before but did not necessarily retain them or understand thoroughly their proper contextual usage, as revealed in their performances in the class-wide pre-test and the pre-interviews with selected students (see below).

Figure 1 depicts the process of our learning design. The four-activity process is iterative and encompasses formal and informal learning spaces, individual and social learning spaces, receptive and productive activities, and the use of both mobile and Web 2.0 technologies (i.e., learning takes place in both the physical world and the cyberspace).

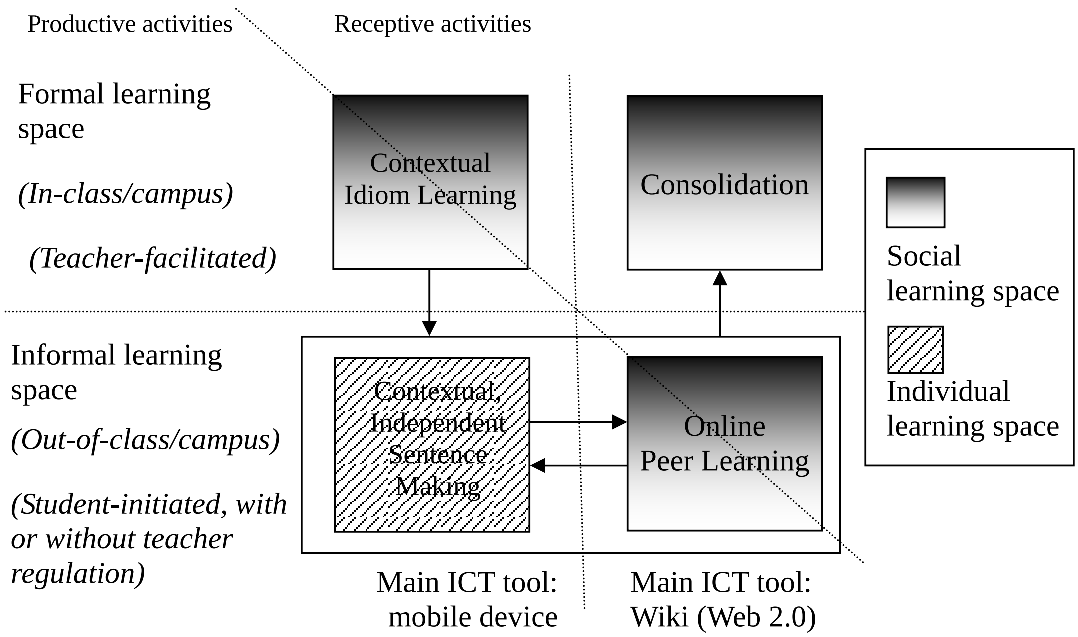

Figure 1. The mobile-assisted idiom learning process

The processes of the four activities are described below:

Activity 1 – In-class contextual idiom learning: The classroom/in-campus activities are conducted to motivate and prepare students to engage in subsequent out-of-school activities. During each lesson, a new set of *idiomatic animations* is shown to the class. The teacher then conduct contextualised learning activities such as flashing context-rich images taken in daily life and inviting students to discuss about relevant idioms, or facilitating them to search for or improvise relevant contexts in the campus that illustrate the idioms, take photos and compose sentences, and upload them to the Web.

Activity 2 – Out-of-class, contextual, independent sentence making: Students carry the mobile phones 24x7. Apart from watching the animations repeatedly, they proactively identify or create contexts in their daily lives which could be associated with any idiom. They then take photos, make sentences by using the idioms to describe the photos, and post them onto a class wiki space. In the wiki space, we create one page for each idiom covered in the class for students to post their photos/sentences. This offers convenience for comparing student-identified contexts and their sentences pertaining to the same idioms.

Activity 3 – Out-of-class, online peer learning: Students perform peer reviews on the wiki by commenting on, correcting or improving their peers' sentences (by making direct modifications on the sentences posted on the wiki pages). Due to technical constraint, they only carry out these activities with PC's or laptops at home, not the handhelds.

Activity 4 – In-class consolidation: Possible activities include class-wide or small group discussions on selected sentences made by the students, or polls for “the most popular photo/sentence” on each “idiom page”.

During the pilot study, the teacher conducted five “idiom classes” (Activity 1) in the first five weeks with one-week intervals. In the first three classes, the students enacted some of the idioms for peers to take photos within the classroom. In the last two classes, they captured images to illustrate idioms within the campus. In between, the students carried out Activity 2 and 3. The teacher then facilitated Activity 4 in the seventh week. Students worked in groups of five, with each group being assigned an “idiom page” to identify erroneous uses of idioms with respect to the contexts in the photos or the sentences made, and to offer recommendation in correcting or improving the sentences. The students returned the smartphones to the school upon the completion of the study.

The data collected and analysed consist of: (1) Pre- and post-tests to assess the students’ learning gains in the target idioms (i.e., proper idiom-context associations); (2) Pre- and post-questionnaires (to investigate the students’ perceptions and behaviours in learning Chinese, learning Chinese idioms and the use of mobile devices in learning.); (3) Pre- and post-interviews with two high-, two medium- and two low-ability students (in terms of their academic performances in Chinese class) selected by the teacher; (4) Video recordings during the in-class activities; (5) Student artefacts and online interactions; (6) Another post-questionnaire for the students to self-report their various thinking processes in creating individual artefacts in order to unveil how *personal meaning making* may take place during such content creation activities. Considering the focus of this paper (students’ content creation process), we will not go into (1) and (2) in great details.

4. Findings

4.1 Pre- and Post-test and Questionnaires

We analysed the students’ pre- and post-test results (full score: 30 respectively) and yielded: mean of pre-test scores = 19.36 (SD = 5.68), mean of post-test scores = 20.77 (SD = 4.50), $t = -2.32$, $p = 0.026$ (< 0.05). The analysis shows that the students achieved a statistically significant improvement in their abilities in associating idioms with the right contexts after the nine-week intervention.

We also applied paired-samples *t* test on the questionnaire data to examine if there were significant changes in students’ perceptions toward Chinese learning, Chinese idioms and writing, and technology for learning before and after the intervention. The results show positive, though insignificant shifts in all the aspects. We believe it was because the intervention was relatively short and therefore did not result in prominent changes.

Nevertheless, the students expressed favourable attitudes in their participation in the intervention through the post survey. The descriptive statistics of the relevant items show that more than 80% of the participants “agreed” or “strongly agreed” that they “enjoyed the learning activities”, “wished to participate in more rounds of such learning activities”, and “could learn idioms better with such activities than the previous ways of learning idioms”.

4.2 Product-oriented Analysis of the Student Artefacts

Within the nine-week period, the 40 students contributed a total of 453 photo/sentence sets, revised (corrected or modified) sentences for 124 times, and posted 134 comments. From their artefacts, the students demonstrated their creativity by making up contexts that associate with specific idioms. Table 1 features examples of different types of photo/sentence set with the idioms underlined in the original Chinese sentences. We analysed all the 453 photo/sentence sets and classified them into 12 categories with respect to two dimensions, namely, “types of physical setting” and “types of meaning making”. “Types of physical setting” refers to the sources of the physical setting captured by each photo, i.e., “natural setting”, “physical object manipulation”, “human enacted scenario”, or “previously published materials” (exemplified by (A), (B), (C) and (D) in Table 1 respectively). “Types of meaning making” refers to how the associated sentence reflects the student's personal meaning making on the photo (i.e., the relationship between the photo content and the sentence content). , which could be “literal meaning making”, “extended meaning making” and “creative meaning making”.

Here is how we distinguish the personal meaning making types: (1) *Literal meaning making*: The sentence demonstrates a direct interpretation of the photo context – all the elements stated in the sentence are visible in the photos (e.g., (B) in Table 1). (2) *Extended meaning making*: The sentence demonstrates a logically deductive interpretation on the photo context – there are elements in the sentence which are invisible in the photos but they are logical deductions from the photo context. For example, in (A), the additional element is “a full day of house cleaning”. (3) *Creative meaning making*: The sentence demonstrates a twisted, perhaps creative re-interpretation on the photo context (i.e., others may not interpret the photo in the same way). For (D), for instance, the author associated a close-up photo of a bird and green plants with “the tiny island” and “tourists to spend holidays”.

Table 1: Four examples of student artefacts created in the pilot study

	(A)妈妈一整天把家里打扫得干干净净之后就精疲力尽地躺在沙发上。 After a full day of house cleaning, mom lays exhausted on the sofa.		(C)现在三更半夜，我不想吵醒爸爸妈妈。可是我想吹一吹哨子所以我以为我掩住耳朵，听不到了。没想到，爸爸听到了出来骂我。他说：“掩耳盗铃没用的。” It is midnight but I want to blow the whistle without waking up mom and dad. Therefore, I plug my ears. However, dad hears me and comes out to scold me, "It is no use to bury your head in the sand."
	(B)有一辆车横冲直撞，撞到了另一个车! A car is romping about and then crashes with another car.		(D)整个小岛绿茵环抱，鸟语花香，吸引了很多游人前来度假。 Surrounded by green plants and joyous sceneries, the tiny island has been attracting many tourists to spend holidays there. *(photo source: http://www.pconline.com.cn/)*

Table 2 shows the cross tab analysis of the student artefacts fit into the respective cells. In generating the table, two researchers coded all the student artefacts independently and then discussed about the discrepancies to reach consensuses.

Table 2: Cross tab of photo contexts versus students’ meaning making (n = 453).

	Natural setting	Physical object manipulation	Human-enacted scenario	Previously published materials	Total
Literal meaning making	154	13	19	52	238
Extended meaning making	89	11	39	32	171
Creative meaning making	18	7	4	15	44
Total	261	31	62	99	453

The variety of photos/sentences reflected the students' greater attention to their surroundings and their more conscious attempts to associate their daily experiences with the idioms – be it in campus, at home, during family outings, when they read books or watch TV shows. In addition, the post-questionnaire results indicate that the students may have extended their mental habit of Chinese-idiom-and-real-life-context association beyond our study, as 75.0% of the students “agree” or “strongly agree” that “after participating in the learning activities, I think of Chinese idioms more often in my daily life.”

4.3 Process-oriented Analysis of the Student Artefacts

The categorisation of the student artefacts in the previouas section was a product-oriented analysis of the artefacts. As stated before, we have also administered another student post-questionnaire for self reporting of their cognitive processes in creating individual artefacts – note that the unit of analysis is individual arterfacts, while a particular student might have created artefacts with mixed types. We compiled the descriptive statistics of the three types of cognitive processes and yielded (n = 453):

- (Type 1) With an idiom in mind → object finding/manipulation or scenario enactment → photo taking: 170 (photo/sentence sets) or 37.5%
- (Type 2) Object/human/scenario encountering → associating with an idiom → photo taking: 150 or 33.1%
- (Type 3) Object encountering/manipulation or scenario encountering/enactment → photo taking → associating with an idiom: 133 or 29.4%

The major distinction among these three types of cognitive process is in where the idioms come in. A Type 1 process (e.g., (B) and (C) in Table 1) begins with having an idiom in mind, which could most likely be attributed to the mentality of conscious, learning objective-driven school assignment doing. One of the target students' claims during the post-interview may illustrate such a strategy, *"I took photos at home … usually started with an idiom, and then thought about how and what to photograph."*

Type 2 (e.g., (A) and (D) in Table 1), on the other hand, could take place anytime and anywhere in the students' daily life, with or without the photo taking / sentence making activities in place. In our study, however, it was such activities that motivated the students to try associating their encounters with some idioms. That becomes a form of incidental learning. One more example created by an interviewed student is presented in Table 3(a). During the post-interview, the student elaborated, *"My sister left the teddy bear on the sofa. I saw it and imagined that it was tired."*

Finally, Type 3 delays the context-idiom-association to later time. Such processes are more likely to take place during family outings or student group photo taking activities in campus. As such activities were rare chances for them to access to specific locations or work with their classmates together, students often considered maximising photo takings as their priority, rather than spending extra time to switch between the kinesthetic tasks of photo taking and the cognitive tasks of context-idiom association *in situ*. Therefore, the photo taking activities became the occasions almost purely for data or resource collection while their linguistic learning only took place after they returned to their PC or laptops to make sentences. One such example is presented in Table 3(b). The author informed us during the post-interview, *"A classmate visited me at home. She played with my smartphone. She took many photos casually and I was photographed. After she left, I checked the stored photos. When I encountered this photo of mine, I thought I could associate it with 眉开眼笑 [grin from ear to ear]."*

Our further analysis of the three types of processes suggests that each type of these processes would correspond to a vocabulary learning strategy. We consider Type 1 the easiest process and could serve as an entry-level activity for newcomers to such photo taking / sentence making activities; Type 2 the highest level process as such immediate retrieval of the relevant idioms require the students' internalisation of their learnt idioms. Type 3, therefore, has the potential to serve as a bridging strategy between the first two.

Table 3: Two student artefacts that exemplify Type 2 and Type 3 cognitive processes

	(a) 小熊筋疲力尽地躺在沙发睡觉。 Exhausted, the bear falls asleep on the sofa.		(b) 姐姐眉开眼笑地笑因为妈妈让她玩电脑游戏。 My sister grins from ear to ear because mom allows her to play computer game.

4.4 Peer Learning Activities

The student artefacts were being accumulated in the wiki space, thus triggering students' ongoing online discussion on their peers' work. Here was where the teacher had chipped in by applying some online forum facilitation strategies to tactfully comment on student artefacts at the right time and in the right way in order to give space for the students to engage in meaningful discussion. During the only Activity 4 session toward the end of the study, each student group compared the photo/sentence sets posted on the assigned "idiom page". Through their group discussions, they managed to identify and explain all the erroneous artefacts, and offered good proposals to improve the sentences (e.g., to replace an idiom with a more suitable one). We attribute such a learning activity to induction-based peer learning, based on learner-created authentic content.

5. Discussion

Looi et al. [13] describes how mobile computing can be an enabler for personalized learning: (a) allowing multiple learning pathways, (b) supporting multi-modality, (c) enabling student improvisation *in-situ*, and (d) supporting the sharing and creation of student artifacts on the move. Our learning design encompasses all four characteristics. While such language learning activities could be carried out without technological support, it is the mobile affordance of *in situ* data collection (phototaking) that offers them the ease of generating their artefacts and helps the teacher and other students to visualise their idiom-and-context associations. Furthermore, the deployment of the mobile technology has made our students paying greater attention to, and perhaps reflecting more upon, the physical world that they are experiencing in their daily life. As sharing and *rising above* the shared artefacts are the key to achieve students' deep learning of the idioms, the incorporation of the Web 2.0 (wiki) technology further enhances their social learning space by "affording" them rapid artefact revisions and interactions. The intertwining usage of both the mobile and Web 2.0 technologies would bring the students an all-round language learning experience that seamlessly integrate their learning experience in both the physical and cyberspace contexts.

This is indeed what makes our work unique from similar prior studies by Joseph, Binsted and Suthers [17], Hasegawa *et al.* [18], and Pemberton, Winter and Fallahkhair [19]. These earlier work treated learner-created content (photos or videos demonstrating vocabularies) created beyond the school fences and the school hours as the end – once verified by the instructors, the content would then become relatively static materials accessible by their peers online. In our seamless language learning design, the rich and diversified learner content is also the means for fostering further peer learning and social meaning making in an inductive manner. Indeed, this learning process extends the language subject beyond the four walls of the classroom to become an authentic learning experience.

Such a learning activity process may be applied to other school subjects, e.g., in science learning, students may take photos of objects with different material types encountered in their daily life, categorise and post them onto the wiki for peer discussions.

6. Conclusion

In this paper, we report a MALL pilot study that focuses both creative learner output and seamless learning. These two aspects, which promised great educational potential, have been seriously untapped in prior MALL studies. In our study, from artefact generation to peer learning activities, we observed a trajectory of personal-to-social meaning making among the students. We are keen to relate the students' three types of cognitive process emerged from their artefact creation activities to linguistic psychology. We believe that these prospective theoretical studies of our learning design and the data collected may inform us to refine the pedagogy (the in-class Activity 1 design and additional scaffolds for all four activities). With proper design and enactment of *seamless language learning*, we see the potential for MALL to reform language learning by using mobile devices to synergise the formal and informal, as well as the personal and social learning spaces.

References

[1] Stevick, E. (1996). Memory, *Meaning and Method: A View of Language Teaching. (2nd ed.)*. Boston: Heinle and Heinle.

[2] Bolte, H., & Herrlitz, W. (1986). Language learning processes and strategies in the foreign language classroom: A reconstructive and interventive model. In G. Kasper (Ed.), *Learning, Teaching and Communication in the Foreign Language Classroom* (pp. 195-223). Aarhus: Aarhus University Press.

[3] Fischer, G., & Ostwald, J. (2002). Transcending the information given: designing learning environments for informed participation. *Proceedings of ICCE 2002* (pp. 378-381), Auckland, New Zealand.

[4] Wong, L.-H., Chin, C.-K., Tan, C.-L., & Liu, M. (in-press). Students' personal and social meaning making in a Chinese idiom mobile learning environment. *Accepted by: Educational Technology & Society*.

[5] Salaberry, M.R. (1996). A theoretical foundation for the development of pedagogical tasks in computer mediated communication. *CALICO*, *14*(1), 5-36.

[6] Long, M.H. (1985). Input and second language acquisition theory. In: S.M. Gass & C.G. Madden (Eds.), *Input in Second Language Acquisition (pp.377-393).* Rowley, MA: Newbury House.

[7] Deng, C. (2001). The common mistakes in the usage of idioms and the solutions. *Learning Language*, *1*, 40-41.

[8] Thornbury, S. (2001). *Uncovering Grammar*. Oxford: Macmillan Heinemann.

[9] Webb, S. (2005). Receptive and productive vocabulary learning: the effects of reading and writing on word knowledge. *Studies in Second Language Acquisition, 27*, 33-52.

[10] Lewis, M. (1997). Pedagogical implications of the lexical approach. In J. Coady & T. Huckin (Eds.), *Second Language Vocabulary Acquisition* (pp. 255-270), Cambridge: Cambridge University Press.

[11] Sanaoui, R. (1995). Adult learners' approaches to learning vocabulary in second languages. *Modern Language, 79*, 15-28.

[12] Looi, C.K., Seow, P., Zhang, B., So, H.-J., Chen, W., & Wong, L.H. (2010). Leveraging mobile technology for sustainable seamless learning: a research agenda. *British Journal of Educational Technology*, *42*(1), 154-169.

[13] Looi, C.-K., Wong, L.-H., So, H.-J., Seow, P., Toh, Y., Norris, C., et al. (2009). Anatomy of a mobilized lesson: Learning My Way. *Computers & Education*, *53*(4), 1120-1132.

[14] Chan, T.-W., Roschelle, J., Hsi, S., Kinshuk, Sharples, M., Brown, T., et al. (2006). One-to-one technology-enhanced learning: An opportunity for global research collaboration, *RPTEL*, *1*(1), 3-29.

[15] Winters, N. (2007). periLEARN: contextualised mobile learning in the era of Web 2.0. *Proceedings of mLearning 2007* (pp.89-95), Lisbon, Portugal.

[16] Brown, A.L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Learning Sciences, 2*(2), 141-178.

[17] Joseph, S., Binsted, K., & Suthers, D. (2005). PhotoStudy: Vocabulary learning and collaboration on fixed & mobile devices. *Proceedings of WMTE 2005* (pp.206 -210), Tokushima, Japan.

[18] Hasegawa, K., Ishikawa, M., Shinagawa, N., Kaneko, K., & Mikakoda, H. (2008). Learning effects of self-made vocabulary learning materials. *Proceedings of CELDA 2008* (pp.153-158), Freiburg, Germany.

[19] Pemberton, L., Winter, M., & Fallahkhair, S. (2009). A user created content approach to mobile knowledge sharing for advanced language learners. *Proceedings of mLearn 2009*, Orlando, Florida.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education. (In Press)

Ubiquitous Learning Log: What if we can log our ubiquitous learning?

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Abstract: This paper proposes a ubiquitous learning log system called SCROLL (System for Capturing and Reminding Of Learning Log). Ubiquitous Learning Log (ULL) is defined as a digital record of what you have learned in the daily life using ubiquitous technologies. It allows you to log your learning experiences with photos, audios, videos, location, QR-code, RFID tag, and sensor data, and to share and to reuse ULL with others. Using SCROLL, you can receive personalized quizzes and answers for your questions. Also, you can navigate and be aware of your past ULLs supported by augmented reality view. The initial evaluation of applying this system in an undergraduate English course is illustrated.
Keywords: ubiquitous learning, ubiquitous learning log object, life log.

Introduction

CSUL (Computer Supported Ubiquitous Learning) is defined as a technology enhanced learning environment supported by ubiquitous computing technologies such as mobile devices, RFID tags, and wireless sensor networks [9]. CSUL augments learning in the real world by presenting information on personal mobile devices through the Internet and surrounding environment like physical objects and sensors.

One of the application domains of CSUL is language learning. For example, TANGO [10] supports learning vocabularies. The idea of this system is to stick RFID tags on real objects instead of sticky labels, annotate them (e.g., questions and answers), and to share them among others. JAPELAS [10] aims to support foreigners to learn Japanese polite expressions according to surrounded persons and the place. JAMIOLAS [11] supports learning mimetic words and onomatopoeia using wireless sensor networks. Those CSUL applications are intended to be used all the time. This is one of the advantages CSUL called *permanency* [10]. It means that learners never lose their work unless it is purposefully deleted and all the learning processes are recorded continuously every day. However, little attention has been paid to this aspect.

The fundamental issues of CSUL are:

(1) How to record and share learning experiences that happen at anytime and anyplace.

(2) How to retrieve and reuse them in future learning.

To tackle those issues, LORAMS (Linking of RFID and Movie System) [13] was proposed. There are two kinds of users in this system. One is a provider who records his/her experiences into videos. The other is a user who has some problems and is able to retrieve the videos. The system automatically links between physical objects and the corresponding objects in a video and allows to share them among users. By scanning RFID tags, LORAMS shows the user the video segments that include the scanned objects. Although this system is useful in certain environments, it is not easy to be applied in practice at any place at the moment. Therefore, we started more practical research called “ubiquitous learning log (ULL)” project in order to store intentionally what we have learned as ubiquitous learning log objects (ULLOs) and consequently reuse them.

How are we learning from past learning log? For example, we take notes, e.g., vocabularies, idioms, sentences in a language learning situation (Figure 1). Whereas, they will not remind us of the knowledge learned, nor the situation where the knowledge was used. We think this process can be enhanced using mobile devices. Therefore, this paper proposes a system called SCROLL (System for Capturing and Reminding Of Learning Log), which supports the learners to record, share and reuse ULLOs using mobile devices. This paper describes the design, the implementation and the initial evaluation of SCROLL.

Figure 1: Note for language learning.

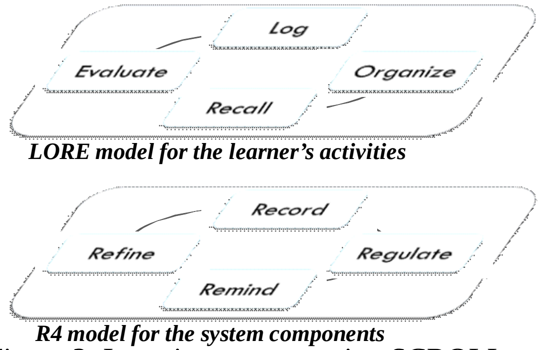


Figure 2: Learning process using SCROLL.

1. Related works

1.1 Life-log

Life-log is a notion that can be traced back at least 60 years [1]. The idea is to capture everything that ever happened to us, to record every event we have experienced and to save every bit of information we have ever touched. For example, SenseCam [4]is a sensor augmented wearable stills camera; it is proposed to capture a log of the wearer's day by recording a series of images and capturing a log of sensor data. MyLifeBits [3] stores scanned material (e.g.: articles, books) as well as digital data (e.g.: emails, web pages, phone calls, and digital photos taken by SenseCam). Ubiquitous Memory system [6] is a life-log system using a video and RFID tags. Also, Evernote (www.evernote.com) is a tool to save ideas using mobile devices such as Android and iPhone. The most common idea of those projects is to use life-log data for memory aid. SCROLL, however, aims to utilize life-log data for the learning process.

1.2 Learning log and e-portfolio

Originally, the term "learning log" was used for personalized learning resources for children [19]. The logs were usually visually written notes of learning journals, which could become an integral part of the teaching and learning program and had a major impact on their drive to develop a more independent learner. Research findings indicated that journals were likely to increase meta-cognition and reflective thinking skills through students who become more aware of their own thought processes [17, 18]. Also "digital portfolio (e-portfolio) or digital portfolio" is used for a collection of electronic evidences maintained by a learner. Our approach focuses on how to enrich learning log or e-portfolio, and to promote retention and meta-cognition by using mobile, ubiquitous and context-aware technologies.

1.3 Mobile language learning

One of the application domains for mobile learning is the language learning, because it is based on situated and collaborative activities, which could occur wherever and whenever people have problems to solve or knowledge to share [15]. Especially, vocabulary is basically used for communication [7] and often seen as the greatest source of problems by second language learners (When the students travel, they do not carry grammar books, they carry dictionaries.) [14]. Thus, mobile learning has been identified as one of the natural directions in which language learning is expected to move [16].
Miller and Gildea [8] compared the way children are taught words from dictionary

definitions and a few exemplary sentences with the way vocabulary is normally learned outside the school. They noted that people generally learn words outside school. Therefore, SCROLL captures what the learners have learned in- and out-class. Also advanced second language readers can learn more vocabulary when they are given the meaning of unknown words through marginal glosses or when they look up meaning in a dictionary than when no external information concerning unknown words' meaning is available [5]. Therefore, SCROLL provides online dictionary for the learners to find the meaning of unknown words and also gives quizzes increased the learning opportunity. The effect of three annotation types (text-only, picture-only, and a combination of the two) on second language incidental vocabulary retention in a multimedia reading setting was compared [13]. The results indicated that the combination group outperformed the text-only and picture-only groups on the immediate tests. Hence, SCROLL allows the learners to link vocabulary and its photo.

2. Design of the system

2.1 Design

In this paper, ubiquitous learning log (ULL) is defined as a record of what a learner has learned in the daily life using ubiquitous technologies. ULL is considered as a set of ULLOs. The learning can also be considered as the extraction of meaningful knowledge from past ULL that serves as a guide for future behavior [2]. Figure 2 shows the learning processes in the perspective of the learner's activity model called LORE (Log-Organize-Recall-Evaluate, shown in the upper layer of figure 2) and the model of the system components called R4 (Record-Regulate-Remind-Refine, shown in the lower layer):

(1) Log what the learner has learned: when the learner faces a problem in the daily life, s/he may learn some knowledge by him/herself, or ask others for a help in terms of questions. The system *records* what s/he has learned during this process as a ULLO.

(2) Organize ULL: when the learner tries to add a ULLO, the system compares it with other ULLOs, categorizes it and shows the similar ULLOs if exist. By matching similar objects, the knowledge structure can be *regulated* and organized.

(3) Recall ULL: the learner may forget what s/he has learned before. Rehearsal and practice can help the learner to recall past ULLOs and to shift them from short-term memory to long-term one. Therefore, the system assigns some quizzes and *reminds* the learner of past ULLOs.

(4) Evaluate: it is important to recognize what and how the learner has learned by analyzing the past ULL, so that the learner can improve what and how to learn in his future. Therefore, the system refines and adapts the organization of the ULLOs based on the learners' *evaluation* and reflection.

All the above learning processes can be supported by SCROLL.

2.2 Linking formal and informal learning

Using this system, teachers can understand what their students learned outside the class (informal settings). For example, they ask their students to record the words that they have learned into SCROLL as ULLOs. In the next class, they make a reflection using their students' ULLOs. Through this process, they can check whether the ULLOs given by their students are correct or not, and allow their students to share their knowledge. In this way, SCROLL enhances and integrates both formal and informal learning.

3. Implementation

SCROLL is a client-server application, which runs on different platforms including Android mobile phones, PC and general mobile phones (Figure 3).

3.1 System architecture

The server side runs on Linux OS and it is programmed using Java and PostgreSQL. The client side is working on Google phone and PC web browser. The developed software for Google phone is a native java application based on Android SDK (Software Development Kit). The users can register and take quizzes by sending a message using mobile phone email like SMS and i-mode.

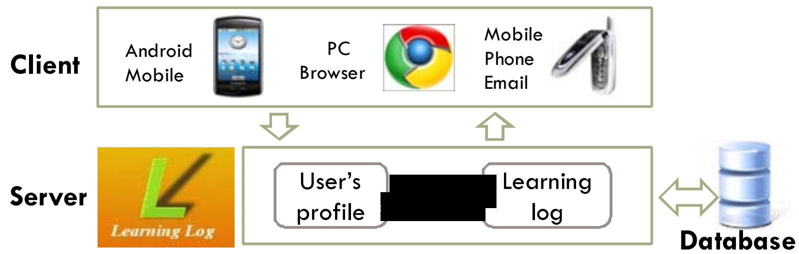


Figure 3: System configuration of SCROLL.

3.2 Database

The database on the server side consists of two main parts:

(1) User's profile: it contains the learner's personal information such as, name, email address, nick name, native language, target language that the user is currently learning.

(2) Learning log object: it contains information about the learning object such as, photo, barcode ID, location, comment, tag and question. An example of ULLO is shown in the right of Figure 4. When a learner was walking around the university, he learned a new English word "fire hydrant" at a street sign. Then, he took its photo and uploaded it to SCROLL with Japanese name, English name, tag and location data. If he would like to know the Chinese name of "fire hydrant", he could register a ULLO with a question. Consequently, the system showed the question in the main window (see left of figure 4) for other learners whose native language is Chinese.

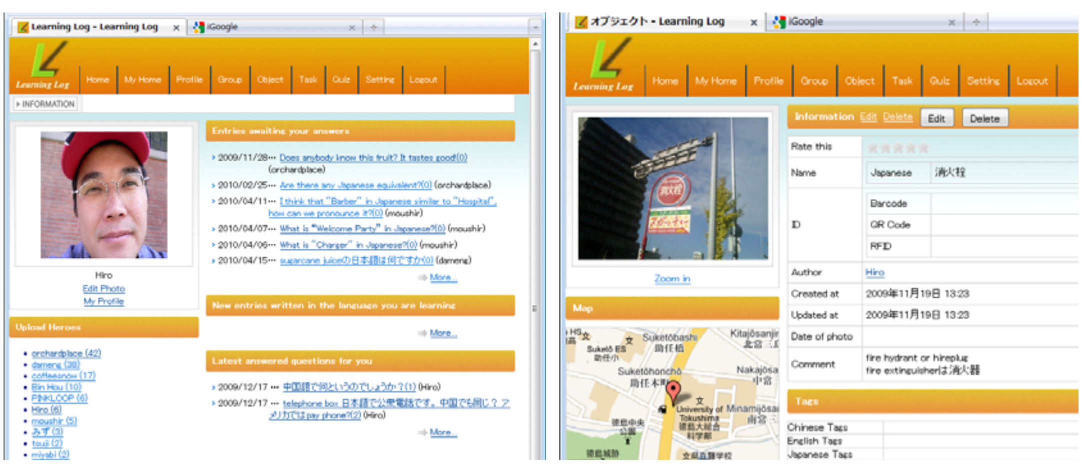


Figure 4: Interface for PC web browser. (main window (left); ULLO (right)).

3.3 System interface

This section describes the Android user interface of each component.

3.3.1 ULL recorder

This component facilitates an easy way for the learners to upload their ULLOs to the server whenever and wherever they learn. As shown in Figure 5 (2), in order to add a ULLO, the learners can take its photo, ask questions about it and attach different kinds of meta-data with it, such as its meanings in different languages (English, Japanese and Chinese), comments, tags and location information. Also the learner can select whether the new ULLO can be shared or not.

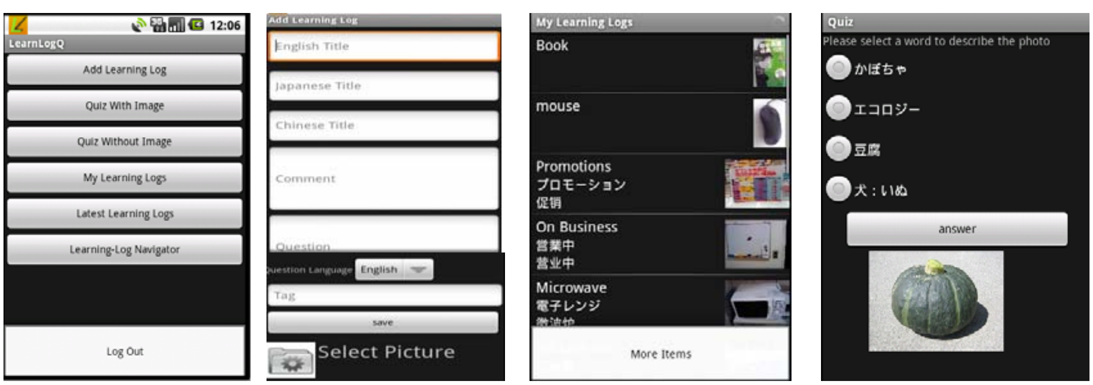
3.3.2 ULL finder

If learner registers a new ULLO, the system checks whether the same object has been already stored or not by comparing the name fields of each object using a thesaurus dictionary. Also, the learner can search ULLOs by name, location, text tag and time. Using this function, learners can understand what, where and when they learned before. In the future works, the visualization of the ULLOs will be developed.

3.3.3 ULL reminder

The list of the learner's ULLO is shown in Figure 5(3), which helps him to recall all his past ULL. Besides, it allows him to be aware of the others' learning objects and to *re-log* them; it means that the learner can make a copy of them into his log. Therefore, the learner can obtain a lot of knowledge from the other learners even though he has not experienced that knowledge by himself. By sharing ULLOs with the other learners and re-logging the other learners' ULLOs, the acquisition of the knowledge is enhanced. As shown in figure 5(4), the system generates simple multiple-choice quizzes based on the meta-data of the stored ULLOs. For example, the idea of "quiz with image" is to ask the learner to choose a word to describe the image given by the system. The system immediately checks whether his answer is correct or not. These quizzes are generated according to his profile, location, time and the results of past quizzes and help the learners to recall what they have learned.

The quiz function is designed not only to help the learners to practice what they have learned, but also to recommend what the other learners have learned and to remind them to re-learn their past knowledge according to their current location and their preferred time. In order to achieve these targets, the learner can practice with the quizzes whenever they want. In addition, the client can send the learners' location information to the server all the time. Therefore, the sever side can automatically assign quizzes for the learner based on the location and time information. It notifies the learner to check the quiz by showing an alert message and vibrating his/her mobile phone. Whenever the learner moves around an area where he has experienced some objects, the system will send him quizzes regarding that objects. Furthermore, the learner can set a time schedule to receive the reminder quizzes.



(1) Start window (2) Add ULLO (3) My ULLO list (4) Quiz with image

Figure 5: SCROLL Interface of Android mobile phone.

3.3.4 ULL Navigator

LL navigator provides mobile augmented reality that allows the learner to navigate through the ULLOs. Like Wikitude [www.wikitude.org] and Sekai-Camera [sekaicamera.com], it provides the learner with a live direct view of the physical real-world environment augmented by a real time contextual awareness of the surrounding objects. While a learner is moving with his mobile phone, the system sends an alert on the phone as soon as entering the region of ULLOs according to the GPS data. This view is augmented, associated with a visual compass, and overlapped by the nearest objects in the four cardinal directions (figure 6, left). Also, it provides the learners with a list of all surrounding objects. When the learner selects one or more of these objects, the Google map will be retrieved, and marked with the learner's current location and the selected objects. Moreover, the system shows a path (route) for the learner to reach to the objects locations (figure 6, right). This assists the learner to acquire new knowledge by discovering the existed ULLOs and to recall his ULLOs. In order to reduce the power consuming of the phone battery, the light-mode (blank screen) is developed. In this mode, the phone camera is turned off, and the system displays only information about the surrounding objects. Moreover, by touching the phone screen, a menu will be displayed; it provides the learners with additional facilities, such as displaying a list of all surrounding objects and photos capturing (Camera-mode).

Figure 6: Learning log navigator (camera view (left); path to ULLOs (right)).

4. Evaluation

4.1 Method

The study group consisted of 20 Japanese university-sophomores (17 males, 3 females) who were taking the communicative English class at the university. The major of the students was engineering and they ranged in age between 19 and 21 years. All the students underwent an initial test one week before the evaluation started. The test was a 60-item pre-test of words selected by the teacher. They were the names of the things easily found in our daily life such as staplers, rulers, glues, etc. The students were divided into 2 groups with the equal English proficiency according to the pre-test result. Each group consisted of 10 students and engaged in learning vocabulary listed in the pre-test, where Group A used smart phones (7 Sony-Ericsson Xperia and 3 HTC-03A) and SCROLL, while Group B learned the words in a conventional way, e.g., using a paper dictionary without technology. Since Group A has never used a smart phone, about one-hour briefing session was held for Group A students have to help them understand how to use smart phones and SCROLL. Evaluation was carried out over a period of two weeks. At the conclusion of the phase, the subjects underwent a post-test, the same vocabulary test as the pre-test. The full mark for pre- and post-test was 60. Further data was collected from the participants by means of questionnaires and the log data contained in the server.

4.2 Results

Since it turned out that only 5 subjects (hereafter Group A1) out of 10 of the test group used smart phones and SCROLL during the trial, the rest of the 5 subjects (hereafter Group A2) were added into group B in the data analysis. The pre- to post-test differences between the mean test scores for Group A1 (with SCROLL) and for Group B (paper-based, without SCROLL) are shown in Table 1, along with the standard deviations for each test result. The analysis was undertaken using one-tail test. There was a significant improvement from pre- to post-test for both groups. Also, statistically significant difference was detected between A1 and B+A2. This indicates that the A1 students learned new words more efficiently and effectively by using SCROLL. If we look at the students whose pre-test scores were under 21, the pre- to post-test difference in A1' and (B+A2)' were shown in table 1. The mean score of A1' was significantly increased (p=.006964 < .01). On the other hand, no significant difference in the pre- to post-test results was found between A1'' students and (B+A2)'' students whose pre-test scores were more than 21 (p=.39187>.1). This indicates that vocabulary learning using SCROLL was highly effective for poor performers or beginners compared with high-achieving students.

Table 1: Pre- and post-test results (full mark: 60).

Group	Pre-test	Post-test	Pre and Post difference	t-value, p-value
A1 (N=5)	M = 19.50 SD = 5.24	M = 53.20 SD = 6.33	M = 33.70 SD = 11.29	t=2.01018 p=.029821*
B+A2 (N=15)	M = 19.50 SD = 4.63	M = 41.00 SD = 12.92	M = 21.50 SD = 11.88	
A1' (beginner) (N=3)	M = 16.17 SD = 1.04	M = 57.67 SD = 2.24	M = 41.50 SD = 3.28	t=2.920406 p=.006964**
(B+A2)' (N=10)	M = 16.90 SD = 2.46	M = 36.85 SD = 12.01	M = 19.95 SD = 12.30	
A1'' (advanced) (N=2)	M = 24.50 SD = 4.95	M = 46.50 SD = 0.71	M = 22.00 SD = 5.66	t=0.289608 p=.39187***
(B+A2)'' (N=5)	M = 24.70 SD = 3.29	M = 49.30 SD = 11.40	M = 24.60 SD = 11.66	

*<.05, **<.01, ***>.1

According to the users' logs in SCROLL, the A1 students uploaded ULLO 15.6 times and did quizzes 112.6 times on average. The quantitative data suggest that some serious students engaged greatly with SCROLL for vocabulary learning. The correct answer rate of ULLO quizzes was 92.9%. A slight difference (4.1%) was found in the percentage of correct answers between the quizzes from ULLO uploaded by themselves and by somebody else. The former (96.3%) was better than the latter (92.3%).

Table 2: Result of the five-point-scale questionnaire.

Question	Mean score /5	SD
Was registering ULLO useful for growing your English vocabulary?	3.25	1.49
Was Smart Phone with SCROLL useful for vocabulary learning?	3.13	1.25
Was this system enjoyable?	3.00	1.31

The questionnaire result is shown in Table 2. The highest mean score was 3.25 when asked whether it was useful to register a ULLO. From the questionnaire response, there was no student of Group A1 who did not want to share ULL. Also some students commented that it was helpful to see the images uploaded by other students. However, for some students, it seemed troublesome to use them because its short duration of battery or unstable Internet connection. Another explanation for the poor engagement is that even though they received the briefing, some did not understand fully how to use them. These are probably part of the reasons why 5 students of Group A did not show any involvement in SCROLL. Thus our next evaluation is being more carefully planned.

5. Conclusion

This paper proposes a ubiquitous learning log system in order to enhance sharing and reusing past learning experiences. The system runs on Web browser, Android and email platform. According to the initial experiment, SCROLL was effective in learning English vocabulary, since statistics shows a significant difference between the control group and the experiment group. Since this system is intended to be used in general domains and for life-long learning, we will apply it in other application domains, e.g., math, physics, and science education and conduct a long-term evaluation with an enough number of subjects in the future work. Also we will design and develop the functions for awareness, reflection and evaluation by making learning process visible.

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References

[1] Bush, V. (1945). As We May Think, *The Atlantic Monthly*, 176(1), 101-108.
[2] Daudelin M.W.(1996). Learning from Experience through Reflection, *Organizational Dynamics*, 24(3), 36-48.
[3] Gemmell, J., Bell G., & Lueder, R. (2006). MyLifeBits: a personal database for everything, *Communications of the ACM*, 49(1), 88-95.
[4] Hodges, S., Williams, L., Berry, E., Izadi, S., Srinivasan, J., Butler, A., Smyth, G., Kapur, N., & Wood, K.R. (2006). SenseCam: A Retrospective Memory Aid, P*roc. of UbiComp 2006*, 177-193.
[5] Hulstijn, J.H., Holl&er, M. & Greidanus, T. (1996). Incidental Vocabulary Learning by Advanced Foreign Language Students: The Influence of Marginal Glosses, *Dictionary Use, & Reoccurrence of Unknown Words, The Modern Language Journal*, 80(3) 327-339.
[6] Kawamura, T., Fukuhara, T., Takeda,et al. (2007). Ubiquitous Memories: a Memory Externalization System using Physical Objects, *Personal and Ubiquitous Computing*, 11(4), 287-298.
[7] Ma, Q. & Kelly, P. (2006). Computer Assisted Vocabulary Learning: Design & Evaluation, *Computer Assisted Language Learning*, 19(1), 15-45.
[8] Miller, G. A., & Gildea, P.M. (1987). How children learn words. *Scientific American*, 257, 94–99.
[9] Ogata, H., & Yano, Y. (2004). Knowledge Awareness Map for Computer-Supported Ubiquitous Language-Learning, *Proc. of IEEE International Workshop on Wireless & Mobile Technologies in Education (WMTE 2004)*, 19-26.
[10] Ogata, H., & Yano, Y. (2004). Context-Aware Support for Computer-Supported Ubiquitous Learning, *Proc. of WMTE 2004*, 27-34.
[11] Ogata, H., & Yano, Y. (2006). JAMIOLAS: Supporting Japanese Mimicry & Onomatopoeia Learning with Sensors, *Proc. of WMUTE 2006*, 111-115.
[12] Ogata, H., Misumi, T., Matsuka, Y., El-Bishouty, M.M. & Yano, Y. (2008). A Framework for Capturing, Sharing, Retrieving and Comparing Learning Experiences in a Ubiquitous Learning Environment, *Int'l J. of Research and Practice on Technology Enhanced Learning (RPTEL)*, 3(3), 297-312.
[13] Yoshii, M. & Flaitz, J. (2002). Second language incidental vocabulary retention: The effect of picture & annotation types, *Computer Assisted Language Instruction Consortium Journal*, 20(1), 33-58.
[14] Segler, M.T., Pain, H., & Sorace, A. (2002). Second Language Vocabulary Acquisition & Learning Strategies in ICALL Environments, *Computer Assisted Language Learning*, 15(4). 409 – 422.
[15] Sharples, M. (2000). The Design of Personal Mobile Technologies for Lifelong Learning. *Computers & Education*, 34, 177-193.
[16] Stockwell, G. (2007). Vocabulary on the move: Investigating an intelligent mobile phone-based vocabulary tutor, *Computer Assisted Language Learning*, 20(4), 365 – 383.
[17] McCrindle, A.R. & Christensen, C.A. (1995). The Impact of Learning Journals on Metacognitive and Cognitive Processes and Learning Performance, *Learning and Instruction*, 5(2), 167–185.
[18] Suwan, S. & White, R. (1994). *The Thinking Books*. Falmer Press.
[19] http://en.wikipedia.org/wiki/Learning_log

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Collboard: Supporting New Media Literacies and Collaborative Learning Using Digital Pens and Interactive Whiteboards

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Abstract: The high-penetration of information and communication technologies in our daily activities renews the question about the type of skills learners need to develop on the 21st century. Seeking to foster the development of new media literacies skills in the classroom, we developed Collboard. The Collboard approach combines a pedagogical rationale based on a collaborative strategy aiming at solving open-ended tasks and a technological workflow that incorporates the notion of seamless interactions across different kind of media. Collboard integrates digital pens to support individual work and interactive whiteboards as a collaborative knowledge construction space. We report on the conception of Collboard, its different technological and software components, as well as our initial findings from the experiences we conducted in a Swedish school with 7th grade students in the field of mathematics. Our qualitative observations and initial results provide some indications that this type of learning environments can support the development of new media literacies skills such as collective intelligence, distributed cognition, transmedia navigation and visualization.

Keywords: New Media Literacies, CSCL, digital pens, interactive whiteboards

1. Introduction

Our society is now evolving at a faster pace than ever before, challenging individuals and organizations to deal with changes and, educational institutions to prepare learners for the future. In this context, educational researchers and practitioners have demonstrated a growing interest in developing pedagogical practices towards fostering a participatory culture in all levels of education [1, 2]. These actions respond to current trends regarding participatory literacies as a key social value of the 21st century workforce [3]. Contrastingly to traditional formal education based on lectures and individual assignments, the emergence of a participatory culture in schools changes the focus of literacy from one of individual expression to community involvement [4].

In recent years, different technologies and teaching practices have been proposed with the purpose of encouraging community participation and active involvement of students in their learning [5, 6]. Particularly, collaborative learning theories have exerted a prominent influence in these efforts [7]. While it is argued that technology by itself has not an intrinsic value and effect in supporting teaching and learning [8], numerous recent investigations support that technology usage guided by an effective pedagogical rationale can be beneficial for learning in the classroom [5, 6, 9]. An effective pedagogical ground can be enacted based on the proper design of integrated sets of coordinated interventions at different levels (i.e. social, epistemic & technological), leading to synergistic scaffoldings in the classroom [7]. Approaches to the orchestration of scaffolding are still quite general and there is a need to deepen on more rigorous empirical research [7].

The emergence of easy to use digital tools, hardware devices and software applications provide teachers and students with new means for augmenting traditional classroom media and activities [10]. Digital pens (DPs) and interactive whiteboards (IWBs) are examples of these latest developments. These technologies open new possibilities for fostering the development of new media literacies [4] in schools, based on collaborative learning strategies. However, integrating DPs and IWBs in the classroom's pedagogical flow to support individual and collaborative work requires that students are able of following the flow of information across multiple modalities and different forms of visualizations [4]. These abilities, also known as transmedia navigation and visualization skills are integral components of participatory cultures [2, 4] and incorporating them in different stages of the pedagogical flow in the classroom becomes thus a design challenge.

In this paper, we present our current research efforts of ascertaining the potential of digital pens and interactive whiteboards, towards creating a learning environment that fosters the development of new media literacies in the classroom, namely: collective intelligence, distributed cognition, visualization and transmedia navigation [4]. We argue that the use of these technologies combined with proper individual and collaborative problem-solving strategies can elicit new conditions for learning that support the development of new media literacies. Our approach, called Collboard, consists of a computer-supported collaboration script that takes advantage of DPs for supporting individual knowledge construction and IWBs, as tools for visualizing and scaffolding collaborative problem solving. We report on the conception of Collboard, its technological components, as well as our initial findings from the experiences conducted in a Swedish school with 7th grade students in the field of mathematics.

2. Related Work

Technology-enhanced learning environments for supporting a pedagogical workflow in the classroom based on collected and aggregated students´ work include student response systems, known as clickers, classroom presenters [11], and systems supporting scripted collaboration, commonly towards solving open-ended tasks [5, 6]. Both, classroom presenters and the latter have been mostly implemented relying on the use of mobile devices with digital ink support, such as Tablet PCs and PDAs.

Student response systems are commonly based on multiple-choice questions, and give the lecturer real-time feedback of students' performance through visualization (e.g. bar graphs), so that he/she can adjust the lecturing according to the reported results. Classroom presenters generally involve Tablet PCs, and most recently, DPs, allowing a richer interaction than clickers [12]. Most generally, they allow the lecturer to manipulate the slides and annotating them with ink. More recent approaches have experimented with collaborative note taking strategies, allowing the students to collectively construct their annotations and also maintain a two-way communication with the teacher [10].

Systems supporting scripted collaboration in the classroom that promote solving open-ended tasks have been developed based on mobile devices supporting digital ink. For example, the CollPad [5] script is based on PDAs or Tablet PCs and guides the students in solving tasks through phases of individual work, small group collaboration and teacher mediated classroom discussion. It allows the individual knowledge contributions in the small groups to be sequentially refined through consensus (i.e. each small group must agree on submitting a single solution to the teacher), and later on, the teacher selects a group of answers that steer the classroom discussion towards the activity's learning objectives. Looi & Chen [6] use the GroupScribbles system based on TabletPCs with digital ink as a medium for collaborative open-ended problem solving. The solutions to the task are represented as sticky notes, meaning that each student can write individual notes, keep them in a private area, and eventually publish them in a common area visible by all the students present in the activity.

The investigations discussed in this section present the results of several projects that have used mobile computers with digital ink support for developing constructivist pedagogical models embracing small group learning. However, the integration of digitally augmented devices, also based on digital ink, such as interactive whiteboards and digital pens to support both individual and collaborative learning have been only superficially explored. Projects integrating these technologies in the classroom have mostly focused on supporting different approaches to note taking in lectures, using digital pens, and visualizing students' contributions through mostly projectors and large screen displays, [10, 12]. In the coming section, we present the design rationale of Collboard together with its different technological and software components.

3. Design and Implementation

3.1. Pedagogical Design

Collboard follows a constructivist approach aiming at facilitating collaborative open-ended task solving, for fostering the development of specific new media literacies skills in the classroom. The approach used in Collboard is based on the CollPad CSCL script [5], i.e., it seeks fostering participatory literacies in the classroom, by encouraging active student involvement in a scaffolded knowledge construction process. The process calls for students' individual contributions as knowledge sources for constructing shared meaning in teacher-guided discussions. Language is taken into consideration as a fundamental tool through which learners elaborate thoughts, explain results, evaluate solutions through appropriate feedback, explore and clarify inconsistencies and knowledge gaps, and find new strategies and possibilities. Collboard comprises five phases which are analog to the ones found in the CollPad script [5]: (1) Problem Statement, (2) Individual Answers, (3) Answers Selection, (4) Discussion and (5) Conclusion.

In the Problem Statement phase (phase 1), the teacher provides all the students with a specific task to carry out, for example, a math problem or a conceptual question about a particular topic. The task is shown on the IWB, while the students solve it on paper using DPs (phase 2). Each student works individually on the assignment, solely based on his/her own understanding of the task and restricted to work with his/her own skills and previous knowledge. Once the students finish their work, they submit their answers to the teacher both on paper and digitally. Submitted answers instantly appear on the teacher's computer screen and they can be visualized in the IWB. The teacher then reviews the students' answers (phase 3) using the medium of his/her choice (paper or IWB) and selects according to his/her own criteria and experience a diverse subset of them involving different strategies, levels of achievement, etc., in order to initiate a discussion (phase 4).

The discussion starts with the teacher calling the students who wrote the solutions, and begins asking them, one by one, to explain their own reasoning and the result obtained. Each student will have to share his/her own view of the problem with his/her companions and the teacher will support and assist him/her as to make his/her own explanation as clear as possible. In this way, the class groups, as well as the teacher, become aware of the distributed portions of knowledge that are available in order to initiate the collaborative construction process towards a consensual answer. Figure 1 illustrates the IWB application that supports the entire process by displaying (1) an area containing the answers involved in the discussion as eligible options in a reduced size, (2) an area in which the current individual solution selected appears (read-only), and (3) an area in which it is possible to perform drawing operations, and copy / paste elements from the individual answers through drag and drop operations. The latter capability allows students to easily pool tangible knowledge objects (or their components) and reusing them on the collaborative construction, thus stimulating the emergence of a collective intelligence.

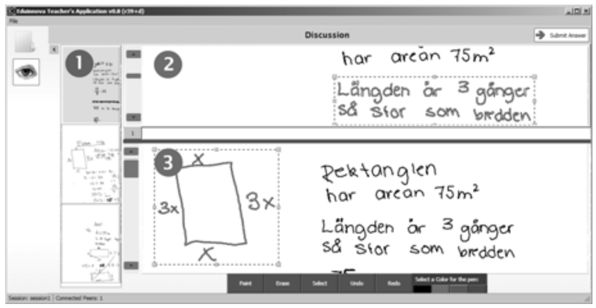


Figure 1 - Collaborative construction space on the interactive whiteboard

The teacher coordinates students' interactions with the IWB, ensuring that proper turn taking is respected. He/she steers the discussion towards debating and negotiating a method to the final solution (phase 5). The teacher should aim at reducing the different students' dissonances by guiding them on how to reach the correct solution for the task. However, students should understand the method by themselves, mutually changing their opinions to finally converge on a common solution. The teacher can then push the discussion further, towards inducing generalizations of the methods or solutions discussed in order to trigger different cognitive and social processes [4].

3.2. Technological Workflow

Collboard integrates digital pens and interactive whiteboards to support the pedagogical flow described in the previous section. Students use digital pens to generate their own solutions for a given task, while the IWB is used as a collaborative workspace allowing students and the teacher to co-construct a solution (or a method to a solution) based on the individual solutions, and/or new knowledge that emerge during the discussions. The technology used in our investigation involves distinct hardware and software components.

3.2.1. Hardware

Evaluation of mainstream digital pens available in the market, based on economic, technical (i.e. SDK availability) and logistical criteria lead us to experiment with IOGear Mobile Digital Scribe pen, which can write on any kind of paper and offer the simplest possible functionality that satisfies the requirements of our study. The IOGear pen works with a scanner device (using ultrasound technology) clipped to the top of the paper sheet, which captures the handwriting and saves it in persistent storage. The device can then be connected to a PC by USB to download digital annotations. Both, the teacher and the students, require computers in order to use Collboard. A desktop, laptop or tablet PC is needed to run the software that operates with the IWB. The IWBs are used as standard pointing devices (i.e. the board marker is used as a mouse), so there are no requirements of specific SDKs or drivers. We have tried Collboard with 3 different IWB brands.

3.2.2. Software

The Collboard application relies on a custom software solution designed to support the proposed pedagogical design, based on the Eduinnova Teaching Platform (ETP) [5]. ETP is designed to support CSCL activities based on 1:1 and 1:3 computing in the classroom, operating with wirelessly interconnected laptops, netbooks or tablet PCs. The Collboard system follows a client-server architecture that involves the following components:

- Server: Provides session management functionality, state management logic, and content repository managing persistent storage for questions and answers generated using Collboard.
- IWB Client: Provides answer visualization capabilities and a collaborative construction space for use with the IWB.
- Answer Submission Client: Provides the students with means to submit their solutions digitally.

Digital annotations are stored in the digital pens in a proprietary format. For the sake of interoperability, we have developed (using the SDK available for the DPs) our own library to convert this data to an open standards format (scalable vector graphics, SVG). Questions and answers generated by the clients are stored in the server as SVG objects and delivered to the clients also in this format. All components of the system were developed based on the ETP Software Development Kit (SDK) and Microsoft .NET 3.5.

4. Empirical Validation

We conducted a trial experience with Collboard during a two weeks period in the spring term 2010. The target group for this trial were 7th grade students at Kronoberg skola in Växjö, Sweden. During the last two years, the majority of schools in the region have been equipped with IWBs, so in the spirit of exploring novel ways of using these devices for fostering better teaching and learning experiences in the classroom, our proposal was welcomed by the principal and the teachers.

4.1. Trial Objectives

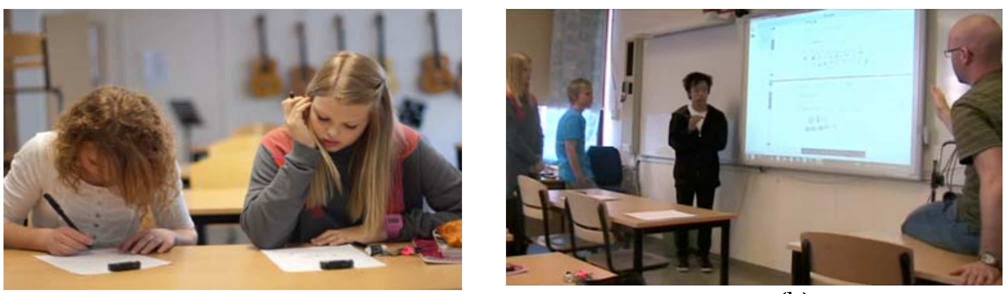
The objectives of our initial trial were twofold. In the first place, we sought to validate the feasibility of enacting the pedagogical design in the classroom according to the Collboard script specifications. Secondly, we wanted to assess the usability of the digital pens and interactive whiteboards throughout Collboard’s pedagogical workflow, in order to establish whether the use of the tools developed for the IWB responded effectively to the pedagogical aims, and if it could be adopted by both teachers and students naturally.

4.2. Description of the Educational Setting

Two different groups of students were involved; the first one was composed by a female teacher, 5 girls and 1 boy, while the second group was more balanced, consisting of 3 boys and 3 girls and a male teacher. Students’ ages were between 13 and 14 years old. The topics of study in this experience were related to Mathematics. The teachers used previously IWBs to support their lectures rather than for endorsing collaborative learning or fostering a participatory environment. The teachers received 1 hour of training on the Collboard software which was limited to learning how to use the client application.

4.3. Experimental Procedure

The two groups described earlier worked with Collboard for 4 sessions. The first session lasted 1 hour for both groups, while the first 20 minutes were used for introducing the students to the experience, giving them instructions on how to operate the digital pen, etc. The remaining time was used for solving the task. For both groups, all three following sessions lasted for 40 minutes, covering all the phases of Collboard's pedagogical workflow. A different task was assigned to the students in each of the four Collboard sessions. The first two sessions covered fractions problems, and the following two, area calculations. The teacher began the activity by presenting the students with the problem projected on the IWB; next, the students worked individually on the problem using the digital pens (see Figure 2a), and as they were ready, they handed their solutions on paper to the teacher. A member of our team received the digital pen and submitted the digital answer to the Collboard system using the answers submission client application. When the teacher finished evaluating the answers on paper, the answers on the IWB client were selected and the teacher-mediated classroom discussions could start. From this point on, the teacher and the students began using the IWB towards creating a collaborative solution (see Figure 2b). All Collboard sessions were video recorded and all the students' answers, in both digital format and paper, were kept for evaluation purposes.



(a) (b)

Figure 2 - (a) Students working on phase 2, (b) teacher and students discussing with the IWB tool.

4.4. Preliminary Results

After the trials, we surveyed the students and interviewed the teachers. The survey consisted of 12 questions aiming at investigating students' perception of their own participation and motivation, their impressions on technology performance and adoption, and their satisfaction with Collboard. The interviews with the teachers aimed at capturing their views and opinions about the pedagogical value of Collboard, as well as their appreciations about the technology adoption process that unfolded throughout the trial.

Figure 3 shows the partial results of the survey. From Figure 3a, it can be observed that the majority of the students had a positive attitude towards being called to the front to actively participate in ordinary math lessons. Furthermore, when working with Collboard (Figure 3b), students felt more motivated to closely work together with the teacher solving problems. We consider that the increased motivation is not solely explained by the use of the new technology, but rather, by the rich social environment fostered on the teacher-guided discussions, calling for active student participation and fostering greater interactivity than in regular math lessons. This is supported by the fact that students perceived an increased level of communication during the discussions with Collboard, not only with the teacher (Figure 3c), but also with their classmates (Figure 3d). During the first sessions, the teachers were cautious about calling the students to the front, as they did not feel familiar with the role of moderating discussions involving multiple students at the IWB. Both teachers progressively evolved towards eliciting richer discussions with more active involvement. By the last session, both teachers could cope to work with three students at same time in the IWB, eliciting explanation, argumentation and mutual regulation, and steering the discussion towards a commonly accepted solution.

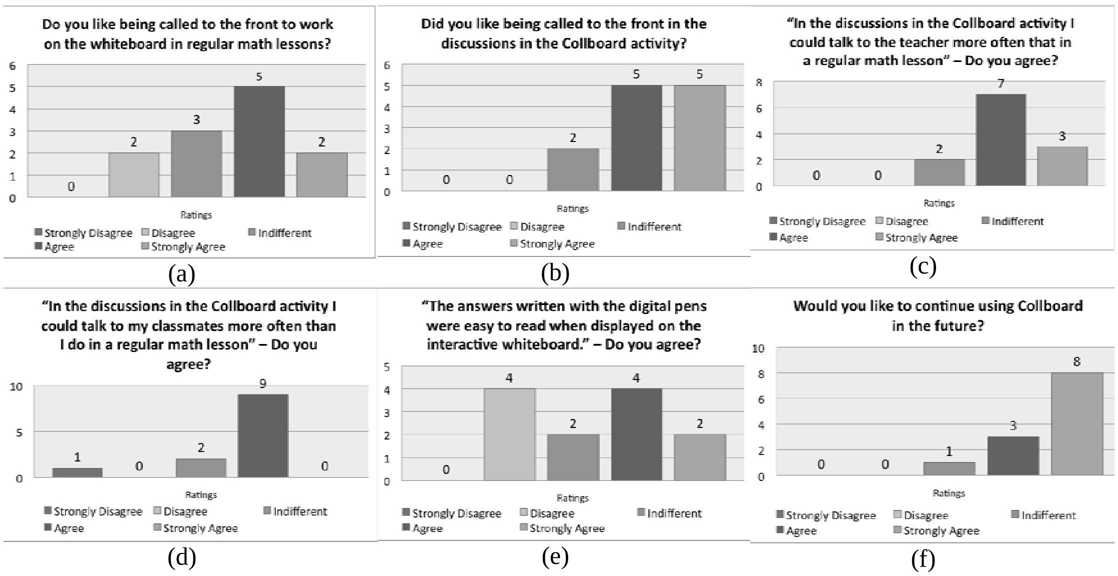


Figure 3 – Overview of survey results

One hour of training was enough for both teachers to appropriate the IWB tools provided by Collboard, without the need of a lot of practice, and no further technical assistance was required during the discussions. The students, having not received prior training on the IWB tools, could intuitively make use of the affordances of the software with some guidance from the teacher. The DPs, however, did not perform correctly at all times (Figure 3e). Sometimes pen strokes were omitted in the digital annotations, possibly because of the students not pressing hard enough on the paper. In some cases the pen's scanner captured noise or distorted strokes. By visualizing the annotations with the software bundled with the pens, we realized that these shortcomings were not due to flaws in our SVG conversion library, as the annotations looked similar in the bundled software. Generally, the answers with missing strokes or noise appeared legible on the IWB, so this was not a disruptive element in the discussions. Despite this technology issue, most students would like to continue using Collboard it in the future (Figure 3f).

5. Conclusion

In the Collboard project, we have taken a step towards incorporating the idea of seamless interactions across different kind of media in the classroom. Digital pens appear to be a suitable tool to support individual work in activities involving open-ended task solving. On the other hand, IWBs and software applications can be leveraged to support collaborative knowledge construction spaces involving small groups guided by the teacher. In this regard, teachers could understand Collboard's scripted collaboration approach and made effective use of the seamless technologies it leverages. However, emerging patterns of teaching and learning, including proper orchestration of the learning activities require coaching and committed practice. At this point, our qualitative observations are favorable towards considering Collboard as a proper means for eliciting shared knowledge construction and developing learners' collective intelligence and distributed cognition skills. Moreover, the proper integration of digital pens and IWBs that has been accomplished indicates that transparent transmedia navigation and visualization comprising paper-based and digital artifacts is possible in the classroom environment. We are aware that these results should be complemented with quantitative data in order to give better support to these claims. Seeking to establish whether Collboard may have a positive impact on learning, we carried out pre and post-tests with the students, each of them comprising two tasks similar to the ones solved with Collboard. We are now conducting a thorough analysis on our experimental data to refine our findings, as well as analyzing further potential for developing other new media literacies skills [4].

6. Acknowledgements

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7. References

[1] Kovalainen, M., & Kumpulainen, K. (2007). The social construction of participation in an elementary classroom community. *International Journal of Educational Research*, *46*(3-4), 141-158.

[2] Coiro, J., Knobel, M., Lankshear, C. and Leu, D. (eds) (2008). *The Handbook of Research on New Literacies*. Mahwah, NJ: Erlbaum.

[3] Shakhgildian, V., Fomin, N., and Dolin, G. (2002). Tomorrow's engineer has inevitably to be a moderate `netman'. *Proceedings of the 30th European Society for Engineering Education Annual Conference* (SEFI'2002), Firenze (2002).

[4] Jenkins, H. (2006). Confronting the Challenges of Participatory Culture. Chicago, IL, MacArthur Foundation.

[5] Nussbaum, M., Alvarez, C., Mcfarlane, A., Gomez, F., Claro, S., & Radovic, D.. (2009). Technology as small group face-to-face Collaborative Scaffolding. *Computers & Education*, *52*(1), 147-153.

[6] Looi, C., Chen, W., & Ng, F. (2010). Collaborative activities enabled by GroupScribbles (GS): An exploratory study of learning effectiveness. *Computers & Education*, *54* (1), 14-26. Elsevier Ltd.

[7] Dillenbourg, P., & Fischer, F. (2009). The Evolution of Research on Computer-Supported Collaborative Learning. *Technology-Enhanced Learning*, chapter 1, pages 3-19. Springer Netherlands, Dordrecht.

[8] Säljö, R. (2010). Digital tools and challenges to institutional traditions of learning: technologies, social memory and the performative nature of learning. In *Journal of Computer Assisted Learning*, 26, pp.56-64.

[9] Tchounikine, P. (2008). Operationalizing macro-scripts in CSCL technological settings. *International Journal of Computer-Supported Collaborative Learning*, *3*(2), 193-233.

[10] Steimle, J., Brdiczka, O., & Mühlhäuser, M. (2008). CoScribe: Using Paper for Collaborative Annotations in Lectures. *Proceedings of the 8th IEEE ICALT Conference*, 306-310.

[11] Anderson, R., Anderson, R., Davis, K. M., Linnell, N., Prince, C., Razmov, V. (2007). Supporting active learning and example based instruction with classroom technology. *ACM SIGCSE Bull*., 39(1), 69-73.

[12] Miura, M., Kunifuji, S., Shizuki, B., & Tanaka, J. (2005). AirTransNote: Augmented Classrooms with Digital Pen Devices and RFID Tags. *IEEE International Workshop on Wireless and Mobile Technologies in Education (WMTE'05)*, 56-58.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Transforming Primary Science Learning via a Mobilized Curriculum for Sustainability

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Abstract: Over a year of time, we co-designed primary three science curriculum to integrate 1:1 mobile technology with teachers. The form teacher of the experimental class in a Singapore school enacted the curriculum as her regular teaching. This paper proposes a cyclic model of how to "mobilize" the curriculum in align with the national primary science syllabus. Preliminary results of the enactment are also presented.

Keywords: Primary science, 1:1 mobile learning; mobilized curriculum; sustainability; transform

1. Introduction

The history of education reform has fundamentally revolved around curriculum development and implementation [1]. With the availability of affordable mobile devices and software applications, educators are trying to integrate the affordances of mobile devices to support science learning. By coupling the technical infrastructures for mobile learning with good curriculum and pedagogical design, teachers can transform science teaching into personalized learning journeys for individual students.

However, although there have been studies on mobile-assisted inquiry-based science learning (e.g., [2][3]), most of them were short-term explorations that may not have to be an integral part of schools' existing science curriculum. In this paper, we report our first year's experience on our three-year study to transform the existing science curriculum into a "mobilized" curriculum which is delivered via a smartphone and enact-able in a typical classroom. We envision that the transformation of the curriculum will have the following characteristics: first, the process will result in a gradual but fundamental change of the nature of the mobilized curriculum; second, the change will be sustainable; and third, the process may be challenging and costly in terms of time and effort.

Norris and Soloway [4] used the term "mobilized lesson" to describe a lesson that starts with an existing, perhaps paper-based lesson design, but then is transformed to make use of mobile technologies' affordances. The "mobilized curriculum" is a transformation from a more content-centered and teacher-centered to a systematic student-centered and mobile technology-mediated practice to foster personalized and self-directed learning [5].

Providing students with 1:1 ownership and 24/7 access to mobile devices and Internet access would also allow students to use their devices to support informal learning. Our work in mobilizing science lessons is thus framed in the broader context of constructing "seamless learning" environments to bridge formal and informal learning [6][7]. We want to go beyond classroom learning and explore the pervasive and longitudinal use of mobile technologies. Therefore, we aim to design a curriculum that facilitates student-centered learning activities that bridge their learning in formal and informal settings by developing student inquiry competence and self-directness. In this paper, we describe the design of curriculum, enactment of the mobilized lesson in a Primary classroom and report changes in the learning outcomes of an experimental class which used the mobilized curriculum for Science. The entire process was guided by a mobilized curriculum model that we developed. Due to the space constraint, we will not present how the model was developed and instead focus on how it is applied. Interested readers may refer to [8] for more details.

2. Context and the Existing P3 Science Curriculum

2.1 Context

We are conducting our study in a Nan Chiau Primary School. Thirty-nine students from a mixed-ability Primary 3 (P3) class are involved in the study. The science teacher, Grace (a pseudonym), has been teaching in the school for about three years. The school chose her to teach the class because she felt comfortable in using technology and is quite receptive to new ideas. She wanted to collaborate with the researchers to enrich her knowledge and skills in using mobile learning to improve student learning.

Prior to the introduction of mobile devices in early 2009, we observed the classroom practices and the students' behaviors to understand the environment and culture. We collected student worksheets, assignments, and teacher resources. Based on the classroom observations and analysis of student artifacts, formative feedback was given to the class teacher to improve the classroom management. After six weeks of observation, we embarked on our plan to mobilize the P3 Science curriculum.

2.2 Curricular materials to be re-designed for mobile technologies

There are five themes to be covered in the P3 and P4 Science Syllabus: Diversity, Cycles, Systems, Energy, and Interaction. The syllabus emphasizes the need for a balance between the acquisition of science knowledge, process and attitudes. Central to the curriculum framework is the inculcation of the spirit of scientific inquiry.

We aim to transform the curriculum by deconstructing its components (e.g. learning objectives and their relationships, concepts, and learning activities) and reconstructing them according to a Mobile Inquiry Learning Experience (MILE) framework, which is more student-centered and takes advantages of the affordances of mobile technology. We adopted a co-design process because teachers and researchers possess different sets of expertise and thus can create interesting synergy of ideas. It is only through collaboration that the innovative pedagogy can be realistic and put into practice. The notion of transformation also means that we have to create a new curriculum which is a transformation of the existing curriculum but to fit into the current school schedule. This has proven to be very challenging but possible and here lies the crux of the technology integration reform effort that we would like to address in this paper.

3. Transforming the Science Curriculum

Since we have identified curriculum development as the major task for our study, we combined teacher professional development (TPD) and curriculum development into a teacher-research co-design approach. The school identified a few science teachers including Grace to participate in a curriculum taskforce with the researchers to work on the design of mobilized lessons. We adopt HTC Tytn II Windows Mobile phone that comes with digital camera, stylus pen, keyboard, 3G Internet surfing plan and educational applications (e.g., GoKnow® (http://www.goknow.com/) applications such as KWL-table for organizing what the user wants to Know, Wonder and has Learned, PicoMap for concept mapping, and Sketchy for creating animations).

Curriculum mobilization entails a holistic view of how learning activities can be organized via technology so that learning is situated in authentic contexts. The Mobile Learning Environment (MLE) provides the infrastructure to develop a learning project. A project is a container of related and interdependent learning tasks. Each task is an instantiation of how mobile computing can be an enabler for personalized learning: (a) allowing multiple entry points and learning pathways, (b) supporting multi-modality, (c) enabling student improvisation *in-situ*, and (d) supporting the sharing and creation of student artifacts on the move [7]. Students can pursue their inquiry in a personalized way, without having to do the tasks in a linear sequential order. A good curriculum design will harness these affordances to transform science curriculum into a mobilized one that makes science learning motivating, engaging and holistic.

The above design principles are illustrated in the example below. As part of the mobilized curriculum, students need to download the files teachers prepared for them by synchronizing their smartphones with the GoManage server. The mobilized curriculum is designed with the learning objectives of the existing fungi topic in the national curriculum in mind. We anticipate that the diverse action verbs in the project objectives shown to the students (such as “Recall the characteristics of living things”, “State the characteristics of fungi”, etc.) could lead to the development of both process skills and higher-order thinking skills. For example, students use KWL application to plan and monitor their own learning. They need to demonstrate planning, analytical, reasoning and evaluating skills, as well as to develop metacognitive skills to manage their own learning journeys.

We have adopted the metaphor of *deconstructing* and *reconstructing* to describe our curriculum redesign process [5]. Informed by the data collected from the practices above, we developed a curriculum development model as illustrated in Figure 1. This mini cycle is embedded in larger cycles when we were considering the overall design for the diversity theme. This means such a cycle is an iterative process that is interwoven across our whole design journey, and now we zoom into one of the basic units to elaborate the rationale and process. We use dashed line to indicate that in reality the order of the steps might change or some steps could be combined when curriculum developers are more experienced with the design process. The solid line arrows indicate that the formative evaluation of the design are on-going because of the nature of research design and co-design approach we adopted.

We will explain the use of the design cycle depicted in the model with examples of the mobilized curriculum we have designed. The explanation below will be illustrated by a lesson plan on fungi which is summarized below,

Activity 1: Look at the slides presented by the teacher and understand that that fungi come in different shapes, sizes, and colour. (Corresponding out-of-class activity: to update KWL daily)

Activity 2: Watch a video on Fungi on YouTube with the smartphone and complete a worksheet on *Are Fungi Living Things?*

Activity 3: Engaged in a Jigsaw activity to research about the characteristics of fungi

Activity 4: Complete a compare and contrast activity on *Are fungi plants?*

Activity 5: Complete a PicoMap to show their understanding on fungi

Activity 6: Play the role of a Fungi detective in the Grand Challenge – take photos of fungi in daily life

Step 1 Deconstructing: Analyzing learning objectives and student learning difficulties

“Deconstructing” means to understand the key learning points in a theme, to make the relationship between the topics and concepts visible to teachers and students, and to seek coherence in the mobile curriculum. The taskforce analyzed and deconstructed the topical content of Diversity in the curriculum to identify the overarching learning goal:

Classification of living and non-living things according to characteristics and purposes. More detailed lesson plans with consideration will be subsequently designed.

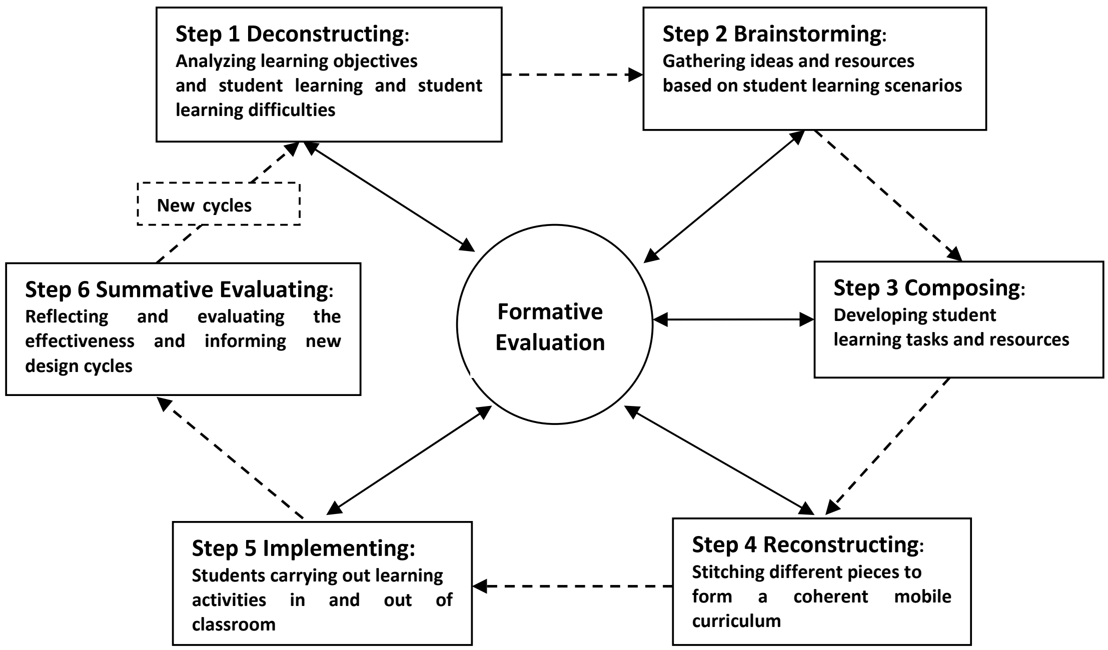
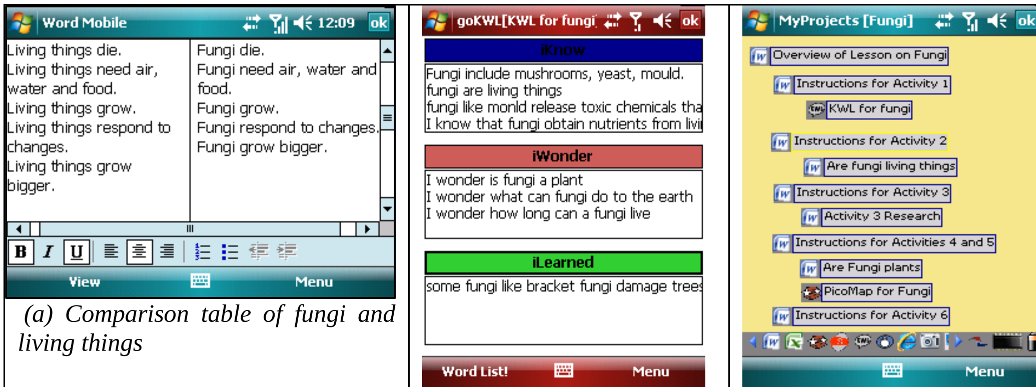


Figure 1. A collective curriculum mobilization cycle

The other outcome of deconstruction was the identification of the epiphany of how materials could be re-sequenced based on students' learning difficulties. For example, our observation showed that students did not necessarily make connection between the general characteristics of living things to specific cases like fungi. Therefore, we designed a comparison table for students to compare and contrast the characteristics (Figure 1a) in Activity 2 of the fungi lesson plan. This pushed for a restructuring of the learning content.
Next, we created learning scenario that defines the students' learning experiences and what they need to achieve. Students learned by participating in class activities, deciphering the textbook concepts, and corroborating information from the Internet. They were involved in the inquiry process in both formal and informal settings which include observing things around them, collecting data and working in groups to reach consensus on their the characteristics of living and non living things; as well as consolidating their learning by creating a digital animation to showcase the characteristics of fungi.
There were formative and summative assessments involved in the process. We identified and addressed the possible misconceptions of the topic in the activity designs. For example, in the scenario planning for the MLE on fungi, the teachers wanted to provide students with thought-provoking and attention-arresting triggers. A YouTube video clip about *fungi* was chosen for such a motivating and anchoring event (Activity 2). After this introduction, we wanted to assess the students' prior knowledge and provided scaffolding to help them engage in self-directed learning, and to make sure that they were able to relate their learning to the prior concepts learned in plants. One way to serve the purpose was to ask them to fill in and frequently update their KWL files (Activity 1) (see Figure 2(b)).

Step 2 Brainstorming: Gathering ideas and resources based on student learning scenarios

As part of inquiry learning, we wanted the students to work in groups to conduct an experiment on bread mold. The students recorded their observations in writing and phototaking. We also wanted them to engage in collaborative learning using the jigsaw method (Activity 3). To bring closure, we introduced a "grand challenge" activity (Activity 6) asked them to identify examples of fungi in their environment.



(a) Comparison table of fungi and living things

(b) KWL-Fungi

(c) Learning instructions and tasks of a mini-project

Figure 2: Some smartphone snapshots pertaining to the MLE fungi lesson

Step 3 Composing: Developing student learning tasks and resources

After the brainstorming session, the taskforce selected relevant ideas for further development. For the topic of fungi, the tasks are:

1. To create a presentation that will impress the students with the idea of diversity of fungi. The teacher has to make this presentation visually attractive (e.g. Activity 1).
2. To find a multimedia resource that introduces the students to the characteristics of fungi as a living thing (e.g. Activity 2).
3. To create a resource to help students research the characteristics of fungi using the jigsaw method. This activity cannot be more than 1 hour (e.g. Activity 3).
4. To create an activity to help students to compare and contrast fungi and plants. The students should be able to create a concept map of fungi after this (e.g. Activity 4).
5. To create opportunities for students to apply what they have learned about fungi in their daily experiences (e.g. Activity 6).

The composing stages entail creative thinking and good understanding of a) content; b) student learning difficulties; c) the mobile affordances; and d) the related applications.

Step 4 Reconstructing: Stitching different pieces to form a coherent mobile curriculum

In reconstructing, we developed the flow of events and learning activities according to the desired outcomes of the learning scenarios. We also stated the desired pedagogies and how the teacher should facilitate the learning. Finally, the resources for the students were packaged in a MLE project and disseminated to the students through the GoManage server. Although the introduction of tasks suggested a sequence of activities which warranted the logical flow of inquiry process, students had more flexibility in controlling their own pace and sequence for the task because they could open the files in any order and freely switch among them (e.g. Word, Excel, Sketchy, PicoMap, and KWL). Figure 2c shows available curriculum materials including instructions of a mini-project on fungi.

Step 5 Implementing: Students carrying out learning activities in and out of classroom

Grace distributed the MLE lesson package to the students' handhelds through the GoManage Server. This enabled learning to take place anywhere and anytime. The students read the lesson overview before Grace started the lesson. By reading the overview, the students had a broad idea of their learning activities and were also aware of the learning objectives. This document also informed them about the schedule and deadlines of the tasks. As researchers, we made observations and interventions during class time. Together with Grace, improvisation and fine-tuning were done during or after class. We also provided timely feedback to help Grace improve her classroom management and facilitation skills. We also observed how the students responded to the activity design. In addition, we collected student artifacts to triangulate our findings about the impact of MLE lessons on student learning. These data will serve to inform the iterative design of our next cycle.

Step 6 Evaluating: Reflecting and evaluating the effectiveness and informing new design cycles

Two researchers stationed in the school to observe all the science lessons. They emailed, and/or talked with Grace almost every day for evaluation of the lessons. Furthermore, the taskforce discussed the results of their formative assessment weekly. Researchers reported classroom observations and selected students' work for analysis. The total teaching time remains unchanged, but there was a significant increase in the preparation time of mobilized lessons. However, once this preparation was done, the revision to mobilized lessons can be easily adopted by other teachers.

4. Teacher and student changes as results of the enacted curriculum

Given the space limit and focus of this paper, which is to describe the process of how to "mobilize" the science curriculum, we may not be able to provide detailed account of the impact of the enacted curriculum. Nevertheless, we present some significant teacher and student changes as below.

4.1 Students are engaged in inquiry-based learning

Students were able to conduct research by formulating questions, conducting online search, collecting data, producing animations, concept maps, and other digital artifacts to reflect their understanding as well as negotiate meanings collectively. For example, after we modeled how to compare the characteristics of living things and fungi as shown in Figure 2(a), they were able to design their own comparison tables. They used their inquiry process skills such as finding evidences, evaluating what they have found, and making comparisons. The use of educational applications also augments Grace's ability to identify students' misconceptions through their multi-modal (pictorial, textual, or even verbal) artifacts. There was an emergence of participatory learning culture among the students when they communicated ideas, shared learning tasks, and sent their artifacts to each other for critique.

4.2 Students showed signs of collaborative and self-directed learning

Students could conduct independent research online, such as searching for relevant YouTube videos, because they had unlimited data plan for their phones. Questions raised by them during class focus more on the content of the lesson, as compared with the pre-intervention stage where questions were centered around the clarification of teacher's instructions. The changes in the nature of the questions could be attributed to students engaging in independent research. They used KWL to record their thinking over time, which facilitated their self-directed learning and also became a means of formative assessment. Student questions in *What I Want to Know* reflect deeper thinking and are more relevant to what they were doing. We consider behaviors such as student formulating their own questions and feeling less inhibited when asking questions as very significant cultural changes. Furthermore, they often worked in small groups and sometimes engaged in Jigsaw activities. They had to complete tasks within certain amount of time with their phones. They exchanged their phones to receive quick feedback to their work in progress. These are the most significant indicators of pedagogical change towards socio-constructivism.

4.3 The teacher positioned herself as a facilitator

There were obvious changes in class structure when implementing the mobilized curriculum. For Grace, she used to be under pressure to cover the syllabus through teacher-centered approach. Now she was able to switch to student-centered learning. She was inclined to give students more time to construct their understanding rather than feeding them with information. With more time to observe students learning with mobile devices, she learned to identify student learning difficulties when she facilitated student learning. The MLE lessons gave Grace more breathing space and she was able to focus on the natural flow of the lessons. As a result of using the redesigned curriculum using the mobile devices, she shared with us that she had more time to reflect on her lessons even during class. She could think on her feet and improvise on the lessons in real time.

4.4 Positive outcomes from Science Summative Assessment

The class which we studied was the only class among the 6 Mixed-Ability classes to receive the intervention of the mobilized lessons over 8 month periods. A year-end science exam was taken by the all the students in the cohort of Grade 3 students. Using a common exam paper done before the introduction of the mobilized lesson as a co-variate, we conducted a one-way analysis of co-variate (ANCOVA) to determine the differences of their year-end Science exam scores as shown in Table 1.

Table 1: ANCOVA on year-end science exam scores across 6 mixed ability classes when holding the exam scores before the introduction of mobilized lessons constant

Class	N	Mean Total year-end score	SD	Adjusted mean Total year-end score
3D	39	75.49	7.786	71.50
3E	39	76.67	8.588	74.11
3F	41	71.63	8.952	68.22
3G	36	41.36	16.507	48.90
3H	40	55.95	12.704	59.31
3I	39	72.13	7.706	71.87

After controlling the exam score before the introduction of mobilized lessons constant, the ANCOVA results showed that there was a significant difference ($F(5,345) = 31.619$, $p<.01$) on year-end science exam scores among the 6 mixed ability classes. The class difference explained 41.1% of the variance in the year-end exam scores. The experimental class P3E which used the mobilised curriculum had the highest score among the 6 classes. Note that in performing this statistical analysis, it was not our intention to compare the effectiveness between the science curricula with and without mobilization, but between the ENTIRE new curriculum and the regular curriculum. As we have adopted design research, rather than experimental design, for the two-year study, we have concentrated our limited resources in developing, enacting and refining the mobilized curriculum, rather than diverting our attention to implementing a non-mobilized version of the new curriculum.

5. Discussion and Conclusion

In this paper, we discussed why we need to redesign the current P3 science curriculum, and how we deconstructed and reconstructed the curriculum in order to harness students' meaningful learning with the aid of mobile technologies. We articulated our proposed design process in transforming the current curriculum into mobilized learning activities, and our experiences in using this framework to design P3 science activities. The *mobilized* curriculum for the theme of *Diversity* has been implemented while more units are currently being developed. The new *mobilized* learning activities are aimed at providing a holistic learning scenario to engage students in student-centered inquiry learning, not conventional drill-and-practice lessons. They also enable the teacher to blend technology into core teaching and learning rather than to use it as add-ons to their routine practices.

Our work on *mobilizing* science lessons was situated in the broader context of constructing "seamless learning" environments to bridge formal and informal learning. We strongly believe that students need to nurture personalized and collaborative learning as a habit of mind and treat their handhelds as both a lifestyle device and a learning device [9]. Our longer-term goal is to reinforce seamless learning through our mobilized curriculum by fostering self-directed learning and providing necessary inquiry-based science learning tools such as the MLE applications. Our future work will look at the use of the mobile technologies beyond classroom learning so that we extend our work from classroom learning to the space of seamless and longitudinal use of mobile technologies.

References

[1] Forbes, C. T., & Davis, E. A. (2007). *Beginning elementary teachers' learing through theuse of science curriculum materias: A longitudinal study*. Paper presented at the Annual meeting of the NARST. Retrieved from http://hi-ce.org/presentations/documents/Forbes_Davis_NARST2007.pdf

[2] Vavoula, G., Sharples, M., Rudman, P., Meek, J., & Lonsdale, P. (2009). MyAartspace: Design and evaluation of support for learning with multimedia phones between classrooms and museums. *Computers & Education*, *53*(2), 286-299.

[3] Spikol, D., Milrad, M., Maldonado, H., & Pea, R. (2009). *Integrating Co-Design Practices into the Development of Mobile Science Collaboratories* Paper presented at the The 9th IEEE International Conference on Advanced Learning Technologies (ICALT 2009).

[4] Norris, C., & Soloway, E. (2008). Getting mobile handhelds help bring K-12 classrooms into the 21st century. *District Administration Magazine*, Professional Media Group, LLC, CT.

[5] Looi, C.-K., Wong, L.-H., So, H.-J., Seow, P., Toh, Y., Chen, W., *et al.* (2009). Anatomy of a mobilized lesson: Learning my way. *Computers & Education, 53*(4), 1120-1132.

[6] Chan, T.-W., Roschelle, J., Hsi, S., Kinshuk, Sharples, M., Brown, T., *et al.* (2006). One-to-one technology-enhanced learning: An opportunity for global research collaboration. *RPTEL, 1*(1), 3–29.

[7] Looi, C.-K., Seow, P., Zhang, B., So, H.-J., Chen, W., & Wong, L.-H. (2010). Leveraging mobile technology for sustainable seamless learning. *BJET, 42*(1), 154-169.

[8] Zhang, B.-H., Looi, C.-K., Seow, P., Chia, G., Wong, L.-H., Chen, W., *et al.* (2010). Deconstructing and reconstructing: Transforming primary science learning via a mobilized curriculum. *Computers & Education.* Published online: 1 July 2010.

[9] Wong, L.-H., Chin, C.-K., Tan, C.-L., & Liu, M. (in-press). Students' personal and social meaning making in a Chinese idiom mobile learning environment. *Accepted by: Educational Technology & Society*.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Development of real-world oriented mobile constellation learning environment using gaze pointing

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Abstract: We developed a real-world oriented mobile constellation learning environment. Learners point at a target constellation by gazing through a cylinder with a gyro-sensor, which can display information related to the constellation. The system has a learning function. Through experimentation, we evaluated the learning environment to assess its learning effects.

Keywords: Mobile function, constellation learning, gyro sensor, gaze pointing

1.Introduction

Two methods are used currently by astronomy beginners to learn star names or constellations: observing and learning stars under the actual night sky, and observing and learning them under a virtual starry sky using a domed projection in a planetarium.

In the former method under an actual night sky, astronomy beginners must identify stars on a star chart or a star observation support tool as those in the real night sky to obtain astronomical information about a target star. Star charts and star observation support tools are indeed useful tools, but beginners must repeatedly shift their gaze between the night sky and the tool when identifying a star in the real night sky. In contrast, the method of observing and learning stars under a virtual starry sky using a domed projection in a planetarium requires costly and large facilities, usually entire buildings, and presents problems such as a lack of interactivity because activities must proceed to meet a schedule. Moreover, a projector is placed in the center of the dome, and seats for spectators are arranged around it. Consequently, astronomy beginners see strained constellations which differ from those in the real night sky; a large gap remains between reality and the astronomy beginner’s imagination.

As just described, astronomy beginners often encounter stress when performing star observation. That stress can deter them from becoming interested in astronomy.

Consequently, our laboratory has conducted studies for star search support and astronomy learning support. We have developed a “constellation learning support environment incorporating finger pointing actions”[1][2][3]. By pointing at a target constellation in the real world, it presents information about the constellation on the system using text and sound. It facilitates the instruction of star names without identifying stars and reduces stress related to star observation. It also answers queries related to respective stars by detecting a pointed star with a magnetic position sensor worn on a fingertip and presents the answers with text and sound. Learners answer a question by pointing at a star in the real night sky. These features lead learners to match a learned star and a real star more quickly when looking up at the real night sky.

Nonetheless, the system presented in previous reports requires AC power and imposes location constraints that hinder their use in the real night sky because they use a magnetic position sensor. Their exercise functions also appear to be insufficient.

Nakajima and others developed a star observation support system using wearable augmented reality technology [4]. This method performs head tracking with a gyro-sensor and superimposes and displays a projected image of a starry sky along with information about constellations on the HMD with video see-through type augmented reality. Although this system supports constellation observation, it is confined to added information: it has no learning support function such as an exercise function.

"DS hoshizora-navi", a star navigation system functioning on DS produced recently by Nintendo [5] runs planetarium software on a Nintendo DS. When holding a DS with an additional orientation sensor module up to the night sky, it displays constellations in that direction on the display screen. This method requires learners to identify stars by comparing the real night sky with a screen display on the DS. It is particularly difficult under circumstances in which only a single star is visible among the clouds. Moreover, the DS hoshizora-navi is not equipped with learning support functions such as an exercise function. Google Sky Map, which is operable on a mobile terminal equipped with Android, can do the same things that the DS hoshizora-navi does, but it also is not equipped with learning support functions such as the exercise function.

This paper therefore presents a proposal of a real-world oriented mobile constellation learning support environment. It can use the actual night sky as learning content in the open air and is available for mobile use with exercise functions. We also describe results of evaluation experiments.

2. Proposed system

This section explains the proposed system, which enables mobile units to be used based on an existing system. The explanation also addresses constellation exercise functions.

2.1 Use of a gyro-sensor

As described previously, the existing system uses a magnetic position sensor to identify the direction in which a learner points. The magnetic position sensor obtains a position coordinate treating a magnetic field generator (transmitter) as the origin and calculates a direction vector to a target star based on the difference between those position vectors by placing a magnetic position sensor in the positions of a fingertip and eyes, respectively. However, such sensors present the following problems: when using the system to determine the reference direction, calibration must be done. Furthermore, preparation for using the system is troublesome.

The method presented herein uses an orientation gyro-sensor to identify the gaze direction. The gyro-sensor is operated on 9[V] AC power, but it is also operable using dry-cell batteries. The gyro-sensor can obtain three axial rotation angles, Roll, Pitch, and Yaw. Of those, Roll is not used for this study because it represents values of change in twisting actions of the gyro-sensor. The direction in which a learner points is obtainable from the gyro-sensor output value.

Based on the consideration above, improvement of operational aspects is expected because calibration operations are not required in the existing system, nor is improvement of location constraints.

2.2 Gaze pointing

We use the device depicted in Figure 1 as the gaze pointing interface for this study. It is a device with a gyro-sensor attached to a cylinder. The mechanism of the released system was to point at the night sky holding a sensor with the hands. However, because evaluation experiments for the released system revealed physical fatigue resulting from gaze pointing actions, we reviewed the interface. The interface proposed this time has a specification to observe constellations in the night sky with a cylinder, which is the same action as peering at the night sky through a telescope. An advantage is that it has higher pointing accuracy for constellations than pointing at constellations by finger with magnetic position sensor. Particularly when the night sky is obscured by clouds and when constellations are difficult to view, looking at the night sky with a cylinder simplifies location of a target constellation compared to searching for a target constellation using gaze pointing.

Figure 1 Gaze pointing interface device.

2.3 Expansion of exercise functions

The existing system has the following constellation exercise functions:

- Constellation layout
- Zodiacal constellations
- Star positions

It is possible to learn the composition and position of constellations using the existing system. However, the system is insufficient for constellation learning functions because it is impossible to learn the relation between constellations and the shape of constellations. This study constructs the following functions:

- Constellation mythology exercise function
- Constellation line-drawing function

(1) Constellation mythology exercise function

This gives an opportunity to learn in the real night sky in relation to a constellation myth and a constellation. It also enables learning of the positional relations of constellation that appear in myths. Learners can get a better understanding of the constellation shape using not constellation lines but constellation pictures.

(2) Constellation line-drawing function

Constellation line-drawing is a function enabling learners to draw straight lines and marks among given stars. A learner points at stars using gaze pointing actions. This function enables learners to draw an original constellation. It is an effective method particularly for younger people to foster an interest in astronomy. In the future, a function to learn constellation lines can be imagined as the following: the system presents a question about constellation lines; a learner draws constellation lines to be corrected in the real night sky; and the system matches the drawing with the correct answer.

3.System configuration

This section presents a description of the system configuration based on the proposed system.

3.1. Interface configuration

The system uses the interface shown in Figure 2 below.

The gyro-sensor communicates serially to the PC. Data are transferred in real time.

The Wii remote controller uses only a button function when operating the constellation mythological exercise function and the constellation line-drawing function. It communicates with the PC via Bluetooth.

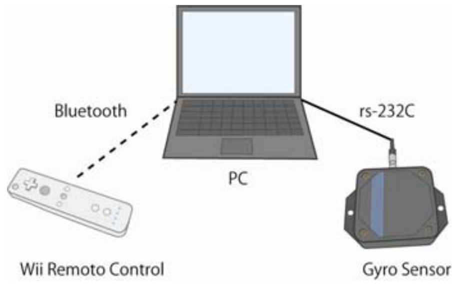

Figure 2 Interface configuration.

3.2. System configuration

Figure 3 presents the system workflow. When a learner points at a constellation using the gaze pointing interface, sensor data are transferred to the PC. After the transfer has been completed, the system analyzes the direction in which a learner is pointing. Then information related to the night sky around the indicated position is given to the learner through the system screen display.

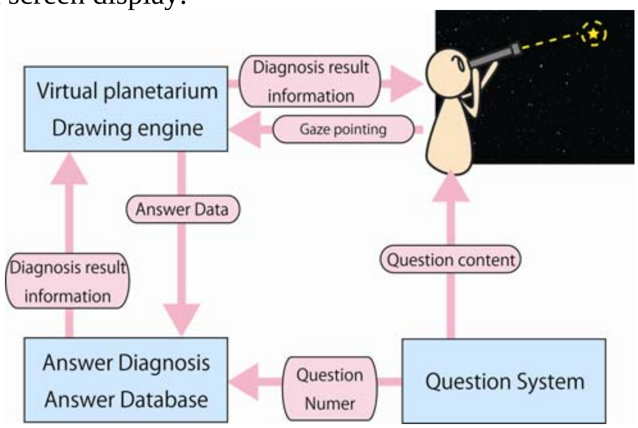

Figure 3 System workflow

For exercise functions, a learner selects an item to learn from the self-exercise panel. In the question system, the content of the question that was selected by the learner is displayed with text and voice. Simultaneously, the question system sends the question number to the answer search engine. The learner selects a star ahead of the gaze with the gaze pointing drawing function. The drawing engine sends star information that is selected by the learner to the answer-correcting engine as answer data. The answer-correcting engine corrects the answer with an answer database according to questions and sends the result to the drawing engine. Based on the diagnosis result, the drawing engine shows a message on virtual planetarium. The diagnosis result is informed by displaying the image in the virtual planetarium. In addition, when the answer is correct, the learner is informed of the next question, or that all answers were correct, with dialogue and sounds. The user is also informed with dialogue and sound accordingly if the answer is not correct.

3.3. Constellation mythological exercise function

The constellation mythological exercise function is a function to set questions about constellations composing constellation myths. The constructed system has realized the constellation mythological exercise function on the theme of myths about Cassiopeia, Andromeda, Cetus, and Perseus.

This exercise function displays one scene of a myth with text according to the order of the myth story, as well as presentation by voice. Subsequently, the system instructs a learner to answer about the constellation appearing in the scene. The learner answers the question by finding the relevant constellation from the real night sky and marking a star in the constellation on the virtual planetarium by gaze pointing with the Wii remote controller button.

Then, the system judges the learner’s answer. When the answer is correct, the system superimposes and displays the constellation picture on the virtual planetarium, proceeds to the next scene and displays it with text, and encourages the learner to answer about the constellation appearing next. The same question is presented repeatedly until the correct answer is given if the learner’s answer is not correct.

The screen scene of the constellation mythological exercise function is portrayed in the left picture of Figure 4.

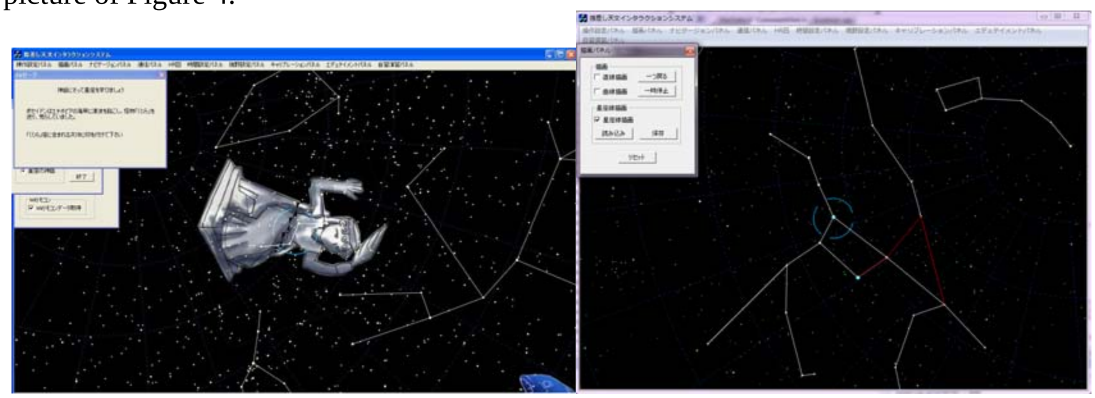

Figure 4 Scenes of the learning environment
(Left: Constellation mythological exercise,
Right: Constellation line-drawing function.)

3.4. Constellation line-drawing function

Constellation line drawing is a function that enables learners to draw straight lines and marks among selected stars. Right picture of Figure 4 presents the screen structure in the constellation line drawing. It is operated as a drawing method using the following procedures:

(1) Point at the starting point of a constellation line (star).
(2) When pressing the Wii remote controller button, the selected point turns red. Point at the next constellation while keeping the button pressed.
(3) After pointing, when releasing the button, constellation lines are displayed at two pointing points.

To draw more constellation lines, repeat procedures (1)–(3). Constellation lines can be stored as data; data saving is possible with the data output function and the data read function.

4.Experiment

4.1. Purposes

We verified the usefulness of the constellation mythological exercise by comparing the following support effects: learning outdoors with the constellation mythological exercise in the system and learning indoors with a book of constellation mythology. We also conducted a questionnaire survey to examine the usefulness and problems in the interface.

4.2. Method

Subjects of this experiment were nine students. First, we asked them to fill in a questionnaire sheet to assess their knowledge of constellations. Then we explained the method of this experiment. Before the experiment, we also asked subjects to use the system freely for a few minutes to become accustomed to its operation.

As Figure 5 shows, Experimental group learned with the constellation mythological exercise in the system. Control group did so using a book of constellation mythology.

Then the subjects orally explained a constellation myth under the real night sky as a recall test. If subjects cannot find some of the constellations, they are allowed to use navigation function. The navigation function is the function that guides a learner to a target constellation in the real sky. The navigation function is supported by the system by inheriting that of the previous learning environment[3]. We counted instances of navigation function usage for seeking constellations in the system. Thereby, we verified the learning effects of associating constellation mythology with constellations in the actual night sky.

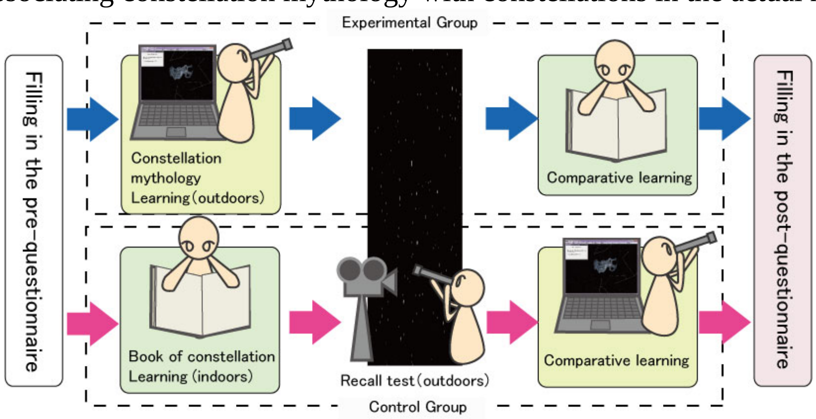

Figure 5 Flow of the evaluation experiment.

In the recall test, seven keywords comprising the story were prescribed in terms of the constellation myth. It was identified whether or not those keywords were included in the explained contents by the subjects.

After finishing recall test, both group exchanged their learning method. Experimental group experienced indoor learning with book of constellation and control group experienced outdoor learning with the system. Therefore, subjects in both groups were able to compare both learning methods and to evaluate system usability and usefulness. We implemented a post-questionnaire survey to determine the system usability. We asked respondents to evaluate questions (1)–(5) using a five-item scale and to fill in comments freely in answer columns of questions (6) and (7).

(1) Sense of physical fatigue
(2) Sense of mental fatigue
(3) Usability of the gaze pointing interface
(4) Usability of the Wii remote controller
(5) Whether constellation mythological exercises are fun?
(6) Advantages of learning with the book
(7) Advantages of learning with the system

4.3. Results and study

First, we conducted a pre-questionnaire survey to elicit astronomical knowledge. Results revealed that the number of constellations that subjects knew were fewer than five; subjects were almost entirely beginners of constellation learning. Furthermore, most subjects had read between zero and five myths in constellation mythology. Taken together, their responses indicate that they were not very familiar with constellation mythology.

Next, we describe an evaluation experiment for the constellation mythological exercise. Table 1 below displays the number of wrong answers in constellation mythology and the number of times the navigation was used. The frequency of use of the navigation indicates that the constellation mythological exercise can be learned by associating constellation mythology with constellations under the real night sky. However, when particularly addressing learning of constellation mythology, the usefulness of the constellation mythology exercise is not well established.

Table 1 Results of constellation mythological exercises

Learning with the system	Subject	A	B	C	D	E
	The number of wrong answers in constellation mythology	1	3	3	1	1
	Times navigation was used	1	0	0	0	6
Learning with the book	Subject	E	F	G	H	
	The number of wrong answers in constellation mythology	4	0	0	0	
	Times navigation was used	2	8	4	4	

One reason might be the abundance of information in the book. In particular, visual information from illustrations strongly affects the learning of subjects in the control group. Another reason could be that subjects in the experimental group were unable to concentrate on the constellation mythological exercise because they were compelled to learn constellation mythology along with the position of constellations. Also, subjects might be unable to concentrate on the constellation mythology exercise, because it was outdoor learning in the cold winter night.

Table 2 Results of the questionnaire about usability and usefulness (Number of subjects of each score)

Score (1:Poor, 2:bad, 3:Fair, 4:good, 5:Excellent)	1	2	3	4	5
Sense of physical fatigue	1	5	0	1	2
Sense of mental fatigue	0	2	3	2	2
Usability of the gaze pointing interface	1	0	5	2	1
Usability of the Wii remote controller	0	2	3	2	2
Constellation mythological exercise function	0	1	2	4	2

Next, we present results in the questionnaire items. Answers varied throughout the whole questionnaire. However, regarding physical fatigue, scores of three and less accounted for the majority of responses, which is attributable to the burden on holding the gaze pointing interface during the exercises. We received an overall evaluation that they enjoyed the constellation mythological exercise function.

Finally, we introduce the freely described comments in Tables 3 and 4.

Table 3 Advantages of using the system

Easy to take in because of ability to identify constellations under the real sky.
Easy to grasp the constellation positions.
Pleasure felt when finding stars.
Easy to remember because a sense of distance, positional relations, and brightness can be experienced.
Learning by searching stars under the real sky is fresher and therefore easier to retain in memory than learning by reading.
I can actually see the real thing. Enjoyable.
It seems practicable continuously because it uses the real night sky.
Easy to remember as an experience because it is learning while watching the real night sky.
It can be experienced. Pleasure of searching.
I can understand the positional relations of the real starry sky.

The advantages of using the system are shown in Table 3. Many comments related to advantages of the system were the following: the pleasure of learning while watching the actual night sky; and information, such as the position of constellations, and myths remain in memory. Making learning fun engenders increased desire to learn. Therefore, using the system affects learning.

By contrast, advantages of learning with the book were listed as shown in Table 4: feeling less fatigue because pointing actions are not required; information sources are plentiful; learning at their own pace. The system includes problems such as not being able to concentrate on learning because it requires pointing actions. In addition, the system necessitates expanded information because the book has advantages attributable to its abundance of information sources.

Table 4 Advantages of learning with the book

Less exhaustive because it does not involve physical body movements.
It has pictures.
The text has abundant information. It is meaty in content.
Easy to understand because it has illustrations.
I can re-read the text any time I want to.
Not tiring. Warm. Shorter than the system in terms of learning hours.
Unaffected by weather conditions.
I cannot take it in because I work very hard at pointing. I can concentrate on a story.
I can read it in my own way. I can turn back to sentences I like.

5.Conclusions

This study replaced a magnetic position sensor used in previous studies with a gyro-sensor to make this system mobile. Using the system examined in previous studies, we constructed a movable constellation learning support environment.

We evaluated the system by comparing experimental group with control group. The result indicated that the learning by the system is appropriate to learn the positional relations of the real starry sky. By contrast, the result also indicated that the learning by the book is appropriate to learn the story of the constellation myths. Probably, the best way to learn constellation totally is to learn it by using both the system and the book. The system and the book can make up for disadvantages each other.

References

[1] Takaseki, K. (2007). Development and evaluation of a star interaction system with finger pointing (in Japanese), *ALST of The Japanese Society for Artificial Intelligence,* 49, 59-64

[2] Koji, M.(2008). Interactive Learning Environment for Astronomy with Finger Pointing and Augmented Reality (in Japanese), *ALST of The Japanese Society for Artificial Intelligence,* 52,47-52

[3] Soga, M., Miwa, M., Matsui, K., Takaseki, K., Tokoi, Hirokazu Taki, H.(2008), The Learning Environment for Stars and Constellations in the Real World with Finger Pointing , Proceedings of the 2008 Second IEEE International Conference on Digital Game and Intelligent Toy Enhanced Learning, pp.160-166

[4] Ken, Nakajima.(2000). An Astronomical Observation Supporting System based on Wearable Augmented Reality, Graduate School of Information Science, Nara Institute of Science and Technology, Department of Information Processing, Master's Thesis, http://chihara.aist-nara.ac.jp/old/public/research/thesis/master/2000/nakashima9851075.pdf

[5] DS "Hoshizora-Navi" (in Japanese),http://www.astroarts.co.jp/products/hoshizora-navi/index-j.shtml , (2009)

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Can a Collaborative Note-taking Method Facilitate External Connections between Lecture Material and Students' Prior Knowledge: An Experimental Study

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Abstract: The authors designed a collaborative note-taking method and experimentally examined whether it could facilitate external connections between lecture material and students' prior knowledge. Results showed no significant difference in the number of external connections between the Pairs condition and the Singles condition. However, significant difference was observed in their variance values. Hence, the Pairs condition was divided into two: those who succeeded in making external connections through collaborative note-taking (high-performance group) and those who were not successful (low-performance group). Analysis of notes of the high-performance pairs showed that the Note-Takers in those pairs were good at recording important points of the lecture in a sentence form, and that the Note-Monitors had rich background knowledge and experience and other flexible relating skills. In conclusion, the authors present three different approaches for improving the collaborative note-taking method.

Keywords: Higher education, active learning, lecture comprehension, one-to-one computing

1. Introduction

1.1 Lecture Comprehension in Higher Education

In recent years, active learning is emphasized as a key factor in improving higher education courses in Japan [1]. According to Mizokami [1], active learning is not only mainly adopted in seminar-style classes, but also significantly adopted in lecture-style classes. Mayer [2] criticizes that constructivist teaching tends to be regarded as purely discovery methods and insists that students must be "cognitively" active instead of only being "behaviorally" active. Therefore, active learning in lecture-style classes at universities needs greater attention.

Kiewra [3] outlines the following three steps for lecture comprehension:

i. Selections
ii. Internal connections
iii. External connections

The first step "Selections" requires selecting the important components from the lecture material. The next step is "Internal connections" that involves integrating the selected components. The last step "External connections" includes relating the lecture material to the students' prior knowledge apart from the lecture topic. The last step is particularly important for lecture comprehension since it is a process in which learners make the lecture material personally meaningful.

According to Armbruster [4], note-taking is a widely accepted learning strategy used during university lectures. She emphasizes that the note-taking method that maximizes both internal and external connections enables best learning for students. However, Kiewra [3] shows that students do not make external connections spontaneously while taking notes during lectures, and he lists the following three reasons for it:

i. Cognitive overload during lectures
ii. Neglect of making external connections
iii. Inactive prior knowledge during lectures

Since personal note-taking results in limited success, a collaborative note-taking method is needed to reduce the cognitive overload.

1.2 Research Question and Research Method

Accordingly, the aim of this research is to examine experimentally whether a collaborative note-taking method would facilitate external connections between lecture material and students' prior knowledge. The authors designed a collaborative note-taking method and developed a collaborative note-taking system for the same.

2. Collaborative Note-taking Method

2.1 Design of the Collaborative Note-taking Method

The authors designed a collaborative note-taking method as an in-class activity performed by paired learners. During a lecture, the paired learners divide their roles into two: the "Note-Taker" who takes notes by selecting and making internal connections with the lecture material, and the "Note-Monitor" who monitors and modifies the Note-Taker's notes and takes his own notes by making external connections between the lecture material and his prior knowledge. In regard to external connections, Note-Monitors are provided with concrete instructions to make elaborations, such as citing examples, analogies, and applications [5] and self-explanations [6]. After the lecture, students edit their notes individually by examining the record of the lectures (selections and internal connections) and external connections.

2.2 Development of "Akinote"

The authors developed a web application called "Akinote." Akinote has real time co-editing functions and an exportable function to Google Docs. This enables collaborative note-taking during the lecture and individual note editing afterward.

During a lecture, the Note-Taker is instructed to take notes on what he/she thinks is important in the lecture. The Note-Monitor, on the other hand, monitors the notes taken by the Note-Taker and modifies them and makes external connections between the lecture material and his/her prior knowledge.

After the lecture, students edit their own notes individually. By exporting the notes to Google Docs, students are able to own their notes separately and edit them individually. Students are instructed to integrate the record of the lecture (selections and internal connections), and to examine external connections that involves eliminating and adding notes on external connections.

3. Experiment

3.1 Method

An experiment was conducted to examine whether this collaborative note-taking method would facilitate external connections as compared to a single note-taking method or taking notes alone with Akinote.

Thirty undergraduate students participated in the experiment. The only requirement for the participants was their ability of touch typing. On applying for the experiment, the participants answered a questionnaire consisting of four-choice questions regarding their prior knowledge of the lecture topic and their regular note-taking behavior during daily classes. The authors randomly divided the participants into two groups so that the answers of the two questions would be equal. As a result, 14 students served in the Pairs condition group and the remaining 16 served in the Singles condition group.

One of the authors, also a university instructor, gave a 60-minute mock lecture on "instructional design that uses technologies." She gave a power point presentation consisting of 17 slides. No handouts were provided to the participants. Before the mock lecture, the authors showed a free e-learning movie on "introductory biology" as a tutorial phase. Each participant was provided with an internet-connected laptop and a mouse. Students in the Pairs group attended the lecture using the collaborative note-taking method and edited their notes afterward individually, while students in the Singles group used the single note-taking method during the lecture and edited their notes afterward individually. The role of the note-taking was randomly assigned to the participants in the Pairs group. The authors referred to the notes made immediately after the lecture as "original notes," and the notes made after note editing as "integrated notes".

The original and the integrated notes were analyzed with respect to external connections. First, the authors categorized each set of notes into sections corresponding to the 17 slides shown in the mock lecture. Next, the authors counted all types of external connection made in each section, such as examples, analogies, applications, and self-explanations. The authors counted each type of external connection made, regardless of the amount of its description. They compared the two conditions with respect to the number of external connections made in the notes of each pair. The Singles condition students, who participated individually, were now paired virtually by the authors to facilitate comparison. The authors averaged the number of descriptions of external connections between the pairs' notes in the Pairs condition, while they considered the maximum number of descriptions of external connections among the virtual pairs' notes in the Singles condition.

3.2 Results

The number of external connections in each note is described in Figure 1 and Table 1.

First, it was observed that the distributions of the data both from the original and the integrated notes were significantly different between the Pairs condition and the Singles condition. The differences between them are mentioned as follows: Original notes (Pairs: $SD = 6.13$; Singles: $SD = 2.45$, $F(6, 7) = 6.27$, $p < .05$), Integrated notes (Pairs: $SD = 5.45$; Singles: $SD = 2.75$, $F(6, 7) = 3.94$, $p < .05$).

The Mann–Whitney U test was used to study the comparisons between the two condition groups. It showed no significant difference between the Pairs condition and the Singles condition in either the original notes or the integrated notes.

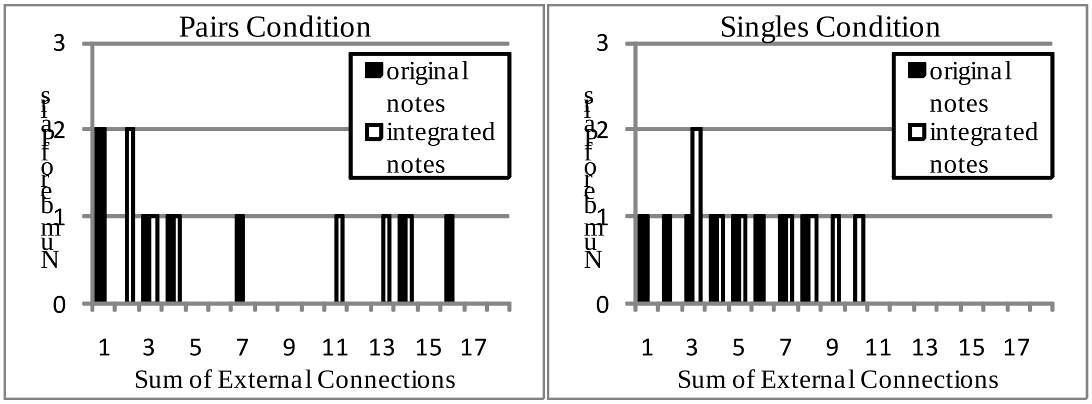

Figure 1: Frequency Distribution of Each Note

Table 1: Number of External Connections in Each Note

		Original Notes		Integrated Notes	
		Pairs (n = 7)	Singles (n = 8)	Pairs (n = 7)	Single (n = 8)
Examples	$\bar{X}$ (*SD*)	3.29 (3.95)	2.25 (1.83)	3.29 (3.64)	3.00 (1.69)
Analogies	$\bar{X}$ (*SD*)	0.71 (1.11)	0.38 (0.74)	0.71 (0.99)	0.63 (0.92)
Applications	$\bar{X}$ (*SD*)	0.14 (0.38)	0.13 (0.35)	0.36 (0.56)	0.25 (0.46)
Self-explanations	$\bar{X}$ (*SD*)	1.43 (1.72)	0.75 (1.17)	1.29 (1.41)	1.25 (1.17)
Sum	$\bar{X}$ (*SD*)	5.57 (6.13)	3.50 (2.45)	5.64 (5.45)	5.13 (2.75)

3.2.1 Analysis of the High-performance Pairs Compared with Low-performance Pairs

Data of the Pairs condition was divided into two: high-performance group (the upper three pairs) and low-performance group (the lower four pairs) (Figure 1). In order to examine why the high-performance group succeeded in collaborative note-taking, the authors qualitatively analyzed and compared the characteristics of the high-performance group with the low-performance group.

First, the authors focused on the record (selections and internal connections) of the notes. The Note-Takers of the high-performance pairs tended to take their notes in the sentence form unlike those of the low-performance pairs who tended to take their notes in forms of short phrases of words. In particular, the sentence-form description of the high-performance pairs' notes formed an average of 83.6% as compared to an average of 69.5% for the low-performance pairs' notes. The Note-Takers of the high-performance pairs seemed to be aware of their partners and tried to explain the lecture contents to them through note-taking.

Second, the authors focused on the content of external connections made in the notes. The Note-Monitors of the high-performance pairs tended to take their notes by connecting the wide range of their knowledge and experiences to the lecture content unlike those of the low-performance pairs who did not do the same. In particular, the Note-Monitors of the high-performance pairs already seemed to have rich background knowledge and experience and flexible relating skills, since external connections were made not only with academic knowledge (for example, an external connection was made by relating the lecture topic "motivation" to one's own educational knowledge on motivation), but also with familiar things (for example, an external connection was made by relating the lecture topic "affordance" to the architectural design of the experimental room on that day).

4. Discussion and Conclusions

In the present research, the authors designed a collaborative note-taking method and examined experimentally whether it could facilitate external connections. Results showed no significant difference between the Pairs condition and the Singles condition in the number of external connections between lecture material and students' prior knowledge. However, significant difference was seen in their variance values, and hence, the Pairs condition was divided into two: those who succeeded in making external connections through collaborative note-taking (high-performance group) and those who were not successful (low-performance group).

From the above analysis, three approaches for improving the collaborative note-taking method are presented.

i. Facilitating note-taking for selections and internal connections.

This approach includes improving the instructions for the Note-Takers, such as making them aware of their partners by instructing them to take notes in the form of sentences that can be easily understood. Another suggestion includes giving the Note-Takers a minimum lecture outline so that they can take notes more easily without being passive.

ii. Facilitating the content of external connections.

This approach includes expanding the available lecture material on external connections to the Note-Monitors by allowing them to use their own notes taken in past classes, whether related to the present lecture topic or not.

iii. Facilitating relating skills for external connections.

This approach includes improving the viewing of others' external connections during the class. Since several external connections common to different pairs were observed (for example, different participants referred the lecture topic "ADDIE model" to be analogous with the same concept in business plans), there is a possibility that the Note-Monitors would be able to come up with more types of external connections by viewing others' external connections. This implies that expanding collaborative note-taking from pairs to a group of learners (i.e. expanding the note-taking activity for the use of backchannel) would be more effective in making external connections.

In this research, the authors were unable to focus on the issues of the learning effect of the lecture topic itself, and of teachers' involvement in the collaborative note-taking activity. The authors are willing to approach these issues in their future work.

References

[1] Mizokami, S. (2007). Problems associated with the introduction of active learning. Nagoya Journal of Higher Education, 7, 269-287.
[2] Mayer, R. E. (2004). Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. American Psychologist, 59(1), 14-19.
[3] Kiewra, K. A. (1991). Aids to lecture learning. Educational Psychologist, 26 (1), 37-53.
[4] Armbruster, B. B. (2000). Taking notes from lectures. In R. F. Flippo & D. C. Caverly (Eds.), Handbook of college reading and study strategy research (pp. 175-199), NJ: Lawrence Erlbaum Associates.
[5] Barnett, J. E., Di Vesta, F. J. & Rogozinski, J. T. (1981). What is learned in note taking? Journal of Educational Psychology, 73 (2), 181-192.
[6] Kiewra, K. A. (2002). How classroom teachers can help students learn and teach them how to learn. Theory into Practice, 41 (2), 71-80.

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Development and Evaluation of a Presentation Software for Web Programming Language Teaching

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Abstract: In this paper, we developed a presentation software for being used in web programming language course. It has functions to display sample source code of web programming language, edit it, and display its execution result in one slide. The reviews by nine teachers proved its efficiency in programming language teaching. By evaluations, good results were obtained for the functions that enable programming classes to be more interactive between the teacher and his/her students.

Keywords: Presentation Software, Computer Education, Web Programming Language, Development of Software

1. Introduction

1.1 Backgrounds

Presentation software and devices are commonly used. The most popular presentation tool is Microsoft PowerPoint [7]. However, various presentation tools that solve some weaknesses or problems of PowerPoint have been developed and used recently; for example, Tablet PC-based presentation system [1], presentation system with Mind Maps which introduces a spatial organization [5], or a system with index cards that are printed with slide content [8].

In a class of programming language, teachers often show a sample code with presentation tools, and then students work coding. To make students imitate sample code is a popular teaching method. Students do not often understand how the code works or imagine the execution result of the code, if the teacher shows only the code. Because of that, teachers should display the result of the sample code at the same time. However, this method has some problems;

Negative effect of split-attention by changing applications

Generally, teachers change two applications (presentation software and the programming environment tool) to display sample code (with explanation of code) and the results. This method separates the explanatory information from the results of executing codes, which is considered to cause the negative effect of split-attention [2] in students. Owing to this, the teaching method, frequently changing applications is not adequate.

Teacher's effort of preparing lectures

An experiment conducted with dual screen operation reduced the frequency of application change than those with single screen [3]. They tried to reduce the negative effect of the split-attention by using dual screen. They used tools of the popup object that corresponded with explanation and the executing programming steps. However, in that study, teachers have to set the popup object. This may be hard for teachers.

Lack of interactivity in the lecture with screenshots

The other method to reduce the frequency of change on a screen is to display both the sample code and the result in one screen at the same time. However, these screenshot cannot be edited during the lecture. That is to say, modifying the sample code during a presentation is not easy. This is considered to be a barrier for interaction between the teacher and the students in a class.

1.2 Purpose of This Study

In this study, we developed a presentation software with the following features:

Reduction of the negative effect of split-attention

We aimed to reduce the effect of split-attention by displaying both a source code and its results of execution without changing application.

Support the interactivity between the teacher and his/her students

Sample code can be edited even when teachers are operating presentation. This function enables teachers to make lectures more interactive.

Reduction of the effort of preparing lectures

When teachers teach a programming course with presentation software, they have to edit both presentation slides and sample code, to be displayed in different application. This software enables teacher to edit them in one file at the same time.

Reduction of the operation between applications

With this presentation software, teachers can display both the sample code itself and the result of executing it. This function enables teachers to display them without worrying to change application for displaying both.

2. Feature and Function of the Software

2.1 Feature of this software

This presentation tool has an “environment” of editing or executing sample codes in a slide. The result of executing a sample code is displayed in the same screen.

When we make presentation slides, we edit text file with the Wiki-like notation. This notation was previously proposed [6], but now it is expanded with new functions.

An example of the layout of this tool is shown in Figure 1. “Code box” is an area to display or edit sample codes. “Execution box” is an area to display the result of executing the sample code.

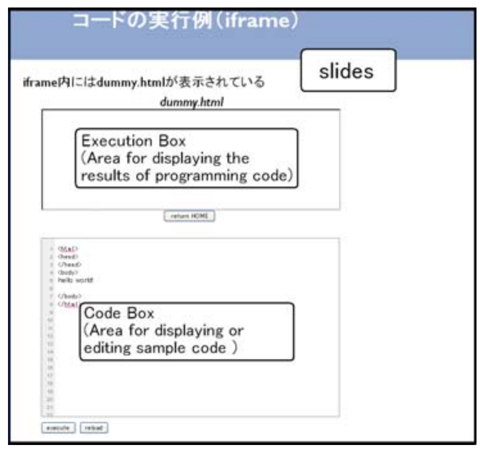

Figure 1: Layout of a slide and components

Users of this software can display in execution box the result of the sample in code box. It is possible to edit this sample code without another application while displaying slides. It is possible to reflect the edited code in execution box with one click.

2.2 Components and functions of this software

Code box

We can display editable text areas using what is called “code box”.

We choose for each code box the what specific programming language to execute when we make presentation file. HTML/CSS/JavaScript are available.

Execution box

“Execution box” is the component which displays the result of executing the codes.

Execution box is made of the “iframe” , one of the HTML element. That is to say, HTML for showing results (HSR) is displayed there.

Executable code is executed and displayed in HSR.

Teachers who use this software have to prepare the HSR files before making slides. In Figure.1, "dummy.html" is displayed in execution box. It is an empty HTML file.

Execution button

Execution button (with the label "execute") is displayed below the code box. When execution button is pressed, an executable code in the code box is executed, and the result is displayed in execution box.

These "execute code function" enable teachers to edit sample codes, and execute them in the same slide.

2.3 Consideration of the functions

Basically, the codes to be executed in this software are not limited, even if they include an unsafe code what is called infinite loop. This is because it is for teaching purpose, and due to the fact that since teachers have enough programming language skills. Besides, it is also for the purpose of teaching the unsafe code to students.

The result of execution "overwrites" results, not "appends" results. This is because in appended mode, students may be confused what code causes the given results. Therefore, we choose the overwritten mode in this software.

3. Software Reviews by Teachers

3.1 Procedure of Experiment

To prove the efficiency of this software, we conducted experiments for review. Subjects were nine people who have experience teaching computer classes in universities. The experiment includes micro teaching session and usability test, with pre/post questionnaire. These procedures are shown in Figure 2.

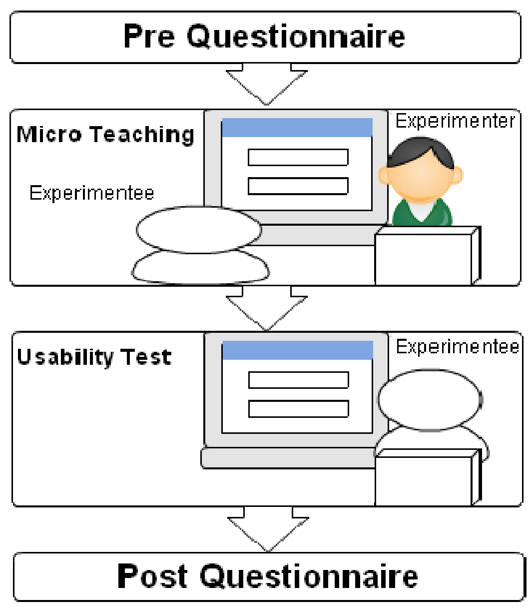

Figure 2: The procedure of an Experiment

Before starting the experiments, an experimenter explained subjects how to use this tool, and let them use it for several minutes. After that, subjects were requested to fill in a pre-questionnaire.

In micro teaching session, the experimenter taught a section of a programming course to a subject. The content of the class was "Introduction to CSS", which includes the grammar of CSS with displaying examples. The experimenter did not display only one sample, but also showed another related sample (for example, examiner replaced class selector of CSS with other one in a sample code) by the function of editing codes.

The course target was university students whose major are not computer science. We chose this content because sample source codes are collaborated with HTML and CSS. Subjects were provided with a paper handout of slides and a pen. They can use a computer with this software that has the same slides as the teacher does. They can watch slides on the computer and try to use this software, for example, type source code and display its execution results.

In usability test, subjects were requested to repeat teacher's operations in micro teaching session with this software.

Later, subjects were requested to fill in a post-questionnaire.

3.2 Results of questionnaire

In the pre-questionnaire, all subjects used presentation tools to show slides and application software to give their lectures. They had to switch the presentation tool and application software to display. The score of the question on whether or not the changing application causes interruption for lecture was 3.67 (SD: 1.05), which has a wide deviation.

Results of post-questionnaire (scored by 5 points: 5 are very good) are shown in Figure 3.

Questions 1-4, related to visual issues, scored low, because of the small size of characters.

Questions 6-8 and 10, those that are related to the main purposes of this paper, scored over 4 points in average. They are appreciable results to evaluate. However, Question 9 did not score high (3.89 in average) compared with other questions. This result is considered to be due to the lack of displaying area. In the case that three or more boxes are included in one slide, to avoid the use of small characters, we deal with the shortage of displaying area by scrolling up and down. Consequently, there is no way but to use scrolling slides in order to deal with this problem.

Free comments on post-questionnaire are shown bellow.

- Display slide without scrolling (5 persons)
- Show error message (3 persons)
- Support other language (2 persons)

3.3 Considerations

Displaying of Slides

In programming lecture, characters in screen tend to be small. This experiment is not an exception, the results related to visual issues in questionnaire, did not score well.

When implementing new functions in screen (execution box in this case), the area to display conventional content (sample code in this case) become inevitably small. To solve this problem, we should use larger, more high-resolution screen or use two or more screens.

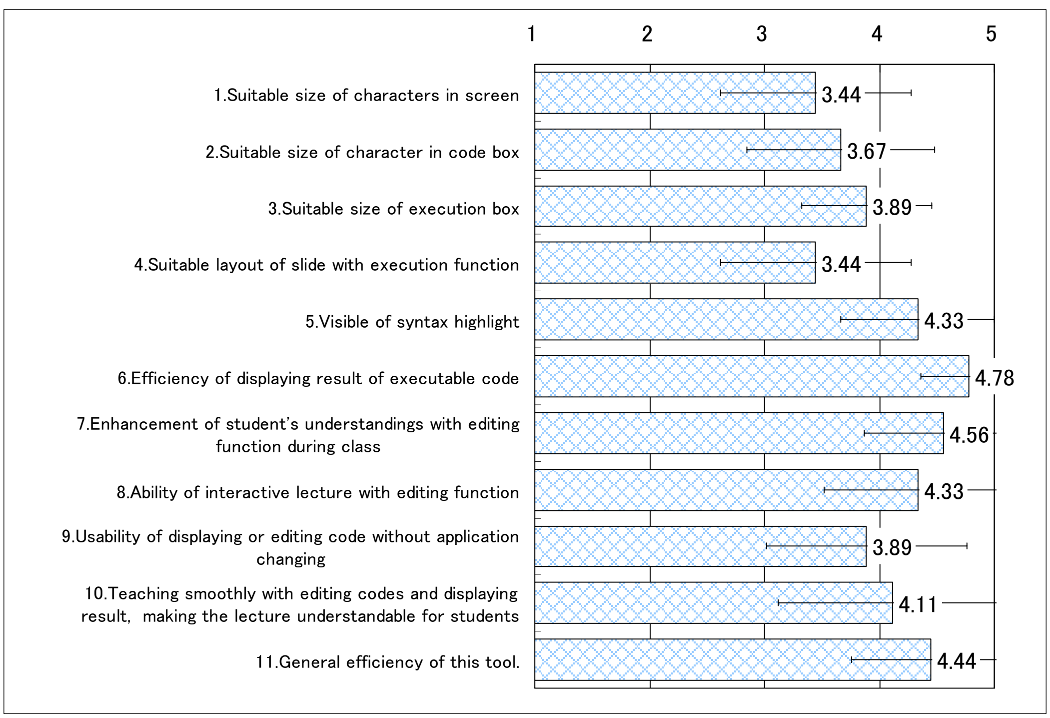

Figure 3 : The result of a post-questionnaire by 5 points (5: very good)

But this is a solution based on hardware. It is difficult to solve it via software.

Functions of Execution and Editing

Because question 10 scored high, teachers evaluated that this software is good for reduction of split-attention. And question 8, related to the teacher-student interactivity, also scored high, so this software is evaluated as an interactive tool between the teacher and his/her students.

Free comments

A problem of scrolling is mentioned before.

Function of displaying error message may be solved by a debug tool. Firebug, that is an add-on of Firefox, is a tool of notifying error of HTML/CSS/JavaScript, et cetera [4]. But at present, it appears unclear messages with this software, so some modifications are required.

To support other languages, we may use “ideone API”. It is an online compiler and debugging tool which allows to compile and run code online in more than 40 programming languages[9] . These results are able to be displayed in web page.

4. Conclusion and future study

4.1 Conclusion

We developed a presentation software for being used in web programming language courses. It contains the function to display sample codes of web programming language, editing these codes, and display the executed results of these codes.

According to teachers’ review, this tool is efficient for interactive lectures between teachers and students. However, scrolling slides derived from the shortage of displaying area did not evaluate good.

4.2 Future study

Evaluate the impact of students’ split-attention

Though this software has been evaluated by teachers, evaluation from the point of view of students is not enough. It remains unclear whether or not this software reduce the students’ split-attention. We plan to assess those on an experimental lecture.

Implementation of the additional function

This web application has also the potential to work on the net. With web server, students will be able to post the code to be checked by teacher.

This software is based on the presentation software of the same authors [6]. That is why it is easy to adopt multi-screen environment.

References

[1] Anderson, R., Anderson, R., Simon B., Wolfman, S. A., VanDeGrift, T. & Yasuhara, K. (2004). Experiences with a tablet PC based lecture presentation system in computer science courses. *Proc. of CSE ’04* (pp.56-60): ACM Press.

[2] Ayres, P., & Sweller, J. (2005). The Split-Attention Principle in Multimedia Learning. *The Cambridge Handbook of Multimedia Learning*, 135-146, Cambridge University Press.

[3] Chang, Y., Chang, T., Hsu, J. & Yu, P. (2009).The Impact of Split-Attention Effect on Dual-Screen Learning Environment for Programming Language Instruction. *Proc. of ED-MEDIA 2009* (pp.2110-2115). Honolulu, Hawaii: AACE.

[4] Hewitt, J. Firebug. http://getfirebug.com/, (Referred on May 2, 2010)

[5] Holman, D., Stojadinović, P., Karrer, T. & Borchers, J., (2008). Fly: an organic presentation tool. *In extended abstract of CHI ’06: Conference on Human Factors in Computing Systems* (pp.863-868). Montreal, Quebec: ACM Press.

[6] Kaminishi, H. & Murota, M.(2009). Development of Muti-Screen Presentation Software. *Proc. of ED-MEDIA 2009* (pp.3934-3939). Honolulu, Hawaii: AACE.

[7] Levasseur, D. G.., & Sawyer, K. J. (2006). Pedagogy Meets PowerPoint: A Research Review of the Effects of Computer-Generated Slides in the Classroom. *The Review of Communication* 6, 1-2, (pp.101-103).

[8] Nelson, L., Ichimura, S., Pedersen, E. R. & Adams, L. (1999). Pelette : A Paper Interface for Giving Presentations. *Proc. of the CHI 99 Conference on Human Factors in Computing Systems*, ACM Press, (pp.354-361).

[9] Sphere Research Labs, ideone.com, http://ideone.com/, (Referred on May 2, 2010)

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Tracking Classroom Activities in Mobile Technology-Mediated Lessons

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Abstract: In this paper, we report on the findings with regard to classroom activities and their time use in a number of mobile technology-mediated classrooms at Hong Kong. The data was collected from a mobile learning project specifically designed to promote students' group and independent learning across a range of subject disciplines through using mobile devices within school environment. A total of 30 lessons in 10 primary and secondary schools were videotaped and analyzed. Results indicate that mobile devices can support establishing a well-balanced structure of classroom activities controlled by both teachers and students, where about 40% of the total class time was allocated to direct teaching and 40% was assigned to students' learning in independent and/or collaborative ways.

Keywords: Mobile technology, School Education, Independent Learning, Group Learning

1. Introduction

Recent advances in mobile devices and technologies have expanded the boundaries and pedagogies of traditional learning [1, 2]. Innovative learning experiences that can take place beyond school settings have emerged, such as informal learning with a mobile museum guide [3] or for environmental awareness [4], experiential learning on a field trip [5, 6], situated and active learning with mobile game [7]. These out-of-class learning experiences can bring opportunities to supplement students' learning in the formal school curriculum. It is still not well known, however, whether mobile technologies can be effectively applied to teaching and learning activities within school settings. To date, research that addresses this issue across a range of subjects in a systematic way is still limited [2].

During classes, apart from direct teaching activity, school teachers may consider to provide students with opportunities to learn individually and in small groups. Based on cognitive constructivism [8], individual students are believed to learn better if they are engaged in active construction of knowledge rather than passive reception from teachers. This perspective provides ground for teachers to promote independent learning activity among students. On the other hand, with its root in social constructivism which emphasizes communication and interaction among students for collaborative knowledge construction [9], group learning activity is recognized as another means of fostering students' learning.

Drawing on the theory of mobile learning advocated by Sharples and his colleagues [10], two critical issues are particularly relevant to the analysis of classroom activities supported by mobile technologies. They include: 1) the control issue which focuses on the level of student control over learning process; and 2) the communication issue which refers to the level of interaction between peers and between teachers and students. In this article, therefore, we focused on examining whether or not mobile devices help attaining a reasonable level in both issues by analyzing the time spent on different kinds of teaching and learning activities in classroom. The results of our study can be applied to inform the effective design of classroom activities with mobile devices for teaching and learning formal curriculum.

2. The Study

There were five primary schools and five secondary schools joined this research project. A representative teacher from each participating school was nominated to participate in the study (6 males and 4 females). The primary school teachers were specialized in teaching Mathematics, General Studies, Chinese, English, Computer and Physical Education, while the secondary school teachers were specialized in teaching Visual Arts, Biology, Integrated Science, Liberal Studies and Computer Studies. In addition, the former had teaching experience varying from 3.5 years to 14 years, while the latter's experience ranged from 3 to 22 years. On the other hand, a total of 278 students participated in the study (163 from primary schools and 115 from secondary schools). The primary school students aged between 8 to 12 years and studied from Primary 4 to Primary 6, while the secondary school students aged between 14 to 18 years and studied from Secondary 3 to Secondary 6. Most participants reported little knowledge of using mobile devices in school education.

Prior to the study, the 10 participating schools were equipped with a wireless classroom management system, namely Infinity Mobile Control (IMC), where teachers can control any mobile devices and broadcast information to them within a Wi-Fi enabled school environment. The schools also purchased a sufficient number of mobile devices like UMPC, Tablet PC or Pocket PC for teaching and learning purposes. During the study, at first, the teacher participants were given training on how to use the mobile devices and operate the IMC system. Second, they were asked to design a lesson plan on using mobile devices to teach two self-chosen subject topics for three consecutive lessons. Finally, a total of 30 corresponding lessons were videotaped and the videos were analyzed with a focus on the control and communication issues.

3. Results and Discussion

3.1 Teaching activities

Teaching activities were divided into two subcategories: teacher-led direction instruction and teacher-led interactive instruction. Table 1 shows that the distribution ratio of the class time spent on teaching activities for the two subcategories was about 1:1. With reference to the teacher-led direct instruction, lecturing (introduction, illustration, revision and/or summary) was the most commonly used way of delivering subject curriculum, and it accounted for nearly 20% of the whole class time. Hence, even though mobile devices were distributed to students, teachers could still maintain their control in a reasonable level.

Regarding the teacher-led interactive instruction, most teachers broadcast student artifacts to mobile devices for initiating and promoting class discussion, which accounted for over 10% of the whole class time. Within this context, mobile device could be viewed as a collaborative whiteboard, and it was advantageous to enhance the communication between peers and between teachers and students in two ways: a) by offering a platform for individual students to share their artifacts with the whole class; and b) by stimulating peer and teacher feedback and discussion about the artifacts displayed on the mobile devices.

Table 1. The distribution ratio of time use for teaching activities

Activity type		**Detailed Activity**	**Time (mins)**	**Percentage**		
				Individual	**Subtotal**	**Total**
Teaching time	Teacher-led direct instruction	Lecturing (introduction, illustration, revision and/or summary)	355	19.8%	22.2%	42.4%
		Playing multimedia resources	20	1.1%		
		Broadcasting student artifacts to mobile devices (without discussion between teacher and students)	17	1.0%		
		Checking answers (without discussion between teachers and students)	7	0.4%		
	Teacher-led interactive instruction	Broadcasting student artifacts to mobile devices (with discussion between teacher and students)	193	10.8%	20.2%	
		Asking questions	75	4.2%		
		Discussing with students	48	2.7%		
		Choosing students to report answers	28	1.6%		
		Checking answers (with discussion between teacher and students)	19	1.1%		

3.2 Student activities

The time allocation for student activities was approximately equivalent to that for teaching activities, which accounted for about 43% of the whole class time (see Table 2). On the basis of the number of students involved, student activities could be divided into “group learning” and “independent learning”. Through group learning activities, students may learn better with the assistance of other group members, resulting in an improvement over their social awareness and communication skills. Through independent learning activities, on the other hand, individual students may be engaged to study autonomously and subsequently develop their own learning strategies for acquiring knowledge and solving problems.

However, independent learning approach requires individuals to be capable of managing their own learning process, so it may not be feasible for an average class containing a number of low-ability students. Teachers tended to believe that primary and secondary students perform better through group learning than by learning alone, bringing the class time use with group learning to almost three times as much as that with independent learning, as shown in Table 2.

3.3 Non-teaching activities

Table 3 indicates that only a small proportion of total class time (15%) was spent on non-teaching activities (see Table 3). Among the non-teaching activities, the distribution of mobile devices or learning resources was a necessary job at the beginning of a lesson. As expected, this kind of job was not a big concern for teachers and it merely imposed a very low overhead (less than 6%) on class time. What teachers really worried about using mobile devices in class may be the large overhead on solving technical problems caused by the mobile technology, which could seriously affect the normal teaching and learning progress. Surprisingly, no more than 2% of the total time was spent on solving technical problems.

Our result challenges the argument against using mobile devices within school environment because of their significant influence on slowing down the normal teaching and learning paces.

Table 2. The distribution ratio of time use for student activities

Activity type		Detailed Activity	Time (mins)	Percentage		
				Individual	Subtotal	Total
Student activity time	Group learning	Discussing with peers based on accessing the preloaded resources in mobile devices, and/or completing worksheet	366	20.4%	31.3%	42.6%
		Discussing with peers based on accessing the Internet resources, and/or completing worksheet	125	7.0%		
		Discussing with peers based on the resources searched by their own using mobile devices, and/or completing worksheet	36	2.0%		
		Completing worksheet (without surfing the Internet/Intranet or using mobile devices)	27	1.5%		
		Discussing with peers based on accessing the Intranet resources, and/or completing worksheet	8	0.5%		
	Independent learning	Completing worksheet based on accessing the preloaded learning resources in mobile devices	164	9.1%	11.3%	
		Completing worksheet based on accessing the Internet resources	26	1.5%		
		Completing worksheet based on accessing the Intranet resources	8	0. 5%		
		Completing worksheet (without surfing the Internet/Intranet or using mobile devices)	5	0. 3%		
		Completing worksheet based on the resources searched by their own using mobile devices	0	0.0%		

Table 3. The distribution ratio of time use for non-teaching activities

Activity type	Detailed Activity	Time (mins)	Percentage	
			Individual	Total
Non-teaching time	Entering classroom	93	5.2%	15.0%
	Distributing mobile devices to students	76	4.2%	
	Distributing learning resources to students	29	1.6%	
	Solving technical problems	31	1.7%	
	Taking pre- and post-tests	40	2.2%	

3.4 Overall structure of classroom activities

As seen in Table 4, the distribution ratio of the total class time for teaching activities, student activities and non-teaching activities was about 4:4:2. The fairly even distribution of teaching and student activities shows that the class time use for teacher-led instruction was almost the same as that for student activities, implying that both teachers and students took an equally active role in exercising control over the learning process. The mobile devices gave impetus to change in the traditional teacher-centered pedagogy where the learning process is solely controlled by teachers. In the mobile technology-mediated classes, teachers no longer dominated the class time for direct instruction. Instead, they provided students with more opportunities to participate in various independent and group activities with mobile devices. Moreover, the result also indicates that using mobile devices to support in-class teaching and learning was a feasible approach because it did not lead to a high percentage of time spending on non-teaching activities (e.g., distributing mobile devices to students and solving their technical problems).

Table 4. The distribution ratio of time use for different types of classroom activities

Activity type		Time use (mins)	Percentage		
			Individual	**Subtotal**	**Total**
Teaching time	Teacher-led direct instruction	399	22.22%	42.43%	100%
	Teacher-led interactive instruction	363	20.21%		
Student activity time	Group learning	562	31.29%	42.59%	
	Independent learning	203	11.30%		
Non-teaching time		269	14.98%		

4. Concluding Remarks

This study provided analyses of classroom activities from 30 mobile-technology mediated lessons in 10 primary and secondary schools at Hong Kong. Drawing on the theory of mobile learning theory [10], this study focused on the control and communication issues associated with using mobile devices in class that could impact students' learning. Our results show that mobile devices could support establishing a well-balanced structure of classroom activities in terms of control and communication, where the distribution ratio of the total class time for direct teaching, group learning and independent learning was 4:3:1.

References

[1] Soloway, E., Norris, C., Blumenfeld, P., Fishman, B. J., & Marx, R. (2001). Devices are ready-at-hand. *Communications of the ACM*, *44*(6), 15-20.

[2] Frohberg, D., Göth, C., & Schwabe, G. (2009). Mobile Learning projects – a critical analysis of the state of the art. *Journal of Computer Assisted Learning*, *25*(4), 307-331.

[3] Sung, Y.-T., Chang, K.-E., Lee, Y.-H., & Yu, W.-C. (2008). Effects of a Mobile Electronic Guidebook on Visitors' Attention and Visiting Behaviors. *Educational Technology & Society*, *11*(2), 67-80.

[4] Uzunboylu, H., Cavus, N., & Ercaq, E. (2009). Using Mobile Learning to Increase Environmental Awareness. *Computers & Education*, *52*(2), 381-389.

[5] Lai, C.-H., Yang, J.-C., Chen, F.-C., Ho, C.-W., & Chan, T.-W. (2007). Affordances of mobile technologies for experiential learning: The interplay of technology and pedagogical practices. *Journal of Computer Assisted Learning*, *23*(4), 326-337.

[6] Huang, Y.-M., Lin, Y.-T., & Cheng, S.-C. (2010). Effectiveness of a Mobile Plant Learning System in a Science Curriculum in Taiwanese Elementary Education. *Computers & Education*, *54*(1), 47-58.

[7] Akkerman, S., Admiraal, W., & Huizenga, J. (2009). Storification in History Education: A Mobile Game in and about Medieval Amsterdam. *Computers & Education*, *52*(2), 449-459.

[8] Piaget, J. (1971). *Genetic epistemology*. New York: W.W. Norton.

[9] Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

[10] Sharples, M., Taylor, J., & Vavoula, G. (2007). A theory of learning for the mobile age. In R. Andrews, & C. Haythornthwaite (Eds.), The Sage handbook of elearning research (pp. 221–247). London: Sage.

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Can one-to-one computing help children learn cooperatively?

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Abstract: This paper proposes and examines a design of technological scaffolding for cooperative learning. An application for learning fractions with handheld devices was designed and tested in a primary three classroom. The outcomes were interpreted according to a two-dimensional framework consisting of the cooperative learning principles (maximum peer interaction, equal opportunity to participate, individual accountability and positive interdependence) and the observed interplay of social, technological and teacher scaffolding which emerged throughout the activity. The focus of our analysis is the technological scaffolding and the support it can give to cooperative learning activities based on the feedback received from two sources: primary school children using the software and a group of teachers trying out and reflecting on our design.

Keywords: Mobile learning, Fractions learning, Cooperative learning, One-to-one computing

1. Introduction

In our three-year study on mobile learning, we have been working on both the design of new technological solutions and the application of new pedagogies in learning [5]. To empower our students with the 21st century learning skill set, we have designed a solution for cooperative learning in which students cooperate around the mathematical concept of fractions. Even though the activity includes forming full circles out of single pre-assigned fractions, it is not only mathematics students have to master. They have to engage in exchange, negotiation, peer instruction, and other forms of communication and mutual meaning making in order to complete the task.

In addition to teacher and social scaffolding, our platform provides the students with technological scaffolding. In this paper, we evaluate our platform against the well-known principles of cooperative learning, namely, maximum peer interaction, equal opportunity to participate, individual accountability and positive interdependence. Although there are no strict boundaries between the three-level scaffolding (teachers, social and technological), in this paper we discuss whether and how our technological design has promoted these cooperative learning principles. To get both practical and unbiased insights into the system, we designed both in-class activities for the primary school students and presented it to the teachers taking a course on cooperative learning.

2. One-to-one Computing for Cooperative Learning

Cooperative learning is much more than competition and individualistic learning although it does encompass some of these. The main difference is that in cooperative learning students must learn how to “sink or swim together”. Building on a vast amount of research body, cooperative learning is based on eight main elements (or principles): heterogeneous grouping, collaborative skills, group autonomy, maximum peer interaction, equal opportunity to participate, individual accountability, positive interdependence and cooperation as value [2].

Early research in computer supported cooperative learning (CSCL) tends to foreground the role of computers as the focus of attention. Typically, each student uses a fixed-location glued-to-the-desk computer as the tool for group work. Both the focus on the tool and the lack of cooperation lead to some skepticism in initial CSCL making it clear that social interaction does not simply happen with a computer-based environment, thus emphasizing social and psychological dimension of the desired social interaction [3]. In advocating their approach to future classrooms organized around WILD (Wireless Internet Learning Devices), Roschelle and Pea [8] argue that CSCL should leverage on application-level affordances such as augmenting physical spaces, leveraging topological spaces, aggregating coherently across all students as well as on the physical affordances of mobile devices. Some research studies have shown that the use of mobile devices in classrooms could significantly impact student collaboration [9]. Students leverage on their own mobility and the mobility of the devices in order to coordinate cooperation and to exchange information simultaneously over the wirelessly connected devices [4, 7].

3. Designing for Cooperative Learning: The Form-A-One (FAO) System

In order to support cooperative learning activities, the Form-A-One (FAO) technological scaffolding for cooperative learning was designed and used to support learning fractions. Each student is initially assigned a single fraction (circle sector) (see Figure 1) and has to identify peers with complementary fractions (with respect to getting a sum of 1) and then invite them to form groups (see Figure 2). The main goal of the assignment for each emerging group is to form a full circle (a whole) by combining circle sectors (graphical representations of fractions).

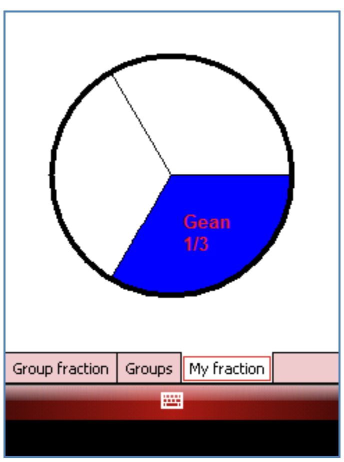

Figure 1. A fraction assigned and displayed on a student's mobile device

Figure 2. Student issuing a group invitation to his classmate

The proposed design was evaluated through a series of trials with Primary 3 children roughly aged 8-9, from a mixed ability class in a neighborhood school in Singapore. Each trial involves 8 and 16 students. In the first trial, we introduce students to the software and the "ways of doing the collaboration". Students had some prior experience in using different mobile learning tools and needed just a brief overview of the FAO software.

Through the conducted trials several sources of collaborative scaffolding were identified: technological, teacher and social scaffolding. All the three components are the sources for collaborative rules which structure student participation in the activity both in the sense of social interactions and task completion [1]. Technological scaffolding provides technology-embedded structures or rules for sending and receiving messages through the handhelds. It relies on a specific rule structure and their interconnection. It is triggered via the user interfaces transmitting the messages. Social scaffolding, on the other hand, builds on top of collaborative rules predefined by the teacher but draws from the emergent collaborative practices such as peer instruction, sharing through discourse, and mediation. The teacher scaffolding provides contextual assistance supplementing both technological and social scaffolding but mainly builds on top of the existing individual and collective group competence.

4. Examining FAO as the Technological Scaffolding for Cooperative Learning

4.1 *Proposing a Framework*

Our socio-technical design revolves around and is influenced by the three levels of scaffolding: technological, teacher and social scaffolding [6]. In analysing cooperative learning practices we limit ourselves to the four main cooperative learning principles: positive interdependence, maximum peer interaction, equal opportunity to participate and individual accountability. The focus of our attention is the technological scaffolding and the opportunities is brings (or can potentially bring) to cooperative learning by strengthening the four cooperative learning principles. Although we are primarily interested in the affordances of technologies driving cooperative learning, we do not neglect the effects of both social and teacher scaffoldings driving the technology supported cooperative activities (Figure 3).

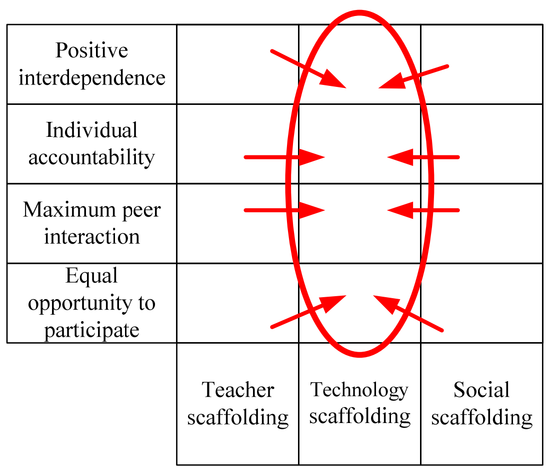

Figure 3. A Framework for Examining Scaffolding in Cooperative Learning

Our examination encompasses trials conducted with primary three children using the FAO system and teachers taking a master course in cooperative learning examining the affordances of the technology through the cooperative learning lenses. From the collected video, audio recordings and software logs, we make conclusions about whether and how the FAO technological scaffolding drives the cooperative activity. On the other hand, the master teacher’s perspective provides us with the practical advice on how to strengthen the cooperation.

4.2 The Affordances of the Technological Scaffolding Identified Through the Trial Runs

In the FAO activity we examine students cooperating around a concept of fractions which are generated by the system in the beginning of the activity. The system is able to determine how many students hold the device and which of them have decided to participate in activity and accordingly generates and disseminates fractions to them. The algorithm ensures that there is at least one global solution possible. This means the system has to ensure the generated fractions can be combined into at least one final configuration of groups of students in which every student belongs to a group and every group completes has reached its local solution (formed the full circle with their members' fractions). Equal opportunity to participate does not come only from the technological scaffolding. By setting activity parameters through the technological network, the interplay of social and teacher scaffolding can be fine-tuned. For example, the teacher might decide to generate "easier" fractions or distribute "more difficult" fractions to some students.

The technological scaffolding took the role of facilitator in overcoming students' impasses. For example, the students were surprised by the system message warning them they are not allow to form a group of just two members (e.g. students with 2/3 and 1/2). To get out of this situation, they had to question or relook at their strategy of merging any two students and looking for the third member to complete the group. In contrast to overcoming personal preferences in achieving both individual and group goals, some students built on their personal relationships and spontaneously offered help to their colleagues. After a group of two girls was created based on personal preferences, they together decided one of them should accept a new group invitation. After their group was dismantled, the girl left alone was offered some help in identifying her new mates.

4.3 Teachers' Point of View

In order to determine the suitability of FAO for cooperative learning, we presented it to in-service K-12 teachers taking a part-time Master course in cooperative learning in the National Institute of Education, Singapore. There were 33 teachers teaching variety of courses, divided into 6 groups, generally comfortable with using the technology. They were required to go through two trial runs of the FAO activity and comment on its suitability for cooperative learning related to the principles of cooperative learning.

The session was split into three main parts: initial exploration, experiencing the system, and evaluating and reflecting on the experiences. The teachers thought maximum peer interaction during the session was encouraged on the quantitative side since all teachers were able to find partners to group up. The system provided enough redundancy and options for the participants to choose appropriate peers. As a means of promoting maximum peer interaction, the introduction of time limit into the activity was proposed. Therefore, the participants would be required to complete the activity in a specific period of time and would be motivated to help each another. In order not to become too passive by receiving instructions from other and just behaving passively according to their instructions, some cooperative skills could be used. For example, when inviting other teachers into their groups, they might be requested to state a clear explanation why they want to invite a student into a group.

The FAO activity scored well in the terms of promoting individual accountability and equal opportunity to participate according to the teacher evaluation. The teachers noted that every participant has to participate and therefore do his or her share of work for the activity to end. If only one participant is left without a group, the activity cannot end for all other participants because the global goal of the game is not fulfilled.

5. Conclusion

This paper presented a FAO technological and activity design for learning fractions with handheld computers. Throughout several trials of the system, students were cooperating in order to complete both their local goals of forming wholes out of single fractions and their global goal of having all groups completed the local goal. The system was analysed in two ways: by having primary three students using it and by discussing its affordances with the teachers interested in cooperative learning. In order to perform the analysis we adopted a two dimensional framework with three-component scaffolding on one level and main cooperative learning principles on the other.

In order to strengthen maximum peer interaction, the system should be upgraded with the “invite with reasons” option requiring students to justify their cooperative decisions. Introducing new cooperative “sponge activities” and a point-based reward activity mechanism might create better positive peer interdependence throughout the activity.

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References

[1] Boticki, I., Looi, C.-K., & Wong, L.-H. (2010). Doing collaboration and learning fractions with mobile devices *Proceedings of 14th Global Chinese Conference on Computers in Education*. Singapore.

[2] Johnson, R., & Johnson, D. (1994). An overview of cooperative learning. In R. V. A. N. J. Thousand (Ed.), *Creativity and Collaborative Learning: A Practical Guide to Empowering Students and Teachers* (pp. 31-43). Baltimore, MD: Paul H. Brookes.

[3] Kreijns, K. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research. *Computers in Human Behavior, 19*(3), 335-353.

[4] Kreijns, K., Kirschner, P., & Jochems, W. (2002). The sociability of computer-supported collaborative learning environments. *Educational Technology & Society, 5*(1), 8-25.

[5] Looi, C.-K., Seow, P., Zhang, B., So, H.-J., Chen, W., & Wong, L.-H. (2010). Leveraging mobile technology for sustainable seamless learning. *British Journal of Educational Technology, 42*(1), 154-169.

[6] Looi, C. K., & Boticki, I. “What fraction will make me whole”: Supporting Mobile Collaborative Learning Activities. *Educational Technology & Society, (under review).*

[7] Nussbaum, M., Alvarez, C., McFarlane, A., Gomez, F., Claro, S., & Radovic, D. (2009). Technology as small group face-to-face Collaborative Scaffolding. *Comput. Educ., 52*(1), 147-153.

[8] Roschelle, J., & Pea, R. (2002). A walk on the WILD side: How wireless handhelds may change computer-supported collaborative learning. *International Journal of Cognition and Technology, 1*(1), 145-168.

[9] Tseng, J. C. R., Hwang, G.-J., & Chan, Y. (2005). *Improving learning efficiency for engineering courses in mobile learning environments*. Paper presented at the x. Retrieved from http://www.wseas.us/e-library/conferences/2005athens/ee/papers/507-124.pdf

[10] Zurita, G., & Nussbaum, M. (2004). Computer supported collaborative learning using wirelessly interconnected handheld computers. *Computers & Education, 42*(3), 289-314.

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Assessment of Student Outcomes of Mobile Game-Based Learning

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Abstract: In this paper, we investigate the effect of the mobile game-based social studies curriculum Statecraft X on the quality of student work. This curriculum involved 34 secondary three students using a mobile game played on Apple iPhones— *Statecraft X*—to engage in governorship practices in the game world of Velar. As part of the Play-between-World curriculum, students also construct their ideal practices of governance in the fictional world of Bellalonia through in-class and outside the classroom activities. The control group of 39 students underwent the regular curriculum in the school for the same duration. Students in the intervention group had significantly higher scores for the assessment criteria of relevance, perspective, and personal voice in a writing task than those in the control group.
Keywords: Mobile game, assessment, game-based learning, social studies, perspective, voice, relevance

Introduction

With the proliferation of handheld devices, mobile learning is an emerging field which is rapidly expanding in educational research across schools as handheld devices offer myriad opportunities for mobile learning [10], [14], [16], [17],[18]. Mobile learning is defined as any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of learning opportunities offered by mobile technologies [14]. There are motivational benefits inside and outside the classroom, as well as high levels of engagement [11], [13]. The convergence of games and mobile devices is also becoming a topic of interest in the educational field [3]. With the advent of wireless networks, students can experience new ways of learning through games outside the classroom [4], [7], [19], [20].

Previous work have discussed issues involved in evaluating the observable aspects of learning or game play in mobile devices such as cooperation and competition [6]. This paper attempts to assess the quality of student work arising from a mobile game-based curriculum. Our present study investigates the quality of student work in terms of relevance, perspective, and personal voice in students' essays after they have participated in a mobile game-based curriculum where students learn principles of governance through playing a mobile game *Statecraft X*.

Several studies have suggested the importance of argumentation in science education [1], [19], perspective [2], [5], and personal voice [6], [9]. However, to our knowledge, there is a gap in the assessment of the above three criteria in student work in a mobile game-based social studies curriculum. Thus, we address the following research in this paper: Is there an effect of a mobile game-based curriculum on the quality of student work in terms of relevance, perspective, and personal voice?

1. Method

1.1 Subjects

Thirty-four students (14 boys and 20 girls), aged 15 on average, participated in our study. Thirty-eight students (27 boys and 11 girls), also aged 15 on average, participated as control students. Three social studies teachers participated in our study: two taught the intervention group and one taught the control group.

1.2 Materials

Apple iPhones with the installed *Statecraft X* game were loaned to all students who took part in the Statecraft X curriculum for the duration of the research intervention. *Statecraft X* was designed based on the following principles of governance in the Social Studies curriculum for secondary three students.

Teams competed against one another in this multiplayer strategy game to rule the fantasy kingdom of Velar populated by humans, dwarfs, elves, and trolls. At the beginning of the game, the previous ruler of Velar passed away without leaving an heir, thus setting up the stage for different student governor-led political factions to compete for leadership of the kingdom. The first game objective is that all the teams must collaborate to ensure that their kingdom, Velar, survives in the face of attackers from other kingdoms. Second, individual teams must consolidate their power and position by winning the trust of the people in their own towns and also the people in the towns of other teams. This game aims to allow students to think as governors. To realise these two objectives, faction members must realise short-terms goals such as developing towns under their control, diffusing internal and external threats as well as maintaining diplomatic ties with internal factions.

In addition to the game world of Velar, students were also given materials from the fictional world of Bellalonia. In the classroom, students were situated in Bellalonia. During the first lesson, students were given their final assignment where they, as fictional governors, had to solve problems in Bellalonia. Bellalonia was formed a hundred years ago and was populated by the ethnic group of Solians. Fifty years later, another ethnic group, the Milous, immigrated in search of a better life. The Milous were very hardworking and prospered in Bellalonia. The Solians were unhappy because they felt that they were entitled to the riches arising from the land and thus many Solians emigrated. With the death of the old king, the Grand Sage of Bellalonia had to choose governors in Bellalonia to form a council to help the young king. The sage sent them to the game world of Velar to practise governance.

A web-portal was also set up to provide a space for students to be informed of events happening both in the game world of Velar and the fictional world of Bellalonia. Additional materials from the real world were also provided to help students consider experiences from real world countries. The above materials were tied to the Play-between-Worlds curriculum model. Students learn by "moving" from one world to another, and also by reflecting on their experience in the three worlds: game, fictional, and real.

1.3 Procedure

Prior to the research intervention, all teachers participated in a two-day professional development workshop that was designed to prepare them for the enactment of the *Statecraft X* curriculum. They were given the *Statecraft X* game to play and were shown the *Statecraft X* curriculum. They gave feedback on the lesson plans designed and worked with the research team to finalize the in-class and outside-classroom activities.

The class was divided into two groups for game play as well as whole class discussions. Each teacher was in charge of one group. During the first of six lessons, the teacher explained to the students the Play-between-Worlds curriculum model using the powerpoint slides provided by the research team. She also explained the history of Bellalonia and her current problems. Then, the game designer of *Statecraft X* game also presented the backstory of the game world of Velar, showed students the various actions that they could take in the game, and distributed iPhones to participating students.
During the next four lessons, for the first thirty minutes of the lesson, students responded to questions related to Velar, Bellalonia, and the real world. In the last thirty minutes, the teacher gathered students in a circle and discussed their responses to these questions. During the final lesson, five students from each group presented a speech in front of their groups. The day after the final lesson, the first and third authors administered a 30-minute writing task to both intervention and control groups with these instructions:

Imagine that you are running for an election to be a member of parliament and that you have to formulate policies to convince the citizens of your country that you are the best candidate. Justify your proposed policies by using examples from what you have learnt, what you have read, and your personal experiences.

1.4 Data Analysis

The first and third authors assessed the three criteria: (1) relevance, (2) perspective, and (3) personal voice in the written student work of both intervention and control groups. Relevance refers to how relevant the policies proposed by a student are to the social and economic needs of the different segments of the country's population and whether this student has given examples from both traditional and non-traditional sources to support his or her proposed policies. Perspective refers to whether a student could give multiple perspectives to the proposed policies and integrate them or whether he could only give the textbook perspective. Personal voice refers to the voice used by a student and whether it matched the situation, how authentic the voice was, whether opinions were well-defined and detailed, whether she communicated strong feelings and honest statements, and whether she showed that she cared about the topic.
The first and third authors assessed each essay separately and awarded a mark for each criterion. They both hold graduate degrees and have at least eight years of teaching experience in Singapore schools, and are part of the *Statecraft X* research team. After having assessed all essays separately, they came together to moderate the marks for each criterion in each essay. They resolved all differences by re-examining the essay and defending the mark that they gave. Thus, the mark for each criterion for each essay is a moderated mark.
A one-way ANOVA was used to compare differences in the means of each criterion between the intervention and control groups. The percentage of exact and adjacent agreement between the two raters was also calculated. For most agencies and educational studies, agreement also requires ratings to be at least adjacent [8]. One study suggests that when scores differ between two raters, discussion as a core resolution method is the best method compared to the averaging of two scores [8].

2. Results

The exact and adjacent agreement rates between the two raters were 93%, 97%, and 95% for relevance of content, perspective, and personal voice respectively. Table 1 summarises the results of the study for the variables relevance, perspective, and voice. The means of all the variables are two times higher in the intervention group compared to the control group.

Table 1 – Summary of Means, Standard Deviations, 95% Confidence Intervals for Scores on Relevance, Perspective, and Voice in Intervention and Control Groups

	Intervention (n = 34)				Control (n =38)			
			95%CI				95%CI	
Variable	M	SD	LL	UP	M	SD	LL	UP
Relevance	12.09	2.82	11.00	13.07	4.38	3.38	3.29	5.48
Perspective	12.32	2.20	11.56	13.09	4.44	3.38	3.34	5.53
Voice	14.00	2.98	12.96	15.04	6.46	4.94	4.86	8.06

Note. M = mean; SD = standard deviation; CI = confidence interval; LL = lower limit; UL = upper limit.

A further analysis of the data revealed that the mean differences between intervention and control groups in relevance, perspective, and voice were highly significant at $p < 0.001$ (see Table 1). Thus, the quality of students' essays in the intervention group was significantly higher with respect to each criterion of assessment: relevance, perspective, and voice. The effect sizes of the variables of relevance, perspective, and voice were also very large at 0.598, 0.661, and 0.431 respectively. Thus, the differences between students in the intervention and control groups were significantly large.

Table 2 – Summary of the ANOVA Analysis between Intervention and Control Groups.

Variable		Sum of Squares	*df*	Mean Square	*F*	*p*	η^2	Power
Relevance	Between Groups	1077.98	1	1077.98	101.12	< 0.001	0.598	1.000
	Within Groups	695.97	71	9.80				
	Total	1773.95	72					
Perspective	Between Groups	1130.09	1	1130.09	132.78	< 0.001	0.661	1.000
	Within Groups	593.03	71	8.35				
	Total	1723.12	72					
Voice	Between Groups	1032.25	1	1032.25	51.43	< 0.001	0.431	1.000
	Within Groups	1219.69	1	17.18				
	Total	2251.95	72					

Note. *df* = degree of freedom; η^2 = eta squared or effect size.

3. Discussion and Conclusion

In the *Statecraft X* curriculum, students were engaged in governor practices while playing the game in the game world of Velar and role-playing as governors in the fictional world of Bellalonia. As a result, students were able to incorporate practices of a governor in their daily lives during the duration of the intervention. They were able to discuss their governor practices in and outside of the classroom. All these have contributed to higher scores in personal voice. Adopting the identity of a governor in both game and fictional worlds has also given students the perspective of a governor in addition to that of a citizen rather than solely that of the textbook. This has led to higher scores in perspective compared to students in the control group. Their experience as a governor in the game and fictional worlds has also contributed to the relevance of the policies that students could generate. However, a major limitation of the study is that the students in the control group did not use the materials for the fictional world of Bellalonia in the classroom. Thus, in future interventions, there should be an additional control group which experiences such in-class activities for the fictional and real worlds.

In conclusion, the *Statecraft X* mobile game-based curriculum had a significantly large effect on the quality of student work. This demonstrates that a mobile game-based curriculum can effectively engage students in learning the practices of governance.

References

[1] Belland, B. R. (2009). Portraits of middle school students constructing -based arguments during problem-based learning: the impact of computer-based scaffolds. *Educational Technology Research and Development, 58*, 285-309.

[2] Branson, M. S. (1989). *International and Citizen Education: Need and Nexus*. Paper presented at the International Conference on Constitutional Government and Development of an Enlightened Citizenry.

[3] de Freitas, S., & Griffiths, M. (2008). The convergence of gaming practices with other media forms: what potential for learning? A review of the literature. *Learning, Media and Technology, 33*(1), 11-20.

[4] Facer, K., Joiner, R., Stanton, D., Reid, J., Hull, R., & Kirk, D. (2004). Savannah: mobile gaming and learning? *Journal of Computer Assisted Learning, 20*, 339-409.

[5] Fincham, D. (2007). Citizenship and Personal, Social and Health Education in Catholic Secondary Schools: Stakeholders' Views. *Pastoral Care in Education, June*, 22-30.

[6] Hiestand, E. (2002). *Writing in a Personal Voice*. Paper presented at the Nieman Narrative Journalism Conference.

[7] Hildmann, H., & Hildmann, J. (2009). *A Critical Reflection on the Potential of Mobile Device Based Tools to Assist in the Professional Evaluation and Assessment of Observable Aspects of Learning or (Game) Playing.* Paper presented at the European Conference on Games Based Learning.

[8] Johnson, R.L., Penny, J., Gordon, B., Shumate, S.R., & Fisher, S.P. (2005). Resolving score differences in the rating of writing samples: Does discussion improve the accuracy of scores? *Language Assessment Quarterly, 2*(2), 117-146.

[9] Kaufman, P. (2008). Teaching Note: Gaining Voice through Silence. *Feminist Teacher, 18*(2), -171.

[10] Klopfer, E., Perry, J., Squire, K., & Jan, M.-f. (2005). *Collaborative learning through augmented reality role playing.* Paper presented at the Computer Supported Collaborative Learning, Taipei, Taiwan.

[11] Lambert, N., & McCombs, B. (2000). Introduction: Learner-centered schools and classrooms as a direction for school reform. In N. Lambert & B. McCombs (Eds.), *How students learn* (pp. 1-15). Washington D.C.: American Pyschological Association.

[12] McLoughlin, C., & Lee, M. J. W. (2008). The Three P's of Pedagogy for the Networked Society: Personalization, Participation, and Productivity. *International Journal of Teaching and Learning in Higher Education, 20*(1).

[13] Naismith, L., & Corlett, D. (2006). *Reflections on Success: A retrospective of the mLearn conference series 2002-2005*. Paper presented at the mLearn 2006. from http://hal.archives-ouvertes.fr/docs/00/19/73/66/PDF/Naismith-Corlett-2006.pdf

[14] Norris, C., & Soloway, E. (2009). Leadership + Mobile technologies = Educational benefits: Cell phones in K12 are inevitable. *District Administration, October*, 28-28.

[15] O'Malley, C., Vavoula, G., Glew, J. P., Taylor, J., Sharples, M., & Lefrere, P. (2003). Guidelines for learning/teaching/tutoring in a mobile environment [Electronic Version], from http://www.mobilearn.org/download/results/guidelines.pdf

[16] Pachler, N., Bachmair, B., & Cook, J. (2010). *Mobile learning: Structures, agency, practices*. New York, NY: Springer.

[17] Petrova, K., & Li, C. (2009). Focus and Setting in Mobile Learning Research: A Research of the Literature. *Communications of the IBIMA, 10*, 219-226.

[18] Sharples, M. (2006). Big Issues in Mobile Learning: Report of a workshop by the Kaleidoscope Network of Excellence Mobile Learning Initiative. [Electronic Version], from http://www.lsri.nottingham.ac.uk/msh/Papers/BIG_ISSUES_REPORT_PUBLISHED.pdf

[19] Squire, K., & Jan, M.-f. (2007). Mad city mystery: Developing scientific argumentation skills with a place-based augmented reality game on handheld computers. *Journal of Science Education and Technology, 16*(1), 5-29.

[20] Squire, K., & Klopfer, E. (2007). Augmented reality simulations on handheld computers. *Journal of the Learning Sciences, 16*(3), 371-413.

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Remote Training-Support of Running Form for Runners with Wireless Sensor

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Abstract: This paper describes the environment of the remote training-support for runners with wireless sensor. The system provides the visualization to a remote advisor about their running-form and feedback function to them by using their kinetic feature of arm swing at the real-time. In particular, 3D-acceleration sensor catches repeats of arm swing. Sensors transmit such information to the remote server on the Web. The advisor can observe runners' condition by way of waveform changes as graphic reports. Moreover, runners can receive several advices as alarms from the advisor. We have designed and implemented our proposal.

Keywords: Remote monitoring tool, wireless sensor, arm swing, running form, runner

Introduction

Currently running is regarded as an effective sport in promoting healthy life for those who have few chances of exercise. With respect to this sport, some people tackle to reach their own physical limit through high-intensity training such as interval or build-up one. Others take note of growing the ability about the control of exercise intensity to keep up a pace [1]. The latter training is called pace training. It is defined as the fundamental training in promoting physical performance safely and a preliminary step for the former. In the pace training, the most significant point is that runners keep their own velocity to maintain a stable running-form [2].

In many cases, it is not easy for novice runners to stabilize their velocity with their own running-form in mind. Therefore, a professional advisor or a trainer can give appropriate advice about the improvement of the form instability. However, most of traditional coaching-style about running is tutoring or training session. Individual tutoring is tough to schedule. Moreover, many fun runners including novice might want to be trained in the surrounding field which they can exercise in a daily life and nature against indoor running such as treadmill. A conceivable solution to meet their needs may be the remote support via internet. Gotoda et al. have already started the research project of an SNS (Social Networking Service) based learning-support for such runners. They call this project as "e-running" [3]. In this project, the system provides asynchronous support-functions in order to keep their motivation and promote the development of the physical skill through communications with peers. In contrast, this paper tackles to overcome the environment that an expert as a remote advisor can easily teach novices' runner how to correct running-form at the real-time. The system presents two function with wearable wireless sensor; a waveform visualization of their arm swing to an advisor and feedback from him/her to runners by using alarms.

1. Learning how to run

1.1 Theoretical background

In the field of sports science, human motor skill has long history as one of the studying domain [4]. According to Gentile's well known taxonomy for motor skill, human skill could be divided into two dimensioned space by environmental context axis and functions of action one [5]. Within the environmental context, two factors are considered; the regulatory conditions and the inter-trial variability. Running is one of human skill appeared in such taxonomy. In addition, discussion related to environmental context was tackled in the paper about the difference “Open Skill” and “Closed Skill”. The existence of stationary conditions without variability from response to response represents a closed task, while the presence of motion and inter-trial variability represents an open task. Concretely speaking, closed skill is self-paced in a stable in the unchanging environment. On contrary, open skill is performed in a variable environment and must be repeatedly adapted to the changing demands of that environment.

Regarding illustrative embodiment of running from these viewpoints, indoor running by treadmill exercise for the purpose of correction about posture or motion is regarded as closed skill development because runners can train them freely according to the preset program at a uniform pace without any other expectations. On the other hand, open skill needs for runners in an outdoor-field training in the real world because they have to perform against unstable environments such as facing uphill or downhill, and so forth. The target style of running belongs to open skill development because intended runners from the background of this research train in the surrounding field which they can exercise in a daily life.

1.2 Running training in the remote/field environment

Most of traditional researches in computer-supported education, technology-enhanced learning, computer-supported collaborative learning, and so forth assumed real instructors, teachers to lead learners to correct answer by the computer program. These aspects, in fact, have strong tendency to physical learning and training domains because they are more skill-oriented [6]. When an expert gives a novice some advice, most of such a physical education is face-to-face coaching-style.

However, recent physical education offers different condition to learners. The diversification of lifestyles promotes learning activities into online community. In the case of the SNS for the promotion of exercise, users have far-away relationship each other [7]. They do not have to be aware of each location in the real world. Moreover, they can easily find peers and learn something discovered online. If runners' peers including experts put notes about their daily training, methods, and topics related to advice.

In addition, in the real world, runners may find peers who point their weakness or give advices up. In that case, they can keep the friendship to be highly motivated each other. However, they are likely to have unsatisfactory on schedule coordination such as selecting course or time and so forth. In such a case, the remote monitoring system can help their chances of collaboration about running. The fundamental idea of this study met this motivation.

1.3 Direction for adequate running form

As for running-form, some researchers who are experts of running point out the importance of arm swing. There are some technical points of which runners are unconscious or which are implied indirectly during training. The frequency of arm swing tends to decrease slowly over time. It causes slowdowns in running. Similarly, the direction of repeats tends to be changed from front-back to cross direction. Moreover, the amplitude about the motion of arm swing weakens in connection with the direction change. Therefore, we defined the change of arm swing as the support target of the running-form. However, runners have no meanings to catch the information about their running without any sensing devices or monitoring tool. Hence, we adopt 3D-acceleration sensor and notice equipment with alarms that can be put directly. The system observes the change about the acceleration of arm swing. Additionally, the system makes phenomena noticeable to runners. In this way, an advisor and runners can share timings of awareness through almost the same immediacy as the occurrence of changes.

2. Design and implementation

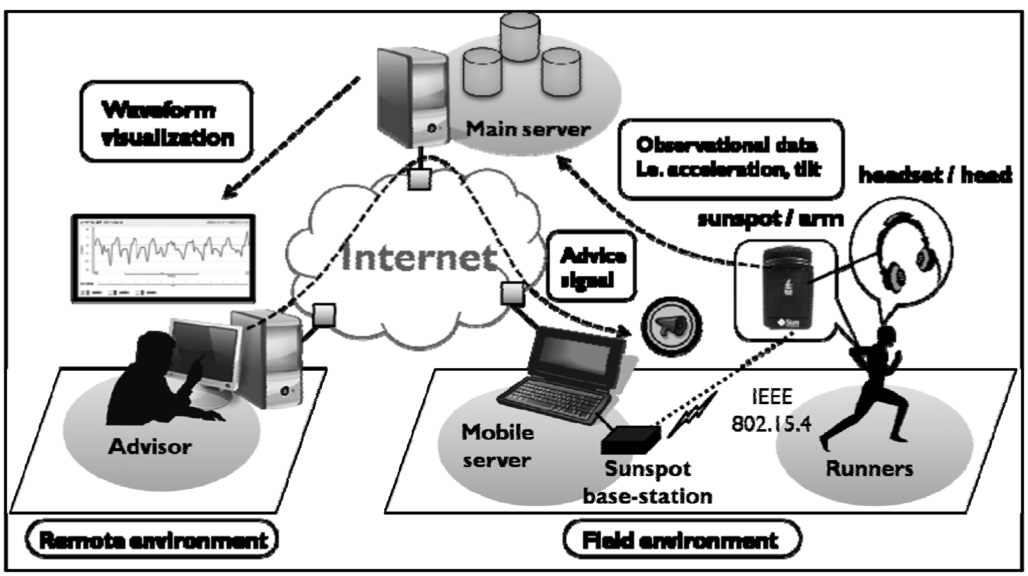

Figure 1 System Configuration

2.1 Sensor and feedback function

Figure 1 illustrates the system configuration of our proposal. The remote environment and the main system are connected in the field via internet. The seamless network by 3G (3rd generation mobile) technology via internet enables a remote adviser to point out improvements of the training at the real-time except for a little communication delay. Since the system works under the 3D-acceleration records, runners have to wear the sensor tool during running. This project adopted the wearable sensor network named “SunSPOT” (Sun Small Programmable Object Technology) by Oracle Corporation. The sampling rate to get the data about the acceleration of their arm swing is 50 milliseconds. All observational data of runners are collected at the mobile server by way of IEE802.15.4 ad-hoc-network. Such data on a mobile server is transferred to the database of the main server during running. A base station connected to the mobile server and relay nodes which also using sunspots are set at the suitable location depending on the course of running. An advisor can refer to such stored information as waveform through a web browser. S/he can decide the type of indication about runners' improvements among several options. That feedback from an adviser sends to the mobile server via the main server. Finally, the extension interface of runner's sunspot connected to a headset plays the sounds based on controls of advice signals.

2.2 System implementation

The main part of the remote environment was developed on the Flash by Action Script because it has a strong advantage in real-time observation with the dynamic graph animation. The flash content is embedded in the web-content generated by Apache built in the main server. The content automatically updates the waveform graph of the observation data on Sun-My-SQL relational database. Furthermore, Observed users are preset by the interface of grouping realized by PHP script. In the field environment, the transmission and the receive functions on the mobile server were developed by the same script. On sunspot, the observation and the sound-conversion functions were implemented by JAVA.

3. Functionality

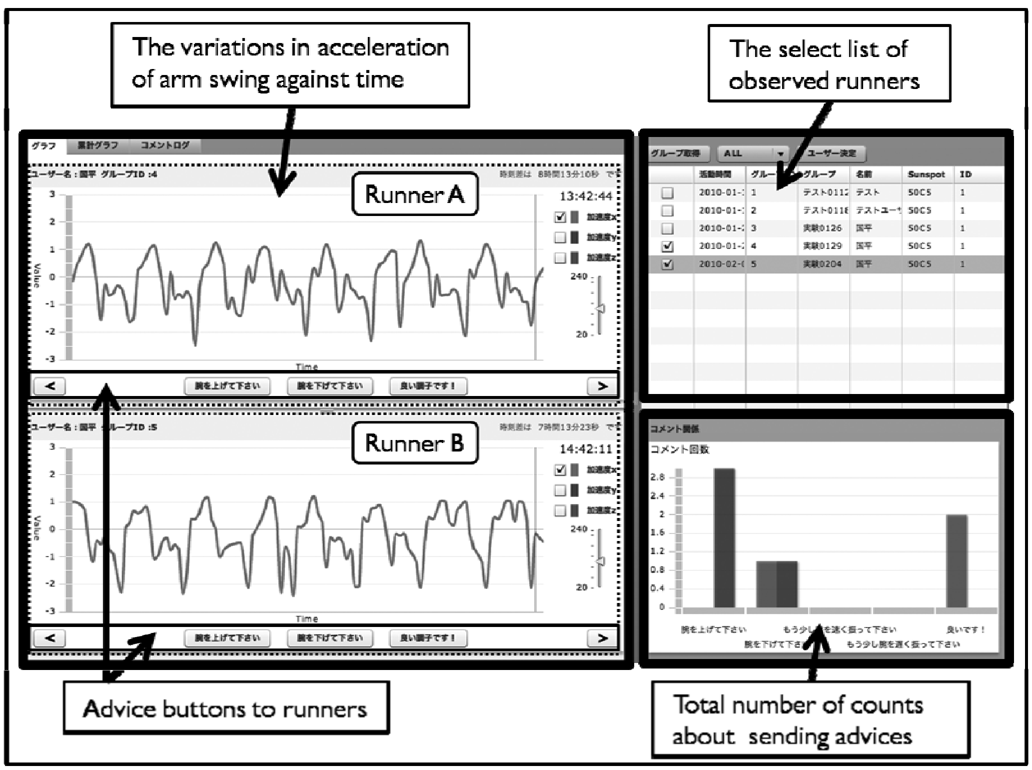

Figure 2 Interface about the waveform visualization and the operation of advice signal

3.1 Waveform visualization of runners' arm swing

Figure 2 shows the interface about the remote monitoring tool. Waveform graphs in the left side of figure 2 provide variations in the amplitude about the acceleration of runners' arm swing against time. An advisor can observe plural runners who are selected on the list shown in the right upper figure simultaneously. S/he can change the time-line scale from the narrow section which s/he can recognize the pattern about a wave of arm swing to the wide one which it is easy for her/him to view the process of comprehensive changes. Also, s/he can switch between display and non-display by way of checkbox of each axis on the interface. Therefore, an advisor can observe the change about the direction of arm-swing through changes about axial components of the acceleration. In addition to real-time play, comparative play with previously-recorded data is supported. S/he can point the improvement of the running form through the comparison with the waveform of a stable condition based on log data.

3.2 Feedback with alarms

If an advisor notices unsteadiness of waveform in a graph, s/he can send the advice signal to runners by the push of advice button in the bottom of individual graph. S/he choice an appropriate button due to the condition of waveform such as changes of a shape, amplitude, frequency, and so on. Several sounds as alarms which play on the sunspot correspond to each signals. Runners know how to be conscious of movement of their arm swing depending on types of sounds in advance. Furthermore, when an advisor can confirm the improvement of waveform or the continuity of stable condition of it, s/he can encourage runners to keep their conditions by playing preset cheer-melody.

4. Conclusion

In this paper, we described the supporting environment of the remote training for runners with wireless sensor network. This sensor network was implemented by tiny devices with ad-hoc radio communication and multi-sensors by Sun Microsystems' sunspot. We applied this architecture to help the stability of their arm swing with alarms from a remote advisor.

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References

[1] Winett, A. R. (1998). Developing more effective health-behavior programs: Analyzing the epidemiological and biological bases for activity and exercise programs. *Applied & Preventive Psycology, 7*, pp. 209-224.
[2] Gotoda, N., Matsuura K, Kanenishi, K, & Yano, Y. (2009). Supporting Skill Awareness for Runners through Wireless Sensor Network. *Proc. of ICCE2009* , pp. 608-615, Hong Kong, China.
[3] Gotoda, N., Matsuura K, Kanenishi, K, & Yano, Y. (2007). Organizing online learning-community based on the real world log. *Lecture Notes in Computer Science*, *4694*, pp. 608-615, Springer Berlin / Heidelberg.
[4] Higgins, S. (1991). Motor Skill Acquisition, *Physical Therapy*, 71, 123-139.
[5] Gentile, A.M. (2000) Skill acquisition: Action, movement, and neuromotor processes, In Carr, J.H. and Shepherd, R.B. (Eds.) *Movement science: Foundations for physical therapy in rehabilitation*, pp.111-187.
[6] Vanden Auweele, Y. Bakker, F., Biddle, S., Durand, M. and Seiler, R. (1999). Psychology for Physical Educators, FEPSAC Human Kinetics. (Translated into Japanese by TAISHUKAN Publishung Co.Ltd.).
[7] Gotoda, N., Matsuura, K., Kanenishi, K. and Yano, Y. (2008). Organizing Online-Community for Jogging Support based on the Physical Log, *Journal of Human-Interface Society*, 10(2), 19-29.

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A Mobile Application for Collecting Numerical and Multimedia Data during Experiments and Field Trips in Inquiry Learning

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Abstract: In this paper, we present work in progress on developing and integrating a mobile application for collecting numerical and multimedia data into a learning environment called SCY-Lab. This learning environment is currently being developed within the European SCY project on collaborative inquiry learning. In SCY, collaboration is centered around the sharing of "emerging learning objects" (ELOs) produced by the students themselves. The aim of this paper is to show how the ELO centered approach of SCY has been used to integrate mobile scenarios into the SCY system.

Keywords: mobile, data collecting, learning environment, integration, SCY, Android

Introduction

A considerable portion of work on mobile learning aims at supporting the usage of mobile devices in learning scenarios outside the classroom. Here, we can distinguish the functions of knowledge provision for the student through the device as opposed to the collection of data and learning objects for later analysis and/or re-use. Knowledge provision is often used for language learning [1, 2]. Data collection scenarios have been elaborated in [3, 4, 5]. A combination of both scenarios has been shown using a mobile application for teaching butterfly ecology, in which information is provided on the devices and also data can be collected [6]. Moreover, many mobile learning applications are not well integrated with learning environments and follow-up activities.

In this paper, we present work in progress on a mobile application for form-based collection of numerical and multimedia data and the integration of this activity into the SCY project [7]. The objective of SCY is to provide a learning environment for constructive and productive learning of science in different domains. SCY uses a flexible and adaptive pedagogical approach to learning, which is based on "emerging learning objects" (ELOs) that are created by learners in different missions. Students work on these missions using the SCY learning environment called SCY-Lab. Within this system students use different tools to work on experiments, simulations, read background information, create mind maps and produce reports. One of these missions is the so-called ECO mission that deals with topics of the students' ecological environment. These missions combine the domains of biology, chemistry and environmental science and formulate questions like: *"What influence has light on the size/distribution of the plant populations?"* or *"What influence has environment (soil, factories, acid rain) on the pH of the water?"*. For this purpose students need to go to the field, take measurements and collect data in the real world environment. This paper presents a system that consists of a mobile application for the actual data collecting activity and an authoring application for structuring these activities as forms. All the data will be shared and stored as ELOs in the central repository and will therefore be accessible in the main learning environment, the SCY-Lab, for follow-up activities.

1. Data Collecting Scenario

In SCY students work as junior researchers and have to organize and plan their work in a mission. SCY-Lab offers tools for planning and organizing the work. The same applies for data collecting activities in the field. Typically, students prepare the field trip in the classroom, defining the goal of the trip, i.e., the data they need to collect for later analysis and to get results for follow-up activities like mind maps or simulations. Taking the research question *"What influence has light on the size/distribution of the plant populations?"* as an example throughout this paper, the students could define the following data to collect: *pictures of plant, description of plant, size of plant, location, date, intensity of light* (by an external tool, e.g., a luxmeter).

To achieve meaningful results, these data need to be collected in different locations with different lighting conditions. This can be achieved by one group of students or by several groups working at different locations. In order to get comparable results, the collection of data needs to be structured and organized. In our approach flexible forms with different types of fields represent the data collection. These forms are created using a dedicated authoring application and are stored into the repository as templates. On the mobile device these templates can be queried from the repository and opened for the data collection. During the outdoor activity, students can then fill the forms according to the form template and store their results on the mobile device. Back in the classroom the collected data can be uploaded into the repository and used for further processing.

2. Concept of Forms for Collecting Data

The basic idea of forms for collecting data is to standardize and structure the data collection. This has the advantage that data can be compared between collections based on the same form(s). Furthermore data have a defined meaning and a type identified by the form entry and are therefore better readable and understandable in later post-processing.

There are two types of forms: the *template forms* created by the authoring tool and the *instantiated or filled forms* with actual data. The lifecycle of forms starts with the template that is later on being filled with data during the activity and can also further emerge, i.e., by refilling and modifying it afterwards. In general, forms have a *title*, a *description* and a *version number*. The description can be used to describe the data to be collected by this form or, if created by a tutor or teacher, to formulate a task for the students. The version number identifies the version of the form during iterative modifications.

Forms consist of several fields. Each field has specific parameters, i.e., *field name, field type, field cardinality, events* and the actual *value.* The name describes the field, e.g., *"height of plant in cm"*. The *field type* defines the data type of the value, e.g., the height would be entered as a *number*. Currently the following data types are supported: *text, audio, photo, time, date, number, counter* and *GPS location.* The *field cardinality* defines the quantity of values that can be collected in this form field, e.g., a cardinality of "3" on a field with the type *photo* would allow to take three photos and store them as the value of this field; a cardinality of "0" means unlimited amount. Finally, *events* can be defined to be fired *before* and *after* the data has been captured. These events can store the *GPS location, date* and *time* and allow for complex configurations with location, time and date annotated data collection series within one field.

Forms are stored as ELOs in the SCY repository for exchange between the authoring application and the mobile devices as well as for later retrieval for follow-up activities.

3. Flexible Form Authoring Tool

To support students or teachers in creating form templates for data collecting activities, a form authoring tool has been developed. It provides a simple way to author forms and store them into the repository. Figure 1 shows an example form for the previously defined research question.

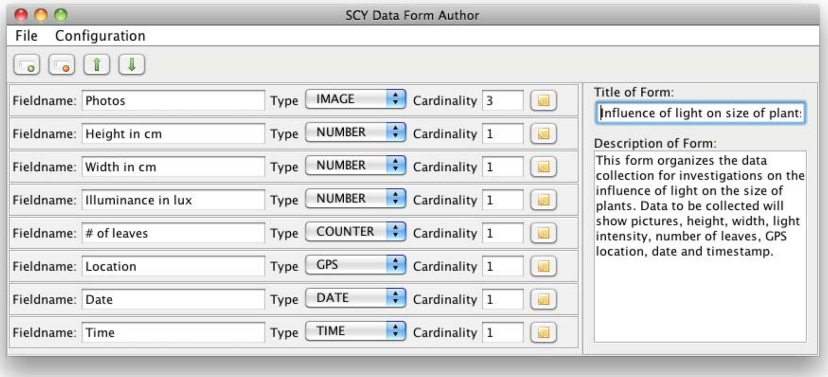

Figure 1: SCY Data Form Authoring Tool

The application reflects the form defined in section 2. On the right hand side the title and the description can be provided for the form. The rows in the center of the application represent the form fields and can be flexibly added, removed and reorganized. The properties *field name*, *type* and *cardinality* can be set as well as the *events* (using the button at the end of a row). Finally, this document can be stored locally as an XML file or as an ELO in the SCY repository.

4. Mobile Client for Data Collection

Once the form template has been stored in the repository, students can access and download it using the mobile client, called “SCY Data Collector”. For this purpose students need to login to the SCY system and connect to the server. They can query for form templates or already filled in data forms to continue their work. The mobile client has been implemented for the Google Android platform on HTC Magic devices.

Following the scenario, the students first download the empty form template and open it on the device. They can read the title and description and start collecting data. The presentation of the form is very similar to the presentation in the authoring tool.

Figure 2 presents the main application screen on the left side. The menu items allow for *opening forms* from the device’s database, *loading forms from repository*, *configuration* of the application and finally to *quit* the application. The first step in the scenario would be to download form templates from the repository (c.f. center of Figure 2). Here the student can select to download templates or already filled in forms. Once a form has been downloaded, the student can open it and start collecting and filling in data (c.f. right side of Figure 2).

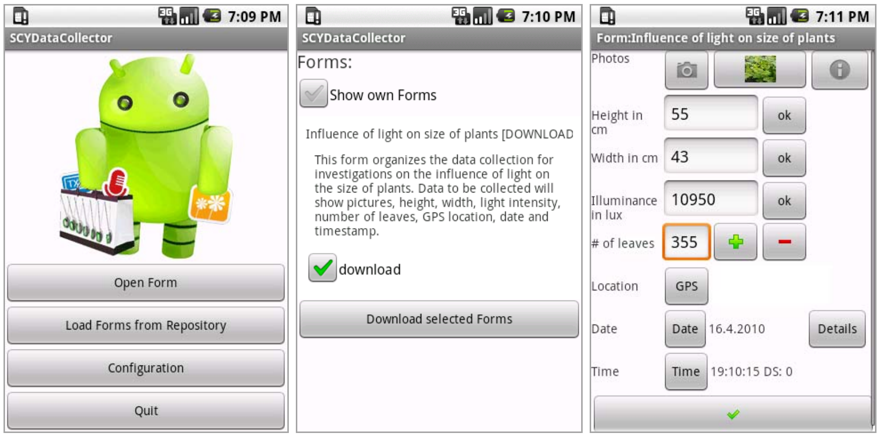

Figure 2: Different Views of SCY Data Collector

The fields of the row will be presented to the student in a similar way to the authoring tool, but are extended with data type specific controls for interaction, e.g., the photo field will have a button to capture a photo using the built-in camera of the smartphone. Audio recording will be done using well-known icons for recording, stopping and playing an audio file. Finally, the counter has a "+" and a "-" button to increment and decrement the counter. With this flexible user interface the user can start collecting data and the application will automatically access the different hardware components of the device for capturing photos, GPS and so forth. Finally, the student can store the filled in form to the local database of the device and upload it to the repository.

5. System Architecture

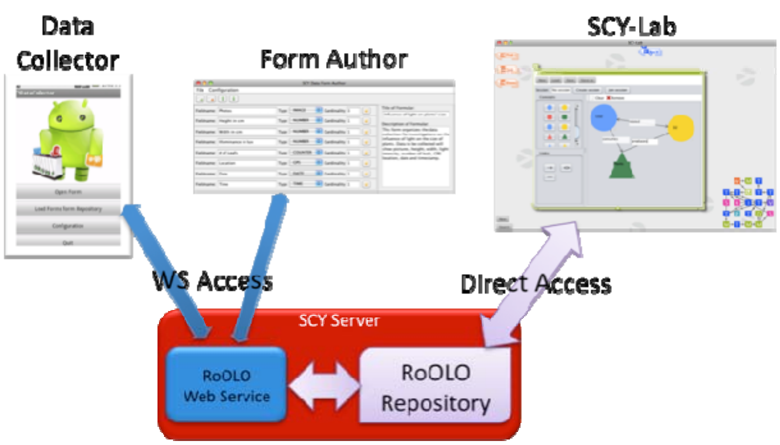

Figure 3: Integration through Web Services into the SCY system

The presented system is a distributed and heterogeneous system in terms of hardware devices and implementation platforms. SCY-Lab and the Form Authoring Tool are desktop applications implemented on the Java platform, whereas the mobile client is implemented for the Android mobile devices on the Android platform. The integration of these two worlds has been achieved by providing a platform independent web service based on JSON and XML.

Figure 3 shows a simplified overview of the system architecture. The SCY ELO repository, called RoOLO (Repository of Open Learning Objects), is running in the server environment and is directly accessed by SCY-Lab using native means of the Java platform, which are not available on other platforms. The web service provides heterogeneous access to the repository for integration with the SCY system. ELOs are based on a common XML format, allowing for sharing, creating and processing ELOs on different platforms in different programming languages. SCY has defined a schema for the XML ELO format, containing a rich set of meta data and a flexible content part, that can handle various kinds of different ELOs created in different scenarios, for different purposes by different devices.

6. Discussion and Conclusion

This paper presents work in progress on developing and integrating a mobile data collecting activity into the learning environment SCY-Lab. The approach described allows for flexible authoring of forms for collecting numerical and multimedia data with access to the central SCY ELO repository. A mobile application has been developed for conducting the data collecting activity in the field with access to the repository for accessing and storing forms. This integration allows for later reuse of the collected data within SCY-Lab by extracting and post-processing collected data and further usage in simulations and experiments.

The SCY project is a still ongoing project. Next steps in the development are the reuse and post-processing of the collected data as well as final specifications of missions with outdoor activities. Furthermore, the system is currently being tested in first trials and will be finally evaluated towards the end of the project, including the presented application.

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References

[1] Joseph, S., Uther, M., "Mobile devices for language learning: multimedia approaches", Research and Practice in Technology Enhanced Learning (RPTEL), 4 (1), 2009, pp. 7-32.

[2] Yin, C., Ogata, H., Liu, Y., Yano, Y., "PDA-based Language system for learning Japanese Polite Expressions", *The Supplementary Proceedings of ICCE 2007 WS/DSC*, Vol.1, pp.69-74, Hiroshima, Japan, 05.Nov, 2007.

[3] Vogel, B., Spikol, D., Kurti, A., Milrad, M., "Integrating Mobile, Web and Sensor Technologies to Support Inquiry-Based Science Learning", *Proceedings of the 6th IEEE WMUTE Conference*, Kaohsiung, Taiwan, April, 2010.

[4] Giemza, A., Bollen, L., Seydel, P., Overhagen, A., Hoppe, H.U., "LEMONADE: A Flexible Authoring Tool for Integrated Mobile Learning Scenarios", *Proceedings of the 6th IEEE WMUTE Conference*, Kaohsiung, Taiwan, April, 2010.

[5] Verdejo, M. F., Celorrio, C., Lorenzo, E. J., Millan, M., Prades, S., Velez, J., "Constructing Mobile Technology-Enabled Environments for an Integrated Learning Approach", *Innovative Mobile Learning: Techniques and Technologies* , IGI Global, 2008, pp. 147-171.

[6] Chu, H., Hwang, G., Huang, S., Wu, T., "A knowledge engineering approach to developing e-libraries for mobile learning", *Electronic Library*. Vol. 26, no. 3, pp. 303-317. 2008

[7] de Jong, T., et al., "Learning by creating and exchanging objects: the SCY experience", *British Journal of Educational Technology*, in-press.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Design and Implementation of a mobile game-based system to Support Chinese language speaking for International Students in a Chinese Environment

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Abstract: In Taiwan universities many foreign students suffer difficulties due to adaptation problems and language barrier in a Chinese-Speaking environment. An initial survey showed most international students have a basic level of Chinese and they also consider Chinese as a barrier to be involved in different local activities. This paper presents a mobile game-based system to support Chinese language speaking for international students in a Chinese environment. The system contains a scenario-based fulfilling activities associated of students and it encourages users to speak in Chinese through the mission tasks. The users are rewarded based on their tasks performance and extra points for each level reached. The game system may increase students' motivation to continue their Chinese learning. Besides, mobile devices provide the opportunity to learn Chinese outside the classroom and to interact directly with an authentic living environment.

Keywords: mobile game-based learning, Chinese language learning

Introduction

In Taiwan universities there is a considerable amount of foreign students thanks to multiple opportunities offered by the government and different institutions. For reference the National Tsing Hua University (NTHU) international student's population is 2% of the total student's population. Foreign students face many issues mainly related to the adaptation into a Chinese-speaking environment and the language barrier. Universities efforts to help international students are offering Chinese classes but most of the cases the level of Chinese learned is not enough. In an initial survey we asked foreign students about their level of Chinese, from a total of 56 international students, 19 considered having a basic level, 17 a poor level, 13 with an intermediate level and only 7 consider as advanced Chinese speakers. As well 43 students expressed that Chinese is a barrier to involve more with academic and extracurricular activities. We also asked why they do not continue their Chinese learning beyond a basic level. Their major complains include time conflicts, courses not required by curriculum, methodology used, or no interest, etc.
The Chinese itself is already complex but added the academic burden and more may discourage learners to follow their studies. Hence learning strategies that engage learners is needed. Game based learning was chosen because it is enormously versatile, adaptable to almost any subject, information and skill to be learned [9]. Besides, games are naturally engagers of people because games are fun and are able to support learning in complex environments [2]. The game system desired outcome is to **motivate learners** to keep learning Chinese language. It also aims to promote **interaction** among international

students and their environment, through language and information independency, reason why we include a Cross Platform Map System (CPMS) used in Paniagua [8] study as a tool to locate points and obtain information. The CPMS showed student improvement in recognition of Chinese characters and in general **Chinese language learning**. In a real world foreign students may limit the participation with the environment because of the language barrier, the challenge is provide the right Chinese vocabulary related to their activities and experiences all reproduced in a game. The game provides the scenario and tasks designed for players to **learn and speak Chinese**. We review relevant literature regarding game based learning, mobile, learning theories and then present the design of the game system.

1. Literature Review

1.1 Game based Learning

Game-based learning for years has been prejudice but in the actuality academics, writers, foundations, game designers, companies and educators are aware of the enormous potential for learning contained in the gaming medium [9]. Although game-based learning has proved it effectiveness, the key point lies on the design of a game simple and attractive for learners, with good quality of content all combined with most representative characteristic of games: fun.

Technology has changed the learning ways of nowadays learners: learning is oriented into the visual, learners scan instead of read. The new generation of learners requires multiple streams of information, prefer inductive reasoning, want frequent and quick interactions with content, and have exceptional visual literacy skills; characteristics that stick to the approach of game based learning [3]. Besides there is an increase of popularity of games, gamers spends hours playing. Learning systems must take advantages of the popularity of games and develop new ways of teaching that engage learners just like game engage players.

1.2 Motivation and Learning

Learning and motivation are two terms that cannot be separated. A *sine qua non* of successful learning is motivation: a motivated learner cannot be stopped [9]. Motivation matters when learning; we would all like our learners to be: interested, competitive, active learners, etc unfortunately today students are lack of this. Alternative games offer several factors that motivate gamers and learners to keep playing.

A game that engages learners needs to have some characteristics such as: challenge, fantasy and curiosity [7]. Of those game characteristics is the first one which calls the attention. In Schwabe and Goth study [10] the competitive tasks were the most interesting feature to the learners. Learners got engaged because of the emotions immerse on competition. Game based leaning can motivate learners to be persistent with Chinese language learning, based on the idea that appears to be something in gaming that deeply touches people of all ages [10].

1.3 Mobility

Mobile technologies offer the opportunity to embed learning in a natural environment [10]. It is in a natural environment where international students face several issues. A ubiquitous learning environment allows students to learn with a PDA, Web Pad, Tablet PC or laptop, indoor, outdoor, individual, and group situations [1]. Mobile technologies and games technologies are increasingly seen as a fertile ground for the development of resources to support learning [5]. In this study we focus on handheld and mobile phones because of their ubiquitous characteristics and their popular use among students. In addition, the system will be available in regular browsers with personal computers.

1.4 Theoretical and Instructional Background

The main purpose of this study is not just an entertainment game but an educational game. It has a ground basis in learning theories. The system is aligned with discovery learning theory that underscores the importance that learners interact with their environment. Students are more likely to remember concepts if they discovered on their own [6]. Furthermore the study lays on the situated cognition theory: the situated cognition is rooted in the social development theory of Vygotsky [11] in which social interaction plays a fundamental role in the development of cognition. For this game the learning take place in through the discovering of the context and players participate, interact and collaborate with other players in teams, as the members of a community [6].

1.5 Chinese Language Learning

Learning Chinese as a foreign language is considered difficult because of the complicate shape of its characters, different pronunciation and multiple meanings [8]. The Chinese is the official language in Taiwan. It has an inventory of 21 syllable-initial consonants, about half of a dozen vowels, more of 50,000 characters, and four lexical tones: Tone 1 (high level), Tone 2 (mid-rising), Tone 3 (low-falling-rising or low-falling) and Tone 4 (high-falling). The Pinyin is a system of Romanization for the Chinese language, where *pin* means "spell" and *yin* means "sound" the Pinyin Romanization system is used to teach pronunciation of Mandarin; learning Chinese as a foreign language by pinyin may allow learners to "read" and "speak" Chinese. Our system bases on the pinyin system to provide learners the opportunity to speak and communicate effectively, because it is widely agreed that the best way to learn to speak a language is to engage in natural conversation with native speakers [4].

2. Research questions

The research uses a game based system focusing in motivation and interaction to support the continuing of Chinese Language learning. Therefore on the basis of the issues raised in the foregoing discussion, the following research questions were formulated.

- What strategies should the game system have to engage college students to be motivated in learning Chinese language?
- What key factors should be included in the system to make students interact with the physical environment to support and gain language learning?
- How do the learners will respond to the game? Will the learners enjoy playing and value it as a useful supporting tool for their Chinese language learning?
- Does the game lead to increase learner’s motivation so they would like to play again and keep learning Chinese?

3. Participants

The international students of NTHU represent 2% of the total student population. They have different backgrounds, cultures, academic levels and Chinese language levels. The target users will be limited to the students without Chinese background or the basic level.

4. The scenario

The NTHU campus students play daily life and academic activities that are ideal for the game scenario. The learners—international students of NTHU—will learn useful Chinese vocabulary as well discover diverse points of the campus.

5. The content of the game

The Game is played in the physical campus of NTHU. Game level is defined by circuits according the type of buildings. Players receive clues to find a place within the campus map (Figure 1a). Using the map players can find the right location (Figure 1b). Once in the place they must perform a task (Figure 1c). The task and clues are given in English but the vocabulary and phrases needed to complete the tasks are given in Chinese (Figure 1d). After a task is completed the system will question players to verify the task they completed (Figure 1e). Players must visit all spots in a circuit to move to a next level.

(a) (b) (c) (d) (e)

Figure 1: Cell phone applications

6. Game Framework

The proposed game framework is based on the MobileGame of Schwabe and Goth study [10]. In addition, we include the CPMS tool, used as an exploration tool of the NTHU campus and as a language learning that uses a built in English-Chinese dictionary (Figure 2).

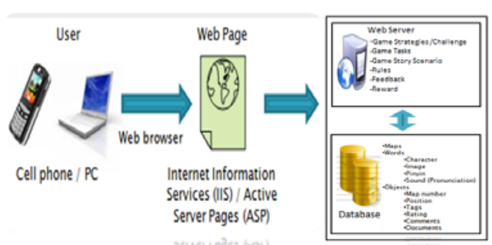

Figure2. System Architecture Design

The players will have the campus as a game scenario. They will complete tasks and interact with the environment. Moreover they will gain language knowledge through the performance of the tasks. Based on the literature review our game has six structural elements [9] as a ground base of our system: 1. Rules (Control the interaction of player); 2.

Goals and Objectives (establish the knowledge to be learnt: Chinese vocabulary and directions); 3.Outcomes & Feedback (to measure the knowledge learnt); 4.Conflict /Competition /Challenge/ Opposition (factors needed to engage and increase the motivation of learners); 5. Interaction (One aim of the system is promote the interaction of player with locals) and 6. Representation or Story. We base in those factors to create the game that teaches Chinese language with the implicit characteristic of games: Fun.

7. Discussion and Future work

This paper has discussed the proposal of a mobile game-based system to support the Chinese language learning of international students in a Chinese environment. Motivation matters: when students are highly motivated the probability of achieve an advanced language level is higher than those who are not motivated therefore a game was chosen for learning tool because games engage people.

Several concerns arise from this work-in-progress study such as the fact that international students come from diverse backgrounds. The system might go through modifications to make sure the whole design of the game can adjust to the needs of the target learners. Next steps in the construction of this project will focus on software development, implementation and collection of results and more research work will be reported later.

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References

[1] Chen, G. D., Chang, C. K., & Wang, C. Y. (2008). Ubiquitous learning website: Scaffold learners by mobile devices with information-aware techniques. *Computers & Education*, 50(1), 77-90.
[2] Downes, S. (2010). New Technology Supporting Informal Learning. *Journal of Emerging Technologies in Web Intelligence*, 2(1), 27-33.
[3] Eck, R. V. (2006) Digital Game-Based Learning: It's Not Just the Digital Natives Who Are Restless. *EDUCAUSE Review*, 41(2), 16–30.
[4] Ehsani, F., & Knodt, E. (1998). Speech Technology in Computer-Aided Learning: Strengths and Limitations of a New CALL Paradigm. *Language Learning and Technology*, 2(1), 45-60.
[5] Facerw, K., Joiner, R., Stanton, D., Reidz J., Hullz, R., & Kirk, D. (2004) Savannah: mobile gaming and learning? *Journal of Computer Assisted Learning*, 20(6), 399–409
[6] Kebritchi, M., & Hirumi, A. (2008). "Examining the pedagogical foundations of modern educational computer games." *Computers & Education*, 51(4), 1729-1743.
[7] Malone, T. W. (1980). What makes things fun to learn? Heuristics for designing instructional computer games. *Proceedings of: 3rd ACM SIGSMALL symposium and the Wrst SIGPC symposium on small systems* (pp. 162–169).
[8] Paniagua, Y. J. (2009). Constructing a Cross-platform Map System (CPMS) to Facilitate Adaptation and learning for International Students in a Chinese-speaking Environment. (Master's thesis). National Tsing Hua University, Hsinchu.
[9] Prensky, M. (2001) *Digital Game-Based Learning*. New York. McGraw-Hill.
[10] Schwabe, G., & Goth, C. (2005). Mobile learning with a mobile game: design and motivational effects. *Journal of Computer Assisted Learning*, 21(3), 204-216.
[11] Vygotsky, L. S. (1978). Mind in society. Cambridge, MA. Harvard University Press.

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A Tetris Game to Support Students' Mental Computation: Design and Evaluation

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Abstract: The objective of this paper is to develop a PDA-based learning game for mental computation, entitled EduTetris. As mental computation skills are used in everyday life, many researchers have indicated that mental computation skills facilitate students' arithmetic computation. It is important to teach students about the skills and strategies of mental computation in their mathematics learning. In this study, we implemented a game on PDA and designed a unique material for learning digits which sum to 10. The game was used to help students practice mathematics addition and mental computation. In addition, an evaluation of the system was also conducted.

Keywords: Game-based learning, digital games, Tetris, primary school education

1. Introduction

People use mental arithmetic skills in everyday life (Bell, 1974; Kulak, 1993). For example, when doing shopping in a supermarket, we tend to choose the cheaper one between two similar merchandises. The ability to compare two numbers is a kind of mental calculation. "Mental computation (arithmetic) is defined as procedure being performed mentally, without using external devices such as pencil and paper. (Rey, 1984)"

Arithmetic operations involve procedure understanding and undertaking. American and England mathematics education experts have indicated that procedural fluency is one of the essentials of successful mathematics learning: a group of American mathematics educators and researchers have list procedural fluency as one of the five strands of mathematical proficiency (National Research Council, 2001), and the experts in England raised the issue that lack of essential technical fluency—the ability to carry out numerical and algebraic operations with fluency and accuracy—is one of the three problems highlighted as an examination of their national mathematics education (London Mathematical Society et al., 1995).

2. Materials design: mental arithmetic skills of addition

For the training of the basic mental arithmetic with elementary school students there have three main points as follows: (1) Mental arithmetic for mathematics teaching requires a certain degree of understanding about the addition such as recognizing numbers, understand the basic mathematical symbols and have ability of add three numbers. For example: first grade student learning mental arithmetic with million-digit addition will be difficult. (2) Proficient in calculation without the use of external force likes pen or calculating machine. This study was using PDA to avoid student calculus in the paper and judging answer immediately. (3) Have ability of judgment in question. System will give students a variety of additions questions which the answer may be right or wrong.

This study was designed some mental arithmetic paper materials which referenced by mathematic books, textbooks, mental arithmetic researches and other related books. The purpose of this category is to observe accuracy of the Two-digital addition questions. If students use ten complement skills we expect the speed and accuracy will increasing.

Material structure as shown in Table 1:

Table1: Material structure with mental arithmetic

Category	Example
One-digital add One-digital	9+1=10
	9+3=9+(1+2)=(9+1)+2=10+2=12
Add three numbers	5+4+1=10
	5+4+2=5+4+(1+1)=(5+4+1)+1=11
Add five numbers	5+8+5+2+3=(5+5)+(8+2)+3=10+10+3=23
	4+5+8+1+3=(4+5+1)+8+3=10+(8+2)+1=21
Two-digital add Two-digital	45+25=70
	45+27=45+(25+2)=(45+25)+2=70+2=72

3. PDA Game Design: EduTetris

Game challenge and the gameplay are very important element of game (Crawford 1980). The design part of the game follows the following principles:

- Game must have a difficulty of speed. Speed will changed with the circumstances of students.
- Use the highest score to create a challenging target for students and enhance their game motivation.
- Using the box which embedded a one-digital number can enhance student's number sense and make then more proficiency with ten complement.
- Design a math game that based on a typical Tetris game to improve students' acceptance.

The gameplay with EduTetris is match two blocks add up to ten. When such a blocks is created, it disappears, and any block above the deleted block will fall. The scoring formula for the majority of EduTetris products is built on the idea that more block clears should be awarded more points. Figure 1 is a basic game skill for removed the two blocks. Figure 2 is an advanced way to remove blocks. When students control the "block 5" stacked in another "block 5" on the left or right then the two blocks will be removed. The top of the "block 2" will drop down a grid and the "block 2" will be also removed with the "block 8". Students can determine better path of every block and pre-calculated results of successive terms in order to achieve the maximum benefit of the game to enable students to skilled number add up to 10 in various combinations.

In addition to the two stacked blocks can be removed, the three blocks add up to ten as another way also can removed blocks. Students can control the "block 5" stacked in the left of the "block 3".Due to the three blocks add up to ten so the three blocks will be removed(Figure 3). Figure 4 is another example of the vertical removed. Students practice by EduTetris with the increasing speed can make students more quickly determine the strategic and proficient of the ten's complement that students can be used in mathematical computation.

Figure1: basic skill

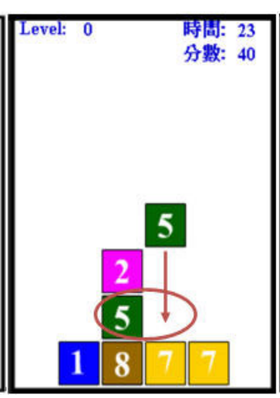

Figure2: advanced skill

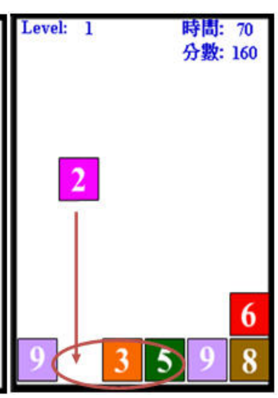

Figure3: horizontal removed

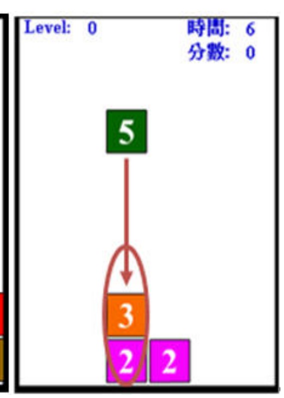

Figure4: vertical removed

4. Methods

In order to evaluation the effects of EduTetris, especially in learning effect, motivation, and self-efficacy. This paper proposed two research questions: (1)EduTetris is able to enhance the students on the computing of mental arithmetic addition. (2)EduTetris could enhance the students learning motivation of mental arithmetic.

4.1 Participants and Context

Participants were 15 nine year-old third-grade students from elementary school in Taiwan. Every student has a computing device with wireless capability. The main objective of this experiment was to evaluate the motivation and effectiveness influences of game. The procedure is shown as Figure 5. There has two phases, phase 1 used to measure student motivation. Students have completed the pre-test and post-test and fill out a motivation scale after playing EduTetris (in order to compare with phase 2). Phase 2 mainly measure learning effect. Students were doing mental arithmetic skill teaching materials for ten minutes and three achievement test whit EduTetris (Figure 5).

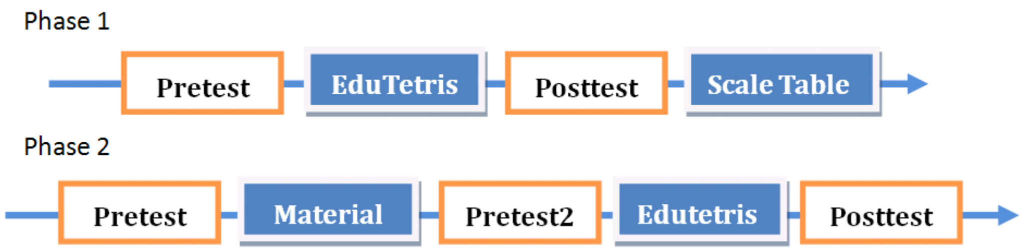

Figure5: Two phase of procedure

4.2 Data collection and measurement

In order to measure learning effect each test has thirty questions which has the same difficult and question types but different content. Test Includes: two One-digit addition (10 questions, such as: 2 +9 = 11), three One-digit addition (8 questions, such as: 2 +9 +8 = 18), five One-digit addition (8 questions, such as: 9 +3 +6 +7 +4 = 27) and two Two-digit addition (4 questions, for example: 45 +25 = 70). In the data collection and analysis, we based on the ARCS motivation theory (Keller, 1987; Keller & Suzuki, 1988) to design a motivation scale (Dempsey, Rasmussen, Haynes, & Casey, 1997). In ARCS**,** there are four major categories of motivational strategies: Attention, Relevance, Confidence, and Satisfaction. Learning motivation can be judged by the scale-score. Motivation scale adopted the five-point items that one-point means strongly disagree and five-point means strongly agree. Every three questions have and reverse question to judge students' careless answer and to improve reliability.

5. Results

5.1 Learning effect

Student learning effect can view by answer time and accuracy. There have three region shown as Figure 6. Region I is students playing EduTetris practice without any intervention. It is the simplest game effects can be observed by EduTetris. Region II is through the learning task with materials regard for students' speed of answer. At this region is mainly to observe the skills that we teach students use ten's complement could be increasing students answer speed. Region III was used both learning skills material and EduTetris to observe it could be able to help students' answer speed. This region was shown in Table 2.

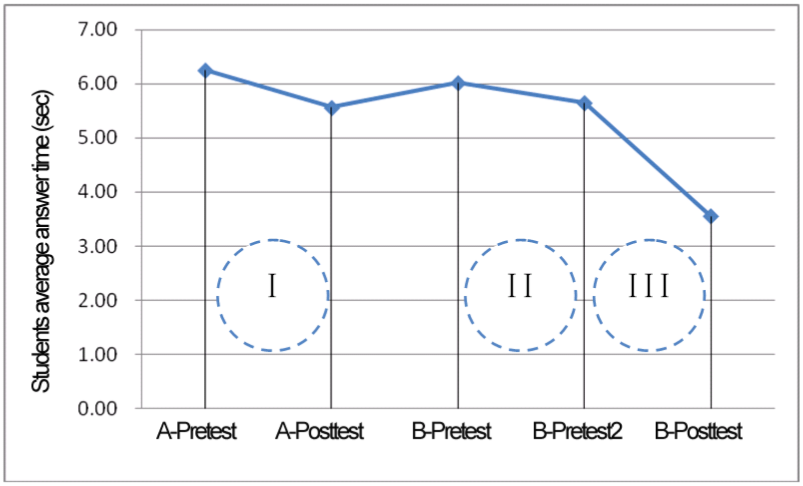

Figure6: the average answer time of various phases

Overall, in region I (did not use materials but playing EduTetris) and region II (after using materials), students' averaged answer speed were increasing but the difference was not significant. Region III can find the influence of both materials and EduTetris on students answer time. Average answer speed have significant improved in Region III. However, in addition to take care of speed we also need to take notice of accuracy. The table 2 was the results of students’ average correct rate. There was no significant difference in accuracy before B-Posttest. But in the B-Posttest seems to have followed the decline in accuracy.

Table2: Students average correct rate

activities	A-Pretest	A-Posttest	B-Pretest	B-Pretest2	B-Posttest
accuracy	94%	96%	96%	94%	82%

5.2 Learning motivation

The results of measure learning motivation as shown in table 3. Four major categories of motivational seen from the standard deviation are not divergent. So it can be assumed that students have held a positive attitude with attention, relevance, confidence and satisfaction. In the part of attention students likes EduTetris with the sensory stimulation and variability. Students were interested in what was happened with this game and agree that EduTetris have attraction for them. In the association category, students also tend to agree that EduTetris have the game goal and training them practice ten's complement. For the self-confidence, students recognized that if they can success to breaking the highest record let they feel accomplished. We also find students are weakness of control and operate with game. In the satisfaction, students agreed that they can learn knowledge from the game and play this game will improve their performance. In the satisfaction, students agreed that they can learn knowledge from the game and play this game will improve their performance. In equity is tending to middle because some students consider that the other one with good math ability has more advantage of playing this game.

Table3: Four major categories of motivational scale (overall and sub-dimensions)

	Perceptual Arousal	Inquiry Arousal	Variability	Attention (overall)
M(SD)	4.1(0.6)	4.1(0.5)	4.3(0.6)	4.2(0.4)
	Goal Orientation	Motive Matching	Familiarity	Relevance (overall)
M(SD)	4.1(0.5)	4.1(0.6)	4.3(0.5)	4.1(0.4)
	Attribution Molding	Expectancy for Success	Challenge Setting	Self-confidence (total)
M(SD)	4.3(0.5)	4.0(0.6)	3.6(0.5)	4.0(0.4)
	Natural Consequences	Positive Consequences	Equity	Satisfaction (overall)
M(SD)	4.3(0.5)	4.2(0.7)	3.7(0.6)	4.1(0.4)

6. Conclusions and future work

This paper developed a mental arithmetic exercise game to support students practice in the mental arithmetic. The preliminary results of EduTetris can be divided into motivation and effect. According to the motivation scale can find students like EduTetris. Comparison of several achievement tests that EduTetris can increase computing speed is mental arithmetic but also followed the lower accuracy. For this result, there is no consensus conclusion. However, these studies are short-term experiments now. In the future we will plan more and more rigorous and long-term experimental design to evaluation of this system.

Acknowledgements

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References

[1] Bell, M. S. (1974). What does "everyman" really need from school mathematics? Mathematics Teacher, 67, 196-202.
[2] Carroll, W. M. (1996). Mental computation of students in a reform-based mathematics curriculum. School Science and Mathematics, vol. 96, No.6,p305-11.
[3] Crawford, C. (1982). The Art of Computer Game Design, New Riders, Vancouver
[4] Dempsey, J. V., Rasmussen, K., Haynes, L. L., & Casey, M. S. (1997). An Exploratory Study of Forty Computer Games (COE Technical Report No. 97-2): University of South Alabama.
[5] Keller, J. M. (1987). Strategies for stimulating the motivation to learn, Performance and Instruction Journal, 26(8), 1-7。
[6] Keller, J. M. & Suzuki, K. (1988). Use of the ARCS motivation model in courseware design In D.H. Jonassen(Ed.), Instructional designs for microcomputer courseware, Lawrence Erlbaum, Publisher.
[7] Kulak, A. G. (1993). Parallels between math and reading disability: Common issues and approaches. Journal of Learning Disabilities, 26(10), 666-673.
[8] Piaget, J. (1962). Play, dreams and imitation in childhood. NY: Norton.
[9] Reys, R. E. (1984). Mental computation and estimation: Past, present, and future. Elementary School Journal, vol. 84, No. 5, p547-57.
[10] Reys, R. E. (1985).Testing mental-computation skills. Arithmetic Teacher, 32(3), 14-16.
[11] Vygotsky, L.S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

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Basic Consideration to Improve Self-Regulatory Skills Using Mobile Devices

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Abstract: Our research goal is to develop a system that can support learners in elementary education to acquire self-regulatory skills. Learners can enhance their learning motivation and build a foundation for life-long learning by developing self-regulatory skills as early as possible in elementary education. However, it is not easy for them to acquire such skills.
In our research, we analyze factors of difficulties in displaying self-regulatory skills and clarify support functions to reduce these difficulties. Then we develop a support system to encourage learners' continued self-regulated learning.

Keywords: Mobile device, emotional states, learning strategy, self-regulated learning

Introduction

Our research goal is to develop a system that can support learners to acquire self-regulatory skills. Zimmerman defined self-regulated learning: "students can be described as self-regulated to the degree that they are meta-cognitively, motivationally, and behaviorally active participants in their own learning process [2]."
Learners with proficient self-regulatory skills can perform appropriate, well-structured learning activities by adapting their own learning strategies in various personal situations: achieving their personal goals enhances their feelings of self-efficacy. Consequently, such learners become able to motivate their own learning activities [1][2][3].
A skill is trained by displaying the skill, in general, although training of self-regulatory skills is not embedded into the current school curriculum. In our research, we analyze factors of difficulties in displaying self-regulatory skills and clarify support functions to reduce these difficulties. We then develop a support system to encourage learners' continuous self-regulated learning by making them conscious of driving cyclic self-regulated learning processes in elementary education.

1. Self-Regulated Learning

Learners are well-known to be able to enhance their learning motivation and construct a foundation for life-long learning by developing their self-regulatory skills as early as possible during elementary education [3]. One characteristic feature of self-regulated learning is that learners must not only control their own learning activities but also must truly control their emotional state.
Emotional states of a learner significantly affect learners' application of learning strategies: it is a main factor for displaying self-regulatory skills. If learners feel uneasy about their learning, for instance, they typically fill their cognitive capacity with worry: they become

unable to allocate sufficient cognitive resources to perform learning processes. Consequently, they become unable to use adequate learning strategies that are appropriate to their own situation. Furthermore, in cases where learners have low self-efficacy, they continue using their own strategies even if they know of more proficient adequate strategies: they have no confidence to perform any different but adequate strategy.

Emotional states and learning strategies have bidirectional relations: emotional states contribute to learners' use of appropriate learning strategies, although using appropriate learning strategies improves their emotional states. Consequently, learners must combine their learning strategies with their emotional states to acquire self-regulatory skills.

Self-regulated learning processes consist of three phases: forethought, performance and self-reflection phases [5].

If the learners can perform following appropriate activities at each process, then they can drive self-regulated learning processes properly. Consequently, learners acquire self-regulatory skills.

- **Forethought:** Learners' conscious setting of their own learning goals enhances their own awareness of achieving the goal. It therefore contributes to improving personal performance.
- **Performance:** Performing meta-cognitive activities that include conscious allocation of their attentional resources contribute to improving the performance of personal learning activities.
- **Self-reflection:** If learners can infer reasons of having gotten desired outcomes as a result of personal effort, it improves the learners' feelings of self-efficacy and learning motivation. Consequently, successful learners can drive active circulation of self-regulated learning processes, adopt useful learning strategies, and improve later learning processes.

2. Design Rationale of Our System to Support Self-Regulated Learning

The design rationale of our system to develop self-regulated learning support system is to support learners to drive learners' self-regulated learning processes by themselves. To achieve this goal, the system requires embedding of support functions to eliminate the following factors of difficulties in acquiring self-regulatory skills:

(a) It is difficult for learners with immature self-regulatory skills to recognize their own learning experiences as targets of their monitoring on a self-regulated learning model.

In such cases, even if learners try to devote attention to them, then the following might be true.

(b) They no longer have sufficient information related to their experiences to learn effectively because of their forgetfulness.

(c) It is difficult to understand what activities they should perform and how they should perform them.

(d) It is difficult to acquire meta-cognitive knowledge related to using strategies because they cannot easily understand that their effects attributable to the learning processes that are influenced by many unconscious factors.

Our system supports learners by eliminating these problems. Design rationales of our system are as described below.

- **For (a):** the system provides viewpoints to induce learners to be conscious of displaying self-regulatory skills according to each process.
- **For (b):** the system provides an interface to record their learning activities easily by themselves during the performance phase.

- **For (c) and (d):** the system provides graphical information with messages to prompt their monitoring and analysis processes of their learning experiences to make causal attributions during the self-reflection phase.

3. i-SERENITY: Self-Regulated Learning Support System

We adopt iPhone/ iPod touch to support learners' self-regulated learning: mobile devices offer the great potential to follow a learner's learning contexts outside of a classroom closely, and to realize suitable and sophisticated support because of their ease of mobility and convenience. This point is important to support learners' successful self-regulated learning processes: it is necessary to analyze their learning processes in as great detail as possible. To do so, learners should record their own learning processes at every opportunity. We embed support functions into the mobile system to facilitate learners' awareness of self-regulated learning and to reflect on their own learning activities with appropriate information in individual life situations. Our system, named the i-Self-Regulated Learning Support System (i-SERENITY), supports learners as they participate in enhanced self-regulated learning at each phase.

(A) Forethought process
Enhancing learners' consciousness of adopting learning strategies is the key at this process. Learners enhance their consciousness to demonstrate their self-regulatory skills by choosing menu items. More concrete functions embedded into the system are as follows.

(1) Providing viewpoints as selection menus that learners should know in starting self-regulated learning, such as setting learning goals and learning strategies.
(2) Providing learning strategies and their explanations based on self-regulated learning task ontology, such as time management strategy, social interaction strategy, memorization strategy, rehearsal strategy, and connecting strategy. These have consistently proved to be effective for self-regulated learning.

These functions prompt learners' activities at this phase by eliminating difficulties of (a) and (c) described in section 2.

(B) Performance process
It is important for learners to enhance their self-efficacy by apprising themselves of it: this knowledge contributes to stimulation of their learning motivation.
The system prompts them to input their feelings of expectation to themselves after performing learning processes, e.g. the score they expect to get on the next exam. This step facilitates their recognition of their own self-efficacy and helps them to grasp their own states of understanding objectively. This feeling of expectation represents an important emotional state of a learner. These functions prompt learners' activities at this phase by eliminating difficulties associated with (a) and (b).

(C) Self-reflection process
The self-reflection process is crucial to encourage learners' self-regulated learning. The important point is that (i) learners must recognize and analyze their own learning experiences consciously and objectively to develop self-regulated skills, (ii) they must construct explicit knowledge by externalizing the acquired knowledge with relation to objective evidence related to their own learning experiences.
Causal attributions in this process drive circulation of self-regulated learning processes. It is important to provide useful information to facilitate the learner's appropriate awareness and causal attributions.

We embed the following support functions into the system to prompt externalization and combination of meta-cognitive knowledge for self-regulated learning based on a learner's experience of his learning processes.

(1) Providing various visualized information of the learner's learning processes appropriately so that the learner must recognize this process

(2) Providing viewpoints to analyze a learner's own learning processes based on self-regulated learning task ontology

Figure 1 shows a screen image of function (1). This is presented according to a learner's requests. It shows three lines. The top line at the left side of the screen represents changes of the target scores of weekly exams that the learner set. The middle line shows marked scores. The bottom shows the goal score of next exam that the learner set. The bar graph at the bottom represents the total learning time each week. This information triggers learners' reflections. In addition, two buttons, "Success" and "Failure" are shown under the graph to encourage the learner's self-reflection.

Figure 2 portrays a screen image of function (2) showing the assignation of causal attributions: it appears when the learner pushes the "Success" button. In this case, results show that frequency data of using each learning strategy that are related to success of her learning and viewpoints as selection menus to make causal attributions based on a self-regulated learning task ontology. Therefore, the learner can objectively review personal learning experiences as evidentiary data and make causal attributions.

Furthermore, the system displays a message to encourage the learner's continuous use of this strategy in case that the learner chose the "Success" button. This encourages the learner's recognition of the value of the strategy: it improves the learner's emotional state (self-efficacy) by combining it with the strategy. These functions prompt learners' activities by eliminating difficulties of (a), (c), and (d) described in section 2.

Figure 1: Providing visual information to facilitate the learners' awareness.

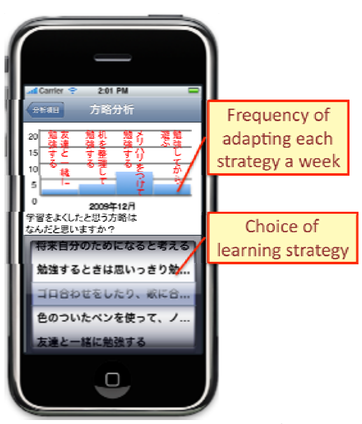

Figure 2: Providing visualized information about learning experiences with learning strategies to make causal attributions.

4. Self-Regulated Learning Task Ontology

We briefly explain the self-regulated learning task ontology as a basis of our system development. It specifies a system of concepts for performing self-regulated learning task, e.g., self-regulated learning strategy, self-regulated learning action, self-regulated learning processes, and factors of difficulties in acquiring self-regulatory skills.

The meaningfulness of building this ontology is the following.

- The system can give learners a viewpoint of what kind of data they should record as learning resources for self-regulated learning.
- The system can encourage learners to reflect on their experiences from their behavior information by specifying domain-independent behavior strategies.
- The system can provide useful information from recorded data for the learner to make causal attributions.

Figure 3: A portion of self-regulated learning task ontology.

Figure 3 presents a part of the self-regulated learning task ontology (is-a hierarchy) that we have been building. It specifies what the self-regulated learning task is. For example, self-regulated learning strategy is specified to cognitive strategy, behavior strategy, and motivational strategy. Cognitive strategies are also specified to "rehearsal strategy," "connecting strategy," "chunking strategy" and others.

5. Related Works

Many researchers have sought to develop learning support systems using mobile devices. Mobile devices offer the great potential to change real life situations to the situated learning resources: we can recognize such efforts as challenges to find a new world. For instance, Ogata et al. are developing CLUE, which can support language learning out of classes in a ubiquitous computing environment [4]. It poses questions to learners for acquiring vocabulary according to their situations by reading RFID tags attached to objects in daily life situations.

Most such approaches are intended to support learners to learn knowledge about subjects. In our research, i-SERENITY is aimed at supporting learners to improve self-regulatory skills that control their emotional states in their individual learning contexts. There are not many approaches yet to facilitate learners' meta-cognitive skill acquisition using mobile devices.

6. Concluding Remarks

This paper presented discussion of a self-regulated learning support system named i-SERENITY, which enables learners to combine their learning strategies with their emotional states through their learning experiences, thereby developing their adoption of life-long learning. Learners can recognize effects of behavioral learning strategies that affect their emotional states using our system.

We plan to conduct an experimental study in an elementary school and to evaluate the usefulness of the system in the near future.

References

[1] Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*, 191-215.

[2] Zimmerman, B. J. & Schunk, D. H. (2001). Self-Regulated Learning and Academic Achievement. *Lawrence Erlbaum Assoc Inc*.

[3] Bransford, J., Brown, A., & Cocking, R. (2000), *How People Learn:* Brain, Mind, Experience, and School, *National Academy Press*.

[4] Ogata, H., & Yano, Y. (2004). Context-Aware Support for Computer-Supported Ubiquitous Learning. *IEEE Computer Society Washington, DC, USA*, 27-34.

[5] Ito, T. (2005). An Examination of the Causal Model for the Relationships among Self-Efficacy, Anxiety, Self-Regulated Learning Strategies, and Persistence in Learning: Focused on Cognitive and Motivational aspects of Self-Regulated Learning Strategies. *Educational Technology Research*, *28*(1.2), 23-31.

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Using Mobile-memo to Support Knowledge Acquisition and Posting-question in an Mobile Learning Environment

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Abstract: This study developed a mobile-memo system that supports the knowledge acquisition and posting-question to assist learners' learning in a web-based learning environment. To understand the effectiveness of our proposed system, the data was collected from the use of the proposed system. The result showed that the mobile-memo was effective for learners to gather information in construction and reflection during the learning activities. In other words, the mobile-memo system could effectively support learners to acquire knowledge and post question relating to the learning course contents during learning activities.

Keywords: Mobile-memo, Knowledge acquisition, Mobile learning, Question-posting

Introduction

In past decade, there has been increased research for the use of digital learning and mobile tools to support mobile learning environment. Because of small size, light weight, portability and wireless communication features, handheld devices are seen as a potential tool to achieve a great positive impact on learning [7][8]. In general, handheld devices are significantly changing human-computer interaction, communication and learning activities. Research has shown that handheld devices provide new opportunities for communication and innovative learner interaction both in and out of the learning setting [4][9]. Although several studies [2] have demonstrated the benefits of mobile learning, the limitation of handheld technology for the delivery in learning objects was the small screen that could available for effective display [3]. That is, a potential limitation of such screen size leads to lack of effective presentation of information and knowledge acquisition. Besides, in such mobile learning environments learners can only retrieve learning materials given solely by the systems.

Besides, prior research showed that gender issues in technology use have been noticed. For example, the males had more positive attitudes, more confidences and more competencies than the females in using the computers and further in participations of technology-related works [6]. Additionally, female students tend to express their ideas verbally, and the least amount of visual representations [5].

This paper presents an implementation of handheld devices in support of a mobile learning on a real curriculum. From another learning perspective, it is taken into account that educational materials could be provided by the learners. By doing so, learners could actively discover their learning contents for themselves rather than via passive guidance to achieve the purpose of knowledge acquisition and sharing. The present study designed a mobile-memo system that allows students to gather information and post question to the website where they can view and share in the classroom or at home. Research questions are as follows:

1. What is the relationship between multimedia elements regarding posted content in the mobile learning?
2. What is the preference for the use of multimedia element by difference genders?
3. By using the mobile-memo system, what are the effects on learner's learning activity and their satisfaction?

1. System Description

Mobile-memo is a service that provides both handheld devices and website to support mobile learning. The workflow and operation of the system are shown in Fig. 1. The system provides a flexible web environment for both discussion and communication. In addition, the mobile-memo system could assist learners to post knowledge/questions by using handheld devices and these contents were subsequently stored in the database server.

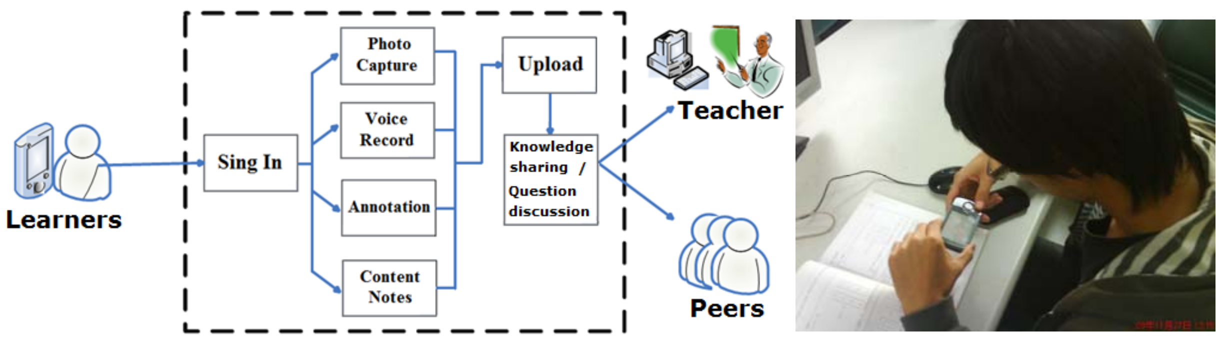

Fig. 1. System Operation Flow.

2. Methodology

2.1 Participants

The participants were included 20 graduate students (10 male, and 10 female) in Department of Information Management, and each learner has a handheld device with network communications.

2.2 Learning activities

The designed activity was to investigate the assistance of using handhelds to support a general learning activity in a mobile learning environment. Specifically, the teacher used the general methodology, which included the theoretical explanation of the concepts in class, to solve the problems for students. During and after class, the students could use handheld devices with the mobile-memo service to support their learning. They could create new contents by using the handheld devices to take photos, record sounds, handwritten notes, and input some texts. All the contents they capture were sent by network communications from the handheld devices to the platform.

2.3 Procedures

The designed learning activities were deployed for 4 months (18 weeks) in a semester including training phase, knowledge interflow and evaluation phase. The training phase took 1 week. In this phase, the teacher assistance instructed the use of the mobile-memo system and introduced the learning activities which include the learning tasks. The knowledge interflow learning activities took place in the next 16 weeks; the students' task was to investigate the process of analyzing and selecting sources/objects, by using the handheld devices to collect relevant information. Therefore, students could present their knowledge or question in the classroom or share them with peers. In the final week, each student needed to accomplish a questionnaire, indicating their perception of use the system.

3. Results

3.1 Effects on elements of multimedia used

Some of the correlations between multimedia elements were significant (see Table 1). For example, the result indicated a significantly negative correlation between photos and sounds (r=-0.831, p=0.000 < 0.01). Moreover, there were significant negative correlations between the multimedia elements used such as sounds and handwritten notes. (r=-0.463, p=0.000 < 0.01).

Table 1. Correlations between multimedia elements used.

	Photos	Sounds	Handwritten notes	Texts
Photos	1.000			
Sounds	-0.831**	1.000		
Handwritten notes	0.634**	-0.463**	1.000	
Texts	0.357*	-0.816**	0.119	1.000

***p < 0.05 **p < 0.01**

3.2 The preference in the use of multimedia elements between different genders

Figure 2 shows the results of using multimedia elements between genders. The results illustrated that most of the females' preference was to take photos (64%). Most of the males were to use sound recording (76%). This result revealed that the males and the females seemed to have different multimedia preference in the mobile-memo system.

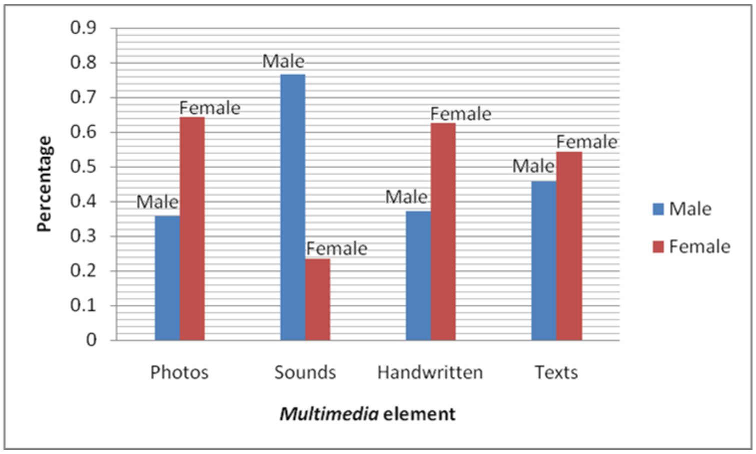

Fig. 2. Gender differences in the use of multimedia element (male = 10, female = 10).

3.3 Evaluation of students' learning attitude toward the use of the mobile-memo system and satisfaction

The effectiveness of the mobile-memo system on students' learning attitude was conducted by a questionnaire. The responses of each question in the questionnaire were designed by using a 7-point likert-scale. In which 7 stands for "strongly agree" and 1 stands for "strongly disagree". The study also examined the students' attitude from open ended question which could present more realistic response. The statistical results were presented in Table 2. We adopted the questionnaire by Arbaugh [1], the questionnaire item includes:

1. I am satisfied with my decision to take this course via the mobile-memo.
2. If I had an opportunity to take another course via the mobile-memo, I would gladly do so.
3. My choice to take this course via the mobile-memo was a wise one.
4. Conducting the course via the mobile-memo made it more difficult than other.
5. I was very satisfied with the course.
6. I feel that this course served my needs well.
7. I will take as many courses via the mobile-memo as I can.
8. Please comment the learning experience as a mobile-memo. (open ended question)

Table 2. Questionnaire results.

Item	Mean	Stand Deviation	Variance	Score >= 6
1	6.350	0.769	0.592	75%
2	6.425	0.675	0.455	90%
3	6.375	0.740	0.548	80%
4	2.570	0.670	0.450	0%
5	6.350	0.699	0.489	85%
6	6.275	0.784	0.614	80%
7	6.350	0.735	0.541	80%

Table 3. Open ended question summary.

Item	Summary
8	(a) … I want to share more helpful online resources with my classmates … (b) … Mobile-memo system is convenient for me to post article, upload photo any time and any where … (c) … when I see an event which is related to the learning concept, I can take a photo by the handheld device and upload it using mobile-memo system immediately …

According to the responses of 8th item (see Table 3), the mobile-memo system was regarded as a helpful, convenient tool in a mobile learning activity and stimulates students to look for more information on the system.

4. Discussion and Conclusions

Since handheld devices are widely used in everyday life, several studies have suggested that guiding the students to learn in the mobile-learning environment has become an important and challenging issue. In this study, the questionnaire results reflected that the mobile-memo system could be used for mobile learning, such as knowledge acquisition and posting-question. Additionally, educational practice could perform conveniently and easily any time and any place. Interestingly, taking photos was a popular activity for females; however, the study observed more males created their own audio descriptions. That was not represented students were focus in their devices, but rather that the technology mediates and extends a experience of m-learning environment. In sum, using handheld devices as a learning tool can not only assist to amplify the feature of the pedagogic theory, but also stimulate students' learning satisfaction and improve students' learning enthusiastically.

References

[1] Arbaugh, J. B. (2000). Virtual classroom characteristics and student satisfaction with internet-based MBA courses. *Journal of Management Education*, *24*(1), 32-54.

[2] Chen, G. D., Chang, C. K., & Wang, C. Y. (2008). Ubiquitous learning website: Scaffold learners by mobile devices with information-aware techniques. *Computers and Education*, *50*(1), 77-90.

[3] Churchill, D., & Hedberg, J. (2008). Learning object design considerations for small-screen handheld devices. *Computers and Education*, *50*(3), 881-893.

[4] Clough, G., Jones, A. C., McAndrew, P., & Scanlon, E. (2007). Informal learning with PDAs and smartphones. *Journal of Computer Assisted Learning*, *24*(5), 359-371.

[5] Ding, N. (2009). Visualizing the sequential process of knowledge elaboration in computer-supported collaborative problem solving. *Computers and Education*, *52*(2), 509-519.

[6] Fountain, E. J. (2000). Constructing the information society: Women, information technology, and design. *Technology in Society*, *22*, 45-62.

[7] Pownell, D., & Bailey, G. D. (2000). The next small thing: Handheld computing for educational leaders. *Learning and Leading with Technology*, *27*(8), 46-49.

[8] Roschelle, J. (2003). Keynote paper: Unlocking the learning value of wireless mobile devices. *Journal of Computer Assisted Learning*, *19*(3), 260-272.

[9] Tatar, D., Roschelle, J., Vahey, P., & Penuel, W. R. (2003). Handhelds go to school: Lessons learned. *IEEE Computer*, *36*(9), 30-37.

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The Effect of a System with GPS and e-map on Junior High School Student's Achievement and Sense of Direction in Geography m-learning

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Abstract: M-learning is an important role in e-learning environment by mobile device. However, in Taiwan junior high education, few research was to develop an m-learning system on the geography curriculum. Geography courses are quite indispensable. The sense of direction of training is one of the first studies in Taiwan junior high education of geography curriculum; however, many students' sense of direction is not particularly good. In addition, geographic information systems (GISs) and global positioning systems (GPSs) are the best technology of map in this era. Thus, this study attempts to develop a system with GPS and e-map function to foster the students' sense of direction. The participants, 12 junior high students on Taiwan for first year students, were invited to participate in this study. After the experiment, the study conduced a post-test and a satisfaction survey of the system. The results showed that using the proposed system enhances students to learn in terms of the sense of direction.

Keywords: M-learning, Geography curriculum, GPS, E-map

Introduction

In Taiwan, the geography curriculum is very vital in junior education. The sense of direction is a personal sensation skill. Generally, students in Taiwan have not any chances to learn about the sense of direction, except the junior education. In the geography curriculum, students often felt boring because they just used a compass for learning the sense of direction. Therefore, the research aimed to enhance the sense of direction for learners. To solve the limitations of the teaching methods, this study used the advance technology and moved the learning activity outdoor. In fact, e-map system is not only a navigation system, but also an education system. Through the use of e-map system and outdoor learning, the learning activities improved students learning and enhanced the attention of learning geography.

Recently, a variety of software on the navigation has been developed [8] . People used the navigator's service in presentation of route and stations. Now, many kinds of mobile device navigator receivers and professional software on the navigation have been recognized. Hence, this research used these devices with e-map system to experiment. This study investigated the effect of e-map system on junior high school student's achievement and the sense of direction in geography m-learning. The present study hope through mobile device can enhance student learning geography in terms of the sense of direction.

1. Related literature

1.1 M-learning content

As the wireless network and handheld technology advances, it is not limited to the classroom learning environment to allow time for no more conflict, ubiquitous learning since then becomes possible. Mobile devices have the potential to change the way students behave, the way students interact with each other, and their attitude towards learning [4] . Previous research has pointed out the [2] conducted an outdoor mobile learning activity for a bird-watching lesson using scaffolding pedagogy in Taiwanese elementary school. Learners can use handheld devices to share information with peers during group discussions and learning activities [7] .

1.2 Literature of geography

Geography’s study area is ‘‘the world and all that is in it” [3] . Tuzun [9] developed a 3D Multi-User Virtual Environments game in geography education. Adams [1] used SimCity 2000, a Commercial-Off-The-Shelf (COTS) game, in an undergraduate introductory urban geography curriculum.

What is the sense of direction, and how do we measure it? According to Kozlowski [6] , the sense of direction is ‘‘an awareness of location or orientation’’. Ishikawa [5] used mobile device (GPS), self-report sense of direction and paper to experiment. Above study assigned three groups to carry out wayfinding skill experiment. According to the result, they found GPS map is not really benefit for helping the learner to find the best way and goal. According to above evidences, these motivated the authors to explore the effect of mobile devices on geography curriculum in terms of the sense of direction in m-learning.

1.3 The purpose of this paper

This paper has the following objectives:

1. Through e-map system to learn the sense of direction,
2. Developing a m-learning process,
3. Assessing students’ attitudes toward the collaborative learning.

Thus, this study utilized an outdoor collaborative activity to train the sense of direction on the learners and to carry out the pre-test and post-test for evaluating their performance. Collaborative learning is very vital in this research, especially the mutual aid. In collaborative learning, the students acquire social skills by discussing and expressing their opinions. After the experiment, this study conducted a questionnaire to the students regarding the system satisfaction. Finally, this study provided some suggestions to the future researcher.

2. Method

2.1 Participants

Twelve junior high school students (6 male and 6 female) participated in this experiment. There were from Huwei Township junior high school, Yunlin County, Taiwan. Their ages ranged from 12 to 13. The experiment time was about 60 minutes, and the participants were divided into three groups (one group with four members).

This study provided each group with a mobile device, carrying e-map system. A map approximately radius 1km was selected for experiment. In addition, the e-map system provided pin function. Thus, the students could use this function to move and draw up the pins regarding their positions on the screen (800 x 480 pixels / 3.2 inch), and they can use this function to find peers (Figure 1).

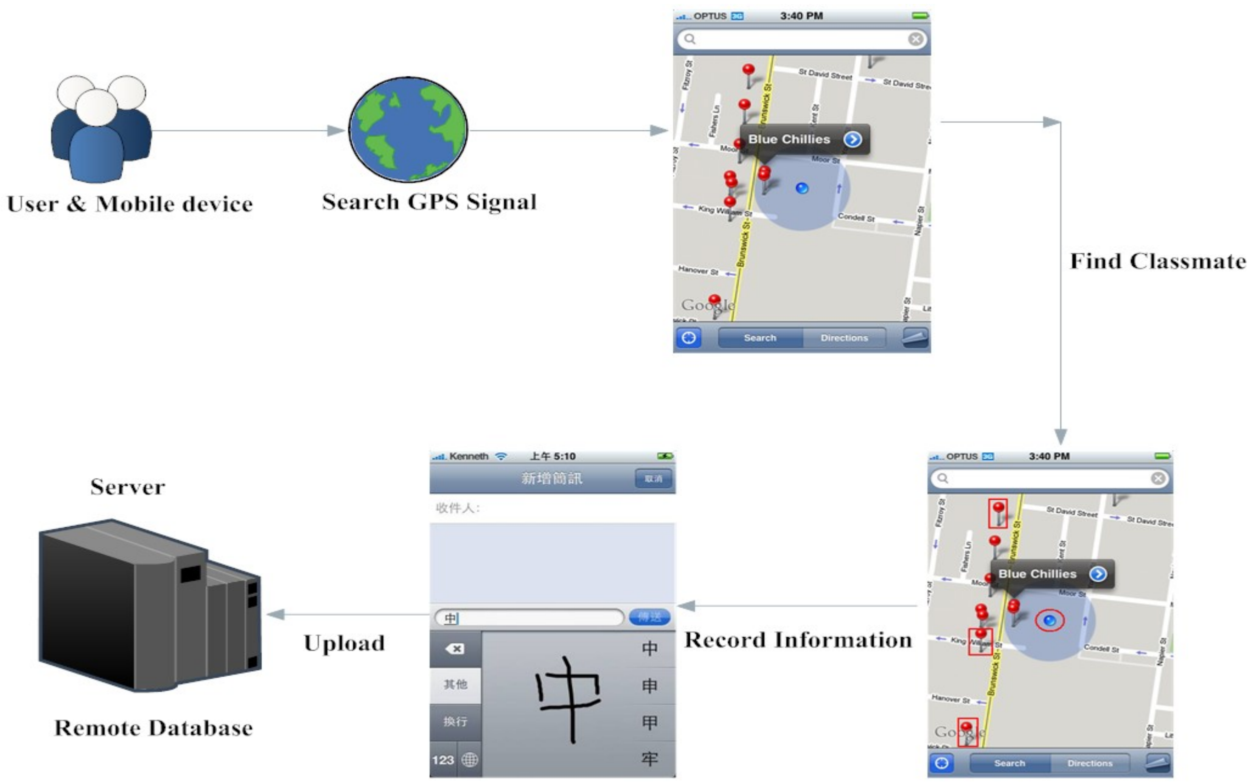

Figure1. System operating flow

2.2 Data analysis

Before the experiment, the students have to carry out pre-test. The question was divided into two parts. First part is about basic knowledge of geography (30%) and another part is about relative position and absolute position of cognitive knowledge (70%). After the pre-test, the researchers took all participants to the fixed location. They recorded assigned group coordinates by using e-map system, and reported back to the researchers. After this step, the researchers inform all participants of each group coordinate. All participants of groups used pin function to record other groups' coordinates on the screen. This study then provided several questions for students. The students were asked to reply the questions. For example, a question describes: "Please answer other groups direction."(Answer example: Southeast, Northeast). After 20 minutes, three groups changed their fixed location, recorded coordinates and answered the questions again. The researchers hint about how to record coordinates for each group. Last, a procedure was retreated based on above manner, except without any hint. After the experiment, a post-test was administered to evaluate students learning performance.

3. Result

3.1 Analysis of the result

As shown in Table 1, there was no significant difference between pre-test and post-test in terms of part1 (pre-test = 20.27, post-test = 20.20). The result indicated that after experiment students' learning performance in terms of part1 not improved. However, regarding the students' learning performance in terms of part2, a significant difference was found. In other words, the cognitive knowledge with respect to relative position and absolute position significantly improved (pre-test = 47.3, post-test = 65.13). The reason for this explanation is that students improved their geography performance after using the e-map system.

Table1. The results of pre-test and post-test

Variable	N	Mean	SD	P
Pre-test	12	67.58	2.76	0.01*
Post-test	12	85.33		
Part1: Pre-test, for a basic knowledge of geography	12	20.27	0.12	0.69
Part1:Post-test, for a basic knowledge of geography	12	20.2		
Part2: Pre-test, for the relative position and absolute position of cognitive knowledge	12	47.3	2.72	0.01*
Part2:Post-test, for the relative position and absolute position of cognitive knowledge	12	65.1		

*p<0.05.

3.2 Analysis of the questionnaire

This study used a 5-point likert scale to execute the system satisfaction, (One is strongly disagree and five is strongly agree). Overall, the results had a positive feedback. In addition, the students agreed that this teaching method could enhance the entire learning process and the interactions. Moreover, this study designed two open-ended questions, regarding the sharing and exchange of opinions, to evaluate students' views. Interestingly, the results showed that using the proposed learning mechanism could lead to a good learning environment and students not are afraid to learn the geography curriculum. In sum, the result showed using e-map system was useful and convenient for learners in learning geography curriculum.

4. Discussion and Conclusion

This study has many valuable results. The researchers believe the analysis results could provide more help on future researchers. The mobile device has many advantages, such as engaging students in learning activities and discussion and facilitating the organization of conceptual information. This study found the students could use the e-map system to train the sense of direction. In conclusion, these findings give positive support and the collected data were consistent with our expectation.

Interestingly, in the first 20 minutes each group try to record other groups' coordinates. The result revealed there exists several wrong answers. After the researchers hint, the ratio of correct answer improved. In the last phase, the results showed that the accuracy was not declined. In sum, the proposed method is useful by training the sense of direction.

Previous research showed that the rapid development of wireless communication has attracted the attention of researchers. According to this study, using handheld devices could achieve better outcome in m-learning. In the future, it is predicted more outdoor learning activities are popular.

REFERENCES

[1] Adams, P. C. (1998). Teaching and learning with SimCity 2000. *Journal of Geography, 97(2), 47–55.*

[2] Chen, Y. S., Kao, T. C., & Sheu, J. P. (2003). A mobile learning system for scaffolding bird watching learning. *Journal of Computer Assisted Learning, 19(3), 347–359.*

[3] Fitzpatrick, C. (1993). Teaching geography with computers. *Journal of Geography, 92(4), 156–159.*

[4] Homan, S., & Wood, K. (2003). Taming the mega-lecture: wireless quizzing. *Syllabus Magazine, October 7–8.*

[5] Ishikawa, T., Fujiwara, H., Imai, O., & Okabe, A. (2008). Wayfinding with a GPS-based mobile navigation system: A comparison with maps and direct experience. *Journal of Environmental Psychology 28 (2008) 74–82.*

[6] Kozlowski, L. T., & Bryant, K. J. (1977). Sense of direction, spatial orientation, and cognitive maps. *Journal of Experimental Psychology: Human Perception and Performance, 3, 590–598.*

[7] Lai, C. Y., & Wu, C. C. (2006). Using handhelds in a Jigsaw cooperative learning environment. *Journal of Computer Assisted Learning, 22(4), 284–297.*

[8] Ruchter, M., Klar, B., & Geiger, W. (2010). Comparing the effects of mobile computers and traditional approaches in environmental education. *Computers & Education, 54, 1054–1067.*

[9] Tuzun, H., Yılmaz-Soylu, M., Karakus, T., Inal, Y., & Kızılkaya, G. (2009). The effects of computer games on primary school students' achievement and motivation in geography learning. *Computers & Education, 52, 68–77.*

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Mobile Virtual Devices for Collaborative M-Learning

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Abstract: The increasing use of mobile devices to support collaborative activities creates a need for developing new methods and perspectives to facilitate information sharing. In this paper, we present an approach for information sharing in mobile collaborative settings through the use of Mobile Virtual Devices (MVD). MVD emerges as a new conceptualization of an organization of mobile devices that supports collaborative tasks. The use of MVD allows designers and users to interact with and through mobile devices in novel ways, considering the aggregation of mobile devices as a single entity. The notion of MVD has been conceptualized on the idea of multirole devices, using components to provide and consume resources.

Keywords: mobile device organization, shared resources, collaborative learning

1. Introduction

The increasing use of mobile technologies in our daily life and improved mobile device performance allow for a wide range of solutions that support various learning activities [2]. The increased adoption of mobile learning (M-learning) solutions allows for learning activities to be performed in indoors and outdoors settings in ways that were not possible before. This provides provisioning for design and implementation of learning activities in a wide range of authentic environments that go beyond the traditional classroom. Providing mobile support in these changing settings means that mobile applications must be adaptive to the environment, thus facilitating the flow of information, provision of services and collaboration in new complex situations.

Mobile devices have several limitations in comparison to regular desktop computers. For example, Ally [2] mentions *display limitation* as a central issue for mobile learning applications and Jones & Marsden [9] point out the unavoidable constraint of the size of the viewable screen. Beside the screen issue, the diversity of mobile devices is large, for instance, regarding available resources (e.g., camera, GPS, connectivity features, etc). Some projects that utilize mobile technologies address this diversity by combining different devices and their resources in order to provide extended functionalities to the users [3]. For instance, Ballard [3] mentions that sharing information can be performed by the use of Pico Nets, Home Servers, and Shared Displays. Sharing data sets belonging to a first device with a second one in order to support mobile collaboration is one possible solution.

In this paper we introduce the concept of MVD and describe the potential benefits of this approach in the field of mobile learning. A MVD may be considered as an alternative approach to mobile sharing, where aggregated devices constitute a MVD, which allows for resource sharing within this aggregation. Our approach may be contrasted to the more traditional approaches where mobile devices, acting as separate units, collaborate and share resources (described in section II). In section III, we present the MVD approach in more detail, including the main notions behind the concept. Some benefits of using the MVD approach are illustrated in two scenarios in Section IV. Finally we conclude and present future avenues of research in Section V.

2. Related Efforts

Recent efforts in the field of M-Learning have explored potential benefits of information and resource sharing in a variety of settings. Several projects have investigated how data between mobile devices can be exchanged in order to accomplish different types of learning tasks and where the display is shared as a resource as well [1, 3, 4, 11].

One of the goals of the Mobile Notes project is to "*support classroom discussions with mobile devices and electronic whiteboards*" [5]. Mobile Notes aims to bring technology advances to the classroom by providing PDAs and one Shared Space in a digital whiteboard. Sharing information between students is supported by a centralized database. A centralized solution that allows for asynchronous information exchange is convenient in some scenarios. However, sometimes data is highly volatile, making direct communications in a synchronous manner more suitable [7]. Another effort in this direction is Collpad [1], where a central repository is located in the teacher's mobile device, and responses from students are sent to this central node using WiFi communications. Even if this approach is closer to a mobile-to-mobile information exchange, it is still dependent on WiFi communications, making it difficult to deploy in outdoors settings. Moreover, resource sharing is limited to student response exchange while support for more complex resource sharing is lacking. Camaleon-RT [4] illustrates how device interface sharing let users interact seamlessly to a multi-display device. Pick-and-Drop is another example of a system that provides functionality to pick and drop objects between devices [11].

The solutions described above are particular for sharing specific types of information and resources and were conceived for environments with unrestricted communication channels. An outdoors-learning environment that employs a GSM network is something completely different [12]. Moreover, our approach should not be limited to one-project goals, such as display or GPS sharing. We envision a solution which is scalable and extendible with respect to future requirements. In the following section, we introduce the MVD and its goal to bring multiple roles to mobile devices [7], in order to address all possible situations for information and resources sharing present in M-learning activities.

3. The Proposed Approach

Many M-Learning projects rely on the use of several mobile devices utilizing their capabilities in terms of connectivity, package of sensors [12] and activity. As each M-Learning activity has different functional requirements, different mobile devices with distinct features may be included in the activity toolset in order to fulfill requirements for a particular experiment. When mobile devices are considered as individual entities, it can be costly to find a device that addresses all requirements specific to a learning activity. With the MVD we advocate another approach, where we consider organizations of mobile devices as single entities that provides the support required by the learning activity. This approach will not only allow for the combination of features provided by resources in one of the mobile devices, but also to combine resources in different mobile devices. MVDs make it possible to comply with functional requirements through the use of several simpler, cooperating, devices. Moreover, it makes possible to create unique features through the combinations of resources from a MVD, e.g. data manipulations of GPS coordinates generated by the devices that are part of the MVD can be used to perform specific calculations, or quality enhancing features such as improving the accessibility of a device using ambient networking strategies.

Sharing resources between mobile devices presents a number of challenges that need to be addressed; accessibility and communication between devices, organization mechanisms for coordination in the MVD, and mechanisms for service provisioning, discovery and consumption. Moreover, a MVD communication language is required for members in the MVD to define, form, and coordinate according to specific activity requirements. Fig. 1 presents a component diagram for the devices that comprise a MVD. Device resources should be considered as service instantiations in the figure. We describe the characteristics and dependencies of the components present in our approach below.

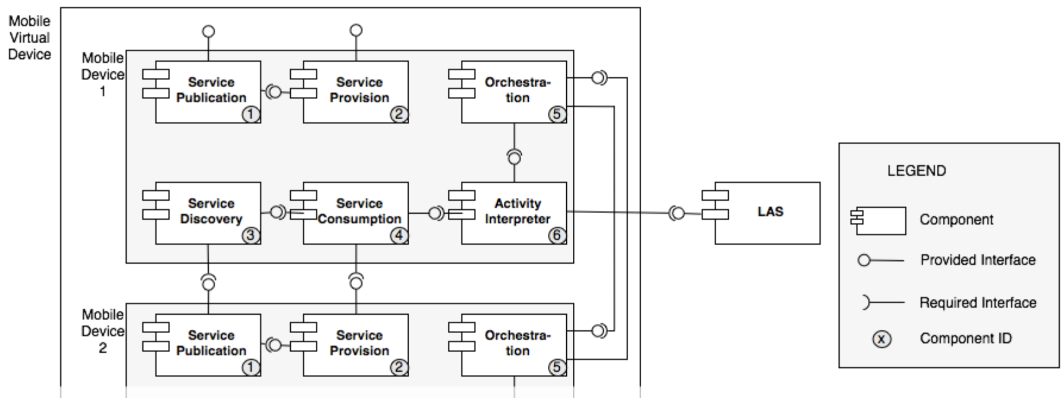

Figure 1. UML Component Diagram. Components for the MVD construction

The components in Fig. 1 provide a minimal set of functionality for resource and service sharing. Fig. 1 specifically illustrates resource sharing through services between two mobile devices in a MVD. All devices in a MVD require the 6 components depicted in Fig. 1 and described below. In one specific scenario, Device 1 retrieves the activity script from a Learning Activity Server (LAS) [7], where activity flows are located. An Activity Interpreter component (C6) analyzes the script and identifies the resources required to perform the activity. The second step to be performed is to identify the location of the required resources, if present in the MVD. Two components are involved in the lookup process; the Service Discovery (C3) and the Service Publication (C1) components. C1 publishes the services available in a mobile device, together with service description and service consumption information. This allows the C3 to identify a proper service required in the activity and to understand how it should be consumed. Consequently, the Service Consumption component (C4) can make use of the services provided by Service Provision (C2). All devices in the MVD must share knowledge of the existing organization, provided by the Orchestration component (C5), defining the role to play for each on of the devices in the MVD. A more detailed, technical, description of the MVD and its components is presented in [8].

Communication between devices in the MVD will address the channel limitations in outdoors settings. A previous solution presented in [7], permits communication over WiFi, GPRS and 3G channels, covering most of the situations for indoors and outdoors settings. In the illustrative case, the activity script is offered by the LAS, but it could also be stored locally in a MVD participant, as an available service.

4. Use Cases

In this section we present two educational scenarios where the notion of MVD has been applied in order to illustrate the potential benefits of this approach. The first case is related to the MULLE (Math edUcation and pLayful LEarning) [6] project, an effort carried out in Stockholm in November 2009 exploring how to support learning with mobile devices in the field of Mathematics. The second instance described in 4.2 is an evolution of case 1.

4.1 MULLE (Sharing GPS and Display resources)

An initial implementation of the proposed MVD approach was tested in the MULLE project with two groups of young learners [6]. From a mobile infrastructure viewpoint, each group was given two mobile devices that formed the MVD that combined two screens and two GPS modules. One of the mobile devices in the MVD communicated with the LAS to receive the activities and to submit the students´ answers. This is presented in Fig. 2 below with the "Perform Learning Task" use case. Fig. 2 also depicts how components from in Fig. 1 are involved. This use case requires from the Activity Interpreter component (C6) to retrieve and interpret the task scripts from a LAS. In this case, two devices formed the MVD. This configuration enables students to calculate distances using two GPS receivers, one per mobile device. Moreover, the fact that the students had two mobile devices allowed for the application to split the visual information along the two mobile phone displays and let the students visualize more information simultaneously. It should be noticed that calculating the distances, as illustrated in Fig. 2, requires discovery of GPS modules (C3), a device to publish and offer the GPS service (C1, C2) and the consumption of this service (C4).

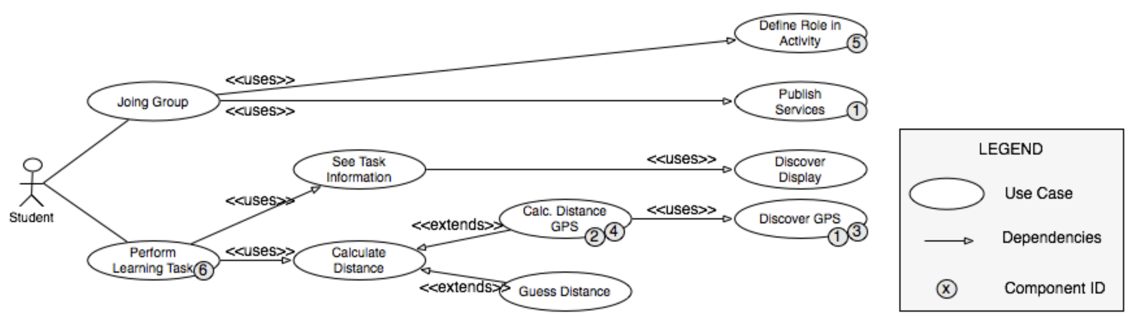

Figure 2. UML Use Case diagram. Numbers link Use Cases to required Component

4.2 MULLE v.2 (dynamism in student group creation)

A new use case was added to the preceding MULLE system. To decrease the centralized control of how pupils solve the tasks, they are allowed to create teams on the fly, instead of having them defined prior to the activity. This introduces new dynamics in the composition of students´ groups, therefore devices in the MVD, which requires the identification of the new existing services. In Fig. 2, this is captured in the "Join Group" use case that requires Orchestration (C5) and publication of the offered services to the MVD (C1). Based on the two cases described abover, we identify two main benefits in the use of MVDs in mobile collaborative scenarios. (1) Resources can be shared between devices by consuming them through the implemented interfaces. In comparison to previous solutions, MVD can be expanded to allow not only display sharing, but new resources as well. (2) The possibility of dynamic creation of teams, thanks to the facilities provided by the orchestration and service publication components.

5. Discussion and Future Efforts

In this paper we have introduced the notion of Mobile Virtual Devices (MVD) and its use in the field of M-Learning. A MVD clusters devices and tools in a learning activity into a single entity and promotes the use of their full capabilities in order to offer new ways for user interaction and resource utilization. The implementation of MVD generates a set of challenges, such as connectivity issues, dynamic configurations, and a MVD communication language. Our current results indicate how some of these challenges could be tackled and how scalability from the technological point of view can be achieved by extending the offered services. We believe that our approach opens up a new door to M-Learning activity designers that deals with settings and activities where multiple devices can be inter connected conceptually and share a MVD space, thus creating new ways of interaction and, in turn, facilitate the activity design phase.

The potential benefits identified in the scenarios encourage us to continue exploring how to utilize MVDs in mobile collaborative environments. Future research efforts include analysis and design of more generic cases which requires a deeper understanding of the roles of mobile devices in relation to the learning activity system, the learners, and the activities along other components in the software ecosystem [10].

References

[1] Alvarez, C. et al. (2009). Teaching Communication, Interpersonal and Decision-Making *Skills in Engineering Courses Supported by Technology*. International Journal of Engineering Education

[2] Ally, M. (2004). Using Learning Theories to Design Instruction for Mobile Learning Devices. *Proc of MLEARN 2004*, Rome, Italy

[3] Ballard, B. (2007). *Designing the Mobile User Experience*. Wiley

[4] Balme, L., Demeure, A., Barralon, N., Coutaz, J., Calvary, G. (2004). Cameleon-RT: A software architecture reference model for distributed, migratable, and plastic user interfaces *LNCS, 291-302*

[5] Bollen, L., Juarez, G., Westerman, M. Hoppe, H. U. (2006) PDAs as Input Devices in Brainstorming and Creative Discussions. *Proc of IEEE WMUTE*, Los Alamitos, CA

[6] Eliasson, J., Nouri, J., Ramberg, R., & Cerratto Pargman, T. (2010). Design Heuristics for Balancing Visual Focus on Devices in Formal Mobile Learning Activities. mLearn 2010, Valletta, Malta

[7] Gil, D., Pettersson, O. (2010). Providing Flexibility in Learning Activities Systems by Exploiting the Multiple Roles of Mobile Devices. *Proc of IEEE WMUTE 2010*.

[8] Gil, D., & Andersson, J. (2010). Enhancing Mobile Learning Activities by the Use of Mobile Virtual Devices – Implementation and Technical Issues. *Accepted in INCOS 2010.*

[9] Jones, M. & Marsden, G. (2006). *Mobile Interaction Design*. Wiley

[10] Pettersson, O., Andersson, J., Svensson, M., Gil, D., & Milrad, M. (2010). On the Role of Software Process Modeling in Software Ecosystem Design. *2nd Workshop on Software Ecosystems in conjunction with 4th European Conference on Software Architecture 2010*, Copenhagen, Denmark.

[11] Rekimoto, J. (1997). Pick-and-Drop: A direct manipulation technique for multiple computer environments. *Proceedings of UIST'97*. ACM, 31-39

[12] Wikman, J. and Dosa, F. (2006). Providing HTTP Access to Web Servers Running on Mobile Phones. *Nokia Research Center* NRC-TR-2006-005

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Supporting Awareness of Learning Partners for Mobile Language Learning

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Abstract: This paper proposes a Social Networking Service site based mobile environment for learning foreign languages called SONLEM, which supports learners to find a partner who can solve the language learning problems at the online community, and an appropriate request chain of friends will be recommended upon their request. The learner can practice his second language with a native speaker who is learning his language.

Keywords: Mobile learning, SNS, foreign language learning.

Introduction

In recent years, participation in online Social Networking sites like MySpace, Facebook and Mixi is very popular for young people. All of these services allow users to create online profile and share personal information with friends. The Social Networking Service (SNS) has got a lot of attention. The SNS is defined as a service that “allow(s) individuals to present themselves, articulate their social networks, and establish or maintain connections with others” [1] or “a site that allows users to create individual profiles in hopes of making contact with other site users that share similar interests or goals” [2]. The number of people who are interested in using the SNS is growing quickly from 2006 to 2010. Users use it to write the diary, read and comment the others’ diary to communicate together.

Moreover, using the mobile devices such as mobile phone, PDA, iPad, we can access the Internet by the wireless at the University, Airport, Office, Station, Family, etc. All of these technologies have given birth to the Mobile Learning field, Mobile Learning is increasing worldwide.

We propose a collaborative learning SNS based mobile learning environment for language exchange and call it SONLEM (<u>So</u>cial <u>N</u>etworking based on Language Exchange site in Mobile learning environment). This is a Mobile Assisted Language Learning (MALL) system. The benefits of m-learning in language education have been widely documented [3,4].

The SONLEM environment supplies learners to study the second language. It allows the members to find foreign language partners, practice foreign language with native speakers, share knowledge, interact, collaborate, and help each other. It can support to find foreign language partner who can help problem-solving and to enhance cooperation between learners. The SONLEM environment is a website for language exchange and international communication. It is supported that each learner has a mobile device connected to the Internet through wireless connection. We make the system can be accessed not only by personal computers but also by mobile devices such as PDA, iPod/ iPad, mobile phone, etc.

1. Language exchange

Language exchange is a method of language learning based on mutual language practicing by learning partners who are speakers of different languages. (http://en.wikipedia.org/wiki/Language_exchange). It is two or more people who speak different languages practicing each other's language.

In a language exchange, learners practice more than in a class, talking with native speakers of the language they are learning. In a class, there is very little time to practice speaking, because a lot of time is spent on instruction and the class may have too many learners to give everyone enough meaningful practice. That means learners are not used to listening to native speakers and may not be able to understand them. A language exchange with native speakers is a good way to improve your language skills. It is also help to learn the real spoken language of the culture, informal expressions and slang.

It is very important to encourage not only individual learning but also collaborative learning in order to augment practical communication among learners and accumulation of the expressions. The SONLEM environment can employ Computer Supported Collaborative Learning (CSCL) that focuses on the socio-cognitive process of social knowledge construction and sharing based on social interaction [5]. This paper describes the design and the implementation of the SONLEM environment.

2. The SONLEM Environment

When a learner faces problems in daily life learning, he will searches the answers on the Internet using search engines, such as Google, Yahoo, etc. The problem is, however, there are lots of irrelevant answers. The learner needs a reliability answers.

In SNS, the members not only have direct personal relationships such as friends, but also have indirect personal relationships such as friends of friends, so the members of the SNS have mutual trust and closeness. According to this characteristic, as a SNS member, a reliability answer can be expected. A new problem is how to find the appropriate person to solve the problem.

In order to find an appropriate person who can help the learner to solve the problem, learner has to be aware of other person's profile, interest and past actions [6]. In this language learning system, the profile includes members' mother tongue, second language and language they are learning.

At first, the learner should write some keywords about the problem and searches it on the SNS, and then the SONLEM will be aware of the person who can effective solve the problem through the other person's profile, action history and individual information, and recommend appropriate person to the leaner.

There is a formula for calculating the appropriate degree. Consider that n is the number of the keywords that the learner input, and compare with the other person's profile, interest and actions, the number of the matched keywords is nm. It is assumed that the Level of Matched Keywords (LMK) is calculated as follows:

$$\left(LMK = \frac{n - n_m}{n} \right) \quad \text{, where} \quad 0 \le LMK \le 1$$

In case of LMK value is equal or close to zero, then the person will be recommended as an appropriate person who is close to the learner's request.

Only finding the appropriate person is not enough, in case the person is a stranger for the learner, how to get help from him?

When a learner needs to ask for help from the stranger, the SONLEM environment is able to advance the learner an appropriate chain of friends (CF), and then the learner contacts the

stranger for help tracing the CF.
In case that there are many CFs, the SONLEM environment recommends the best CF according to the strength of the personal relationship and the length of CF.

2.1. Strength of Personal Relationship (SPR)

As we know, the personal relationship is different in SNS. Some personal relationships are very close: They are friends, family members, colleagues, etc. Other personal relationships are unfamiliar: They are strangers, and they have no personal contacts. In SONLEM environment, the personal relationship is classified into five levels based on the SPR. Level 1 is an unfamiliar relationship and level 5 is an intimate relationship.
Before using the SONLEM environment, the learner should find the friend and preset the level of the personal relationship.
There is a formula for calculating the SPR. Consider that n is represents the level of the personal relationship which was set by the learner before. It is assumed that the SPR is calculated as follows:

$$\left(SPR = \frac{5-n}{5} \right) \text{, where } 0 \le SPR \le 1 \text{ and } n = \{1,2,3,4,5\}$$

In case of *SPR* value is equal or more close to zero then the personal relationship is more intimate, and *n* is a natural number from 1 to 5.

2.2. Length of CF (LCF).

“Length” means the numbers of the intermediaries in the CF. Milgram conducted several experiments to examine the average path length for social networks of people in the United States, he found that anyone can be connected to any other person through a chain of acquaintances that has no more than five intermediaries. The experiments are often associated with the phrase "six degrees of separation" [7].
According to the "six degrees of separation" theory, we can know a social network typically comprises a person's set of direct and indirect personal relationships, and the length of the CF is no more than six persons. So we get a formula for calculating the *LCF*. Consider that n is the number of the persons in the CF.

$$\left(LCF = \frac{n}{6} \right) \text{, where } 0 < LCF \le 1 \text{, n} = \{1,2,3...\}$$

In case of *LCF* value is more close to zero then the number of the persons is smaller, and *n* is a natural number.

2.3. CF Adequacy (CFA).

The CF should not be only the small number of the persons, but also with a close relationship between these persons. It is the conditions to determine whether the CF is appropriate or not.
Consider that *n* is the number of the persons in the CF, m_k is level of the personal relationship for the person *k*. Merge two formulas (*SPR* and *LCF*) into one formula, and we get a formula for calculating the *CFA* in the following:

$$\left(CFA = \sum_{k=1}^{n} \left(\frac{k}{6} * \frac{5-m_k}{5} \right) \right) \text{, where } 1 \le m \le 5 \text{, } n = \{1,2,3...\} \text{, and k} = \{1,2,3...n\}$$

In case of *CFA* value is more close to zero then the CF is more appropriate, *n* is a natural number, and *k* is a natural number from 1 to *n*.

3. Implementation

We used wireless LAN (IEEE 802.11b), Tomcat 5.0 as the server and ran it on the CentOS5.0, used Java to develop the SONLEM environment. The Database schema is designed and implemented using PostgreSQL in order to store all learner profiles, learner actions, messages and information etc. The Figure 4 shows the interfaces on the PDA.

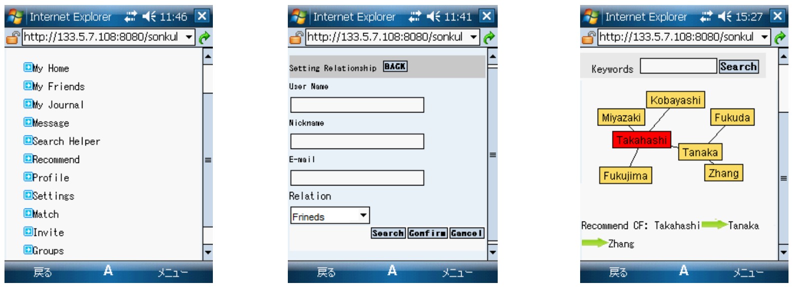

Figure 4. PDA.

4. Conclusion and Future work

In this paper, we proposed the SONLEM environment for language exchange, and the point is it supports learner to get help from other SNS members, at the end makes them help each other. The SONLEM environment is also very beneficial to be taught and corrected by a native speaker of the language you are studying. A language exchange is more effective than the other popular ways to practice a foreign language. By using the SONLEM environment, users can teach and learn languages as well as have international exchanges with each other.

For the future work, we will open this system to the public and evaluate it.

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References

[1] N. B. Ellison, C. Steinfield, and C. Lampe. (2007). “The benefits of Facebook “friends:” Social capital and college students’ use of online social network sites.” Journal of Computer-Mediated Communication, 12(4), article1. Retrieved on 10 August, 2007, from http://jcmc.indiana.edu/vol12/issue4/ellison.html.

[2] R. Hupfer, M. Maxson, and R. Williams. (2007). MySpace For Dummies. Hoboken, NJ: Wiley Publishing, Inc.

[3] P. J. Kiernan and K. Aizawa. (2004). Cell phones in task-based learning. Are cell phones useful language learning tools? ReCALL 16(1), 71-84.

[4] K. Schwienhorst (2000). Virtual reality and learner autonomy in second language acquisition. Unpublished PhD thesis, Trinity College Dublin.

[5] C. O'Malley, “Designing computer support for collaborative learning”, Computer Supported Collaborative Learning, NATO Asi Series, Series F, Vol. 128, Springer-Verlag, 1994, pp. 283-297.

[6] M. El-Bishouty, H. Ogata & Y. Yano, “Personalized Knowledge Awareness Map in Computer Supported Ubiquitous Learning”, Educational Technology and Society Journal, Vol.10, No.3, 2007, pp.122-134.

[7] S. Milgram, "The Small World Problem", Psychology Today, 1967, pp 60 - 67.

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Understanding the Features of Digital Pen Use in Initial Introductory Lessons

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Abstract: In this paper, we discuss the present state and features of the digital pen, as well as its use in school lessons in Japan; it does so by undertaking an investigation of related systems and research, executing a questionnaire survey, and implementing its use in a real classroom setting. We discuss the Anoto digital pen system while reviewing related research studies; we found some of those studies helpful, as they address the issue of sharing each student's writing and, by extension, reflections on their ideas and thought patterns. We then describe the results of the questionnaire on the use of digital pens before and after lessons. The results revealed that adults tend to have negative images of the system prior to actual use. If learners have such images, teachers should work to counter students' system-use anxieties, in the initial introductory stages; by doing so, learners could find the system attractive and discover its effectiveness. We believe they would understand and appreciate the use of the digital pen, given the causal relationships we discovered through a covariance structure analysis of questionnaire data. Furthermore, these causal relationships were demonstrated in interviews with teachers who suggest that students were most appreciative of the system only when teachers worked to make its use as stress-free as possible.

Keywords: Digital pen system, handwriting, sharing students' writing, real classroom setting, questionnaire survey

Introduction

Since the 1990s, computer rooms in schools all over Japan have been adequately equipped with computers and internet access facilities. Furthermore, even ordinary classrooms have been introducing information and communication technology (ICT) since the 2000s. We call this trend the "electronification of the classroom." We believe that the next stage of innovation in ordinary classrooms is to bring about the electronification of students' pens and notebooks. Addressing these tools is of crucial importance to educational practices, as outlined below. Teachers continually modify learning processes and teaching methods on the basis of formative evaluations, and it is essential that they understand the unique traits of their students and the underlying processes involved in assimilating lesson information. Therefore, we consider that as teachers conduct lessons, they will need to check their students' notebooks, as the information therein would be representative of their thinking processes and their situation *vis-à-vis* the lessons delivered. However, it is difficult for teachers to check the notebooks of all students while a lesson. One of the solutions to this problem is to scan and save students' notes through the use of digital pens, and to review them on a nearby laptop computer or on the projection screen itself. Furthermore, from the viewpoint of the learners, students would be able to more easily reflect, in their writing, their thought processes and ideas by using a digital pen. If students had the option of using a shared notebook system, they could participate in collaborative and interactive learning wherein they could easily read other students' writings and engage in related discussions.

1. Related Work

2.1 Digital Pen System

Our knowledge is primarily of two digital pen systems: the Anoto system and the ultrasonic wave system. However, the balance of the paper focuses on the former.

The Anoto system requires the use of the exclusive paper depicted in Figure 1. Numerous dots are printed on the paper in a special arrangement. An Anoto digital pen can read the dots by using a built-in camera, and it records the handwriting and figures written on it by the users (Figure 2) [1]. Although the Anoto digital pen requires the use of this special paper, no other device is needed.

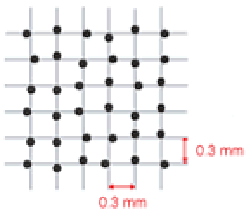

Figure 1 Dot pattern on exclusive paper [1]

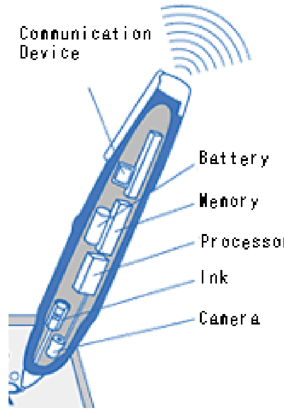

Figure 2 Anoto digital pen system [1]

2.2 Related Research

Some researchers have indicated the benefits of using digital pen technology in education. Kawamura [2] used the digital pen in elementary English classes and reports that the system helped present the ideas of each student; further, the system could convey the written thoughts of students virtually without any delay, and thus helped in carrying out collaborative learning. Finally, the students, of their own accord, were very receptive to the digital pen solution. Wang et al. [3] conducted case studies in three classes at their university and found that the pen-computing environment empowered students and motivated them to acquire knowledge in the realms of the cognitive domain, the affective domain, and communication. Furthermore, it also made learning a more enjoyable experience for the students. It is interesting that the studies undertaken by Kawamura and Wang each highlights the collaborative, interactive, and communicative aspects of learning, which may lead us to consider the enhanced feasibility of collaborative learning when the digital pen system is employed.

Miura et al. [4] developed AirTransNote, a computer-mediated classroom collaboration system that can send a student's handwriting on an ordinary notebook to the teacher's computer by using an ultrasonic wave digital pen system and the services of a personal data assistant device and a wireless local area network. In later years, Miura et al. adopted the Anoto digital pen system and were able, again, to share student handwriting. We consider Miura's research a milestone in the digital pen research field. The four aforementioned studies ([2]–[4]) are helpful in the following ways. They address the subject of the digital pen and its use in classroom settings, and several of them have stated that the digital pen system environment is effective in information-sharing within the classroom; moreover, by using it, learners could communicate with each other in a more comfortable and efficient manner. They also found that the system helped learners review their own handwritten activities and their thinking processes.

Nonetheless, according to our survey results, it seems that learners are unaware of the effectiveness of digital pen systems in the initial, introductory stage of use, and they did not appreciate the technology's potential [5]. This is a little surprise to us, because the digital pen system adapts the traditional learning environment and it seems both problem- and stress-free. We will address and discuss this problem below.

3. Questionnaire on Digital Pen Use before Real Lessons

As part of our plan to introduce digital pen systems to classrooms in Japan, we organized a questionnaire for university and primary-school students. We asked students for their perceptions regarding this proposed introduction to digital pen technology.

3.1 Survey Methodology

The outline of this survey is as follows: The participants included the students of two classes of a course called "Information Literacy Practice 1," delivered at Tokyo Metropolitan University, and one class of a course named "School Education and Multimedia," delivered at Chiba University. In all, 102 university students participated. The survey was carried out on May 8, 2009 and May 6, 2010. Moreover, we also surveyed two sets of primary-school students, in order to compare their responses to those of university students: 27 were from Sakae primary school and another 25 were from Tatsunuma primary school, for a total of 52 primary-school students. The survey was carried out on December 21, 2009 and January 13, 2010. This questionnaire was modeled on another questionnaire that had been designed by the National Institute of Multimedia Education in Japan [6]. First, students watched a three-minute video of a classroom where a lesson was under way and whose students used a digital pen system. This was followed by a formal introduction to the digital pen system. Next, the students filled out our questionnaire on our universities' e-learning systems.

3.2 Survey Results, and Discussion

Table 1 shows the survey results, as well as the items and basic statistics of the questionnaire. The italicized questions are those in which the points have been reversed. The table indicates that the primary-school students' answers ranked significantly higher than those of the university students ($p < 0.01$, except questions 1, 2, 8, and 15).

It seems that adults tend to have negative attitudes toward new ICT tools. Although we have prepared digital pens for researchers and teachers participating in a conference, meeting, and panel discussion—about 20 people in total—nobody used them. We therefore considered the importance of how this technology is introduced to prospective users. How can we improve users' attitudes toward it in the initial stage of use? To answer this question, we performed a covariance structure analysis of our questionnaire data.

Items (each a five-point scale, except question 16)	Prim. Sch. Stu.		Univ. Stu.	
	Mean	S D	Mean	S D
Question 1 The system would be interesting when I use it.	4.06	1.056	4.13	0.792
Question 2 *The system will make me tense when I use it.*	3.04	1.328	3.09	1.234
Question 3 I want to use the system.	4.13	1.010	3.66	1.023
Question 4 The system will be useful for learning.	4.25	0.813	3.40	1.017
Question 5 We can easily learn lessons when we use it.	3.92	0.904	3.01	0.960
Question 6 *Physical pen and paper are better.*	3.15	0.916	2.40	0.882
Question 7 The efficiency of learning will improve when I use it.	3.71	0.977	2.96	0.943
Question 8 *The operation of the system will impose burdens on me.*	2.94	1.243	2.74	1.134
Question 9 *It will be a burden for me as other students will be reading my writing.*	3.29	1.289	2.65	1.078
Question 10 I can enjoy the process of learning when I use it.	3.98	0.828	3.36	0.973
Question 11 I will positively participate in the lessons if I use it.	3.54	0.979	2.85	1.028
Question 12 I will concentrate on the learning when I use it.	3.33	0.993	2.50	0.980
Question 13 *I will worry about the individual information which the system will record.*			3.00	1.072
Question 14 I will be satisfied with the learning when I use it.	3.50	1.038	2.69	0.901
Question 15 I will have a better chance to edit the information when I use it.	3.27	1.097	3.08	1.105
Question 16 Please enter your comments and thoughts.				

Table 1 Results of questionnaire (Points in italicized questions are reversed)

3.2.1 Covariance Structure Analysis

In this subsection, we discuss the causal relationship between the items in the questionnaire, as determined through an analysis of covariance structures. We conducted exploratory factor analysis for 14 items and used the maximum likelihood method to extract the factors. Four factors were extracted when the selection criterion was an eigenvalue ≥1. Table 2 shows the factor pattern of a result conducted by Promax rotation. Correlations among the factors are shown in Table 3. We excluded questions 3, 5, and 6, each of which was a high point in more than one factor and so on; we labeled these four thus: "Appreciate digital pen use in learning" (factor 1), "Effectiveness of digital pen use" (factor 2), "Burden of digital pen use" (factor 3), and "Attractiveness of the digital pen" (factor 4) (Table 3). These four factors were then hypothesized as being latent variables that affected each of the 14 items. These four factors suggest some causal relationship, because there were correlations among them, as shown in Table 3 [7]. First, we assumed that students would find the digital pen attractive only if they did not think that using it would be ineffective; for this reason, we drew a path between "Burden of digital pen use" and "Attractiveness of the digital pen." Second, we supposed that students could determine the effectiveness of the digital pen only if they were attracted to it, and so we drew a path between "Attractiveness of the digital pen" and "Effectiveness of digital pen use." We had been drawing the path figure in this way.

	Fac. 1	Fac. 2	Fac. 3	Fac. 4
Q11 Incentive to study	0.954	–0.109	–0.003	0.07
Q12 Concentration on lessons	0.723	0.045	0.118	–0.117
Q14 Satisfaction in learning	0.709	0.058	–0.045	0.104
Q4 Useful	0.079	0.759	–0.013	–0.034
Q7 Efficiency	0.175	0.637	–0.028	–0.108
Q15 Improve editing skills	–0.056	0.486	0.18	–0.032
Q2 Strain	0.014	0.238	0.855	0.056
Q9 Burden of opening notes	–0.107	–0.012	0.608	0.087
Q8 Burden of operation	0.177	–0.13	0.423	–0.1
Q1 Interesting	0.069	–0.149	0.074	0.952
Q10 Want to use	–0.157	0.449	–0.116	0.413
Q5 Enjoy	0.405	0.2	–0.077	0.303
Q3 Can study easily	0.334	0.507	–0.045	–0.17
Q6 Prefer ordinary pen	0.064	–0.576	0.002	–0.074
Factor contribution	3.584	3.679	1.700	1.827

Table 2 Four factors extracted

	Fac. 1	Fac. 2	Fac. 3	Fac. 4
Fac. 1: Appreciate digital pen use in learning	1.00			
Fac. 2: Effectiveness of digital pen use	0.643	1.00		
Fac. 3: Burden of digital pen use	–0.081	–0.356	1.00	
Fac. 4: Attractiveness of the digital pen	0.214	0.378	–0.349	1.00

Table 3 Correlations among four factors extracted

3.2.2 Checking Goodness of Fit

We verified the correspondence of the variance–covariance matrix between the observed variables and the model (Figure 3), referring to Toyoda's (1998) discussion of how to use the goodness of fit index [8]. We also checked whether or not the path coefficients were significant; all paths were significant ($p < 0.05$). The results of these two goodness-of-fit analyses suggested that Figure 3 could realistically represent the students' understanding structure regarding the appreciation of digital pen use in learning. Therefore, according to the path figure, it is clear that "Burden of digital pen use" affects "Attractiveness of the digital pen," which in turn affects "Effectiveness of digital pen use" and explains "Appreciate digital pen use in learning." That is, students will be attracted to the digital pen system if they are not anxious about its use, and they would thus appreciate it. Therefore, it is important that we as instructors explain, both carefully and adequately, to students that they can use the system easily, choose whether or not to open their notes, and need not be stressed by the use of this technology. Furthermore, teachers should craft their lessons so as to help students understand the efficiency and usefulness of the system, and how it can help them improve their own editing skills. We have to make more such approaches for adult people because they are more skeptical about the digital pen system use than children according to table 1.

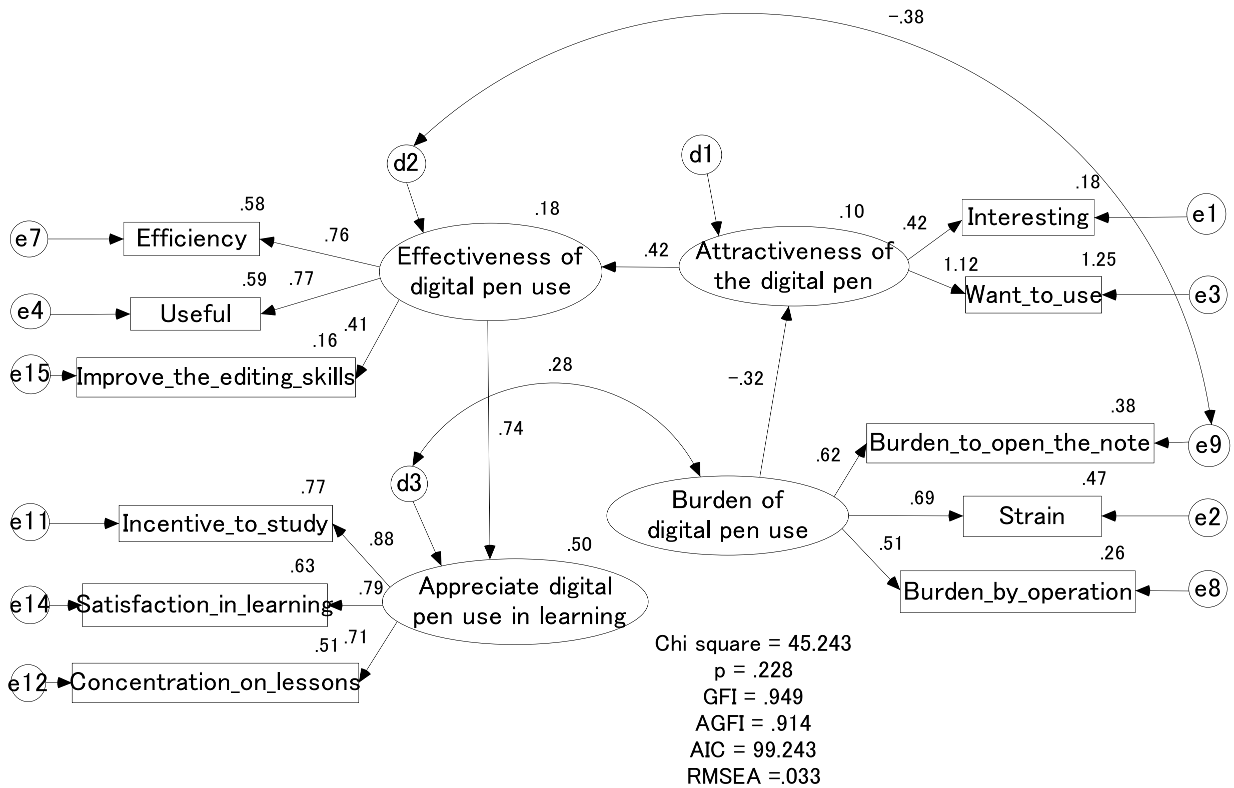

Figure 3 Causal relationships within the structure pertaining to appreciation of digital pen use in learning (Points are not reversed in any items)

*4. D*igital Pen Use in Real Lessons

After executing the questionnaire, we started to implement the use of digital pens in real classroom settings, at two primary schools in Tokyo. All learners used Anoto digital pen systems.

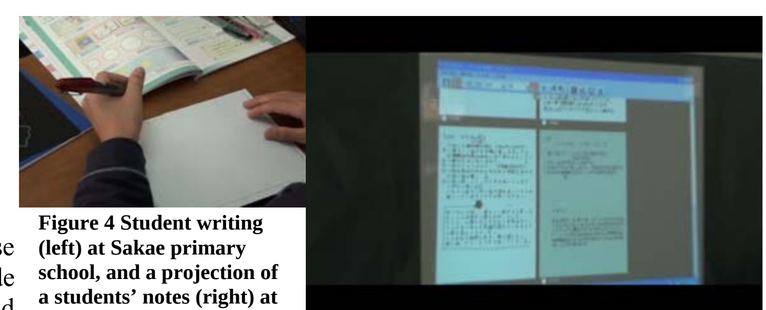

Figure 4 Student writing (left) at Sakae primary school, and a projection of a students' notes (right) at Tatsunuma primary school

4.1 Implementations in Primary-School Classes

One school was Sakae primary school, whose participants comprised one class of sixth-grade students (n = 27). The subjects included Japanese and arithmetic, among others, and there were 10 separate lessons. The other school taking part was Tatsunuma primary school, whose participants comprised one class of sixth-grade students (n = 31). The subjects comprised Japanese, social studies, and the like, and there were seven distinct lessons. Figure 4 shows scenes from lessons at the two schools.

4.2 Results of the Post-questionnaire and Discussion

We executed a post-questionnaire after the lessons, at each of the schools. The post-questionnaire items were the same as those of the aforementioned pre-questionnaire. Figures 5 and 6 indicate the results of the pre- and post-questionnaires at the two schools. As seen in Figure 5, there were significant differences in questions 8, 9, 10, and 15, between the pre- and post-questionnaires at Sakae primary school. Therefore, we can see improvements in student understanding at Sakae primary school, with regards to “Burden of operation,” “Burden of opening notes,” “Enjoy,” and “Improve editing skills.” There were no significant differences among any of the items shown in Figure 6. Therefore, while we considered that the Sakae primary school students might have sustained attitudinal shifts between the pre- and post-questionnaires, such cannot be said of the students at Tatsunuma. The differences between the two schools should be left as the subject of a case study analysis; for the purposes of the current study, however, we must continue to investigate the effectiveness of the system in real conditions and in a number of classrooms over a longer period of time. Furthermore, it is interesting that the plural number of item-points increased with the Sakae primary school implementation, as this result supports our structural equation model (Figure 3). Our model advocates that “Burden of digital pen use” indirectly affects “Effectiveness of digital pen use,” and that these items of improvement were observed variables for the two latent variables. That is, it was revealed that the points of the aforementioned observed variables correspondingly increased, and that these increases were explained by the latent variables bearing causal relationships.

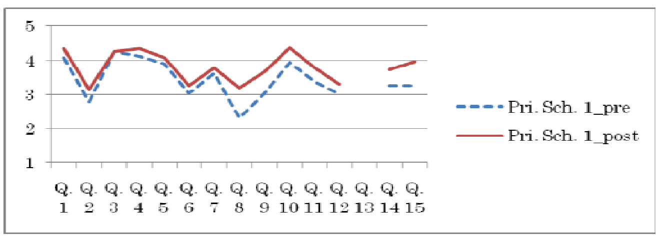

Figure 5 Results of the pre- and post-questionnaires at Sakae primary school (Points are reversed in questions 2, 6, 8, 9, and 13)

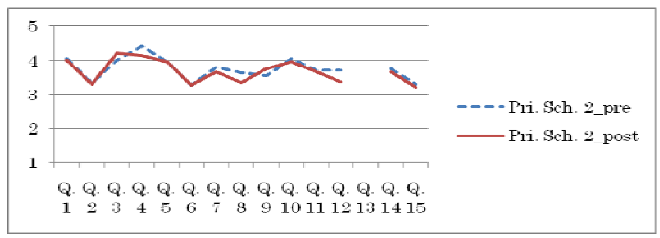

Figure 6 Results of pre- and post-questionnaires at Tatsunuma primary school (Points are reversed in questions 2, 6, 8, 9, and 13)

Therefore, we consider that students are more likely to appreciate the digital pen system when teachers can remove students’ feelings of anxiety with regards to it, and that students would be attracted to it and discover its effectiveness through hands-on use in lessons. Finally, the following anecdote demonstrates the efficacy of the anxiety-reduction approach suggested for teachers. The teacher at Sakae primary school said that his students were nervous about using the new technology tools, and he made the effort to tell them that the use of the digital pen was both problem- and stress-free.

References

[1] DNP (Dai Nippon Printing) Co., Ltd. web page, http://www.dnp.co.jp/bf/digitalpen/mechanism/index.html

[2] Kawamura, H., Susono, H., & Shimomura, T. (2008). Using a “digital pen” in elementary English classes. *Japan Society for Educational Technology 24th Annual Conference Proceedings*, 347–348.

[3] Wang, H., Hoopingarner, B., Weigel, C., Hrepic, Z., & Fulton, D. (2007). Exploring the pen-computing learning environment: A case study. *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications*, 573–578.

[4] Miura, M., Kunifuji, S., Shizuki, B., & Tanaka, J. (2005). Interactive learning support system using digital pen devices. *IPSJ (Information Processing Society of Japan) Journal*, 46(9), 2300–2310.

[5] Nagai, M., & Kitazawa, T. (2010). Features and Issues of Digital Pen Use in Classrooms. Society for Information Technology and Teacher Education (SITE) 2010 at San Diego, California, USA, 2799-2806.

[6] Shimizu, Y. (2009). Research contributing to the promotion of the electronification of education, National Institute of Multimedia Education in Japan, http://it.site21.net/lec/refer.php.

[7] Toyoda, H., Maeda, T., & Yanai, H. (1992). *Statistics to Try to Find the Cause: A Primer of Covariance Structure Analysis*. Tokyo: Kodansha, 134–159. (in Japanese)

[8] Toyoda, H. (1998). Covariance Structure Analysis [Edited for Novice]; Structural Equation Modeling, Asakura Publishing, Tokyo, pp. 171-177 (in Japanese)

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An Enhancement Model for Motivation on Learning Sentence Combining

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Abstract: Due to the current method on sentence combining, which results a frustrated and bored outcome on Taiwanese student's motivation, this study provides an enhancement model for stimulating student's motivation. Through integrating the in-class lecture with teacher-centered design, this model focuses on an after-class activity with student-centered design which concentrates on the impact of peer pressure. During the after-class learning activity, this study applies a drill-and-practice pedagogy. Student would accumulate personal cognitive knowledge as every student would have generated their self-constructed learning outcome, and s/he would be rewarded for her/his effort. Then the students would return to the in-class activity, and the teacher would allow the students to begin peer-evaluation. Every student starts to rank their peers' answers; as a result, the students own both a score on their efforts and a score on peer-evaluation. As soon as the peer-evaluation ends, student's personal identity (score) would be initiated. Student would have an opportunity on comparing their identity with the other students, so that there would be a peer pressure established among students. Students could enhance their self-motivation, and to work harder in the next stage of practicing (after-class activity). This study describes the design on the enhancement model for student's motivation, and further study would be mentioned at the end of this article.

Keywords: sentence combining, motivation, game-based learning, one-to-one learning, peer pressure

Introduction

The key of learning depends on how student learns [21]. For the student who learns in a traditional elementary classroom, Taiwanese students are required to imitate given examples in order to learn sentence patterns for writing. The design of the imitation may result a problem that it is required to create a sentence which bases on the given example. Students may come up with confusion as the learning goal is not clear, since many publishers adopt this methodology for most of the textbooks in elementary school learning. Student needs to build his/her personal idea to fitting in the provided sentence patterns which are pre-set in Chinese textbook. Many Taiwanese students encounter this challenge since the textbooks require them to adopt this skill, and the qualify examinations are designed to evaluate the skill on imitation, which is considered to be the ability to master sentence structures [26]. Some students could not achieve the assigned learning task (imitation) by the school teacher, i.e. unable to finish the given question because they may encounter side effects prior to the understanding on sentence structures. It is believed that students dropped out of the learning flow, as they lose interest and motivation on specific topic [8]. The reason for this phenomenon is that student faces unexpected difficulties such as creativity, wordiness, or context knowledge problem [18]. Yet the goal of imitation is not to challenge student's creativity, it is designated to understand sentence structures.

1. Related Work

1.1 Background

User-centered design differs from the learner-centered design as the motivation is one of the important differences between two designs [23]. The user is motivated to facilitate their learning, but the learner (elementary level) does not. The reason why affects learner's motivation is that user holds a clear goal for attending the learning activity [23]. However, during the field observation in the elementary classroom, the learner often holds an absent mind when she/he attends the class, especially during the latter half of the class lecture. This might relate to the personal recognition on individual experience [11], peer pressure [17], and tutor's facilitation [2].

From the cognitive perspective, based on the psychological view, the independent and interdependent view of self result an inference on individual experience, which was considered as a factor on affecting student's learning [19], while they reviewed the different cultures on the affection of the cognitive, emotional, and motivation perspectives. The independent view on self implies a limited, unique, less integrated, low motivated cognitive ideas (Geertz, 1975), personal preference, and self realization (Johnson, 1985; Waterman, 1981). Under an isolated environment on one's individual thinking, she/he may be limited by the size of living space, the feeling (emotional), and a bounded idea generation/brain storming.

1.2 Fundamentals

[19] showed that many Asian cultures focused on the relation among others, which indicated a possibility that Asian people are more favored to share, discuss, and work collaboratively/cooperatively. Therefore, because of the less-stimulated learning is less-motivated [2], individuals may easily drop out of the learning flow, such as fall asleep, lost interest, or distracted from the learning activity [8]. As a matter of fact, since Asians incline to work together, there are possibilities that group learning may result a better stimulation on individualize learning [19]. After the field observation in the elementary classroom, the reason why it would result a better motivation on individualize learning would be that learners talk and discuss after attending the class. Factor appears on changing the way of individual learning, whereas different perspectives were summarized for group learning: the viewpoints on individual affects group cognition or group cognition affects individual [22, 28], human nature and similar studies [2], educational views of school teacher [10]. From 3 positions to recognizing learner's perception, characteristic, and learning efficacy, the aforementioned dimensions were discussed in three boarder ways [25]:

- Perspective on cognition: besides the individual/peer perspective of Piaget [22] and Vygotsky [28], Springer [25] also discussed the cognitive growth, cognitive elaboration, and cognitive restructuring (Dansereau, 1988).
- Perspective on affection: it was discussed on the interaction between students, teachers, and school. Since it was believed that school life was a social basis, student interacts with peers, and teacher interacts with schools...etc [10].

- Perspective on motivation: Springer [25] listed one phenomenon that "one's success might affect another's success" (Slavin, 1992) with comparison to an incentive model that stimulating one's motivation and individual accountability.

More specifically, this study emphasizes on the perspective of motivation, peer pressure plays a role on stimulating the individual in different ways: personal and social behavior (Michell & West, 1996; Brown & Bradford, 1986), team production (Barron & Gjerde, 1997), partnership and sharing [17]. It indicates that learners are easily "affected" by their peers, especially when they sit next to each other, because learners would like to communicate in an informal way, and to have comparison among the others. This informal communication and the comparison imply that peer interaction makes a stimulation on individuals, and the stimulation may result possibilities on cultivating individuals [5] and motivation [3].

1.3 Sentence Combining and Syntax Structure

Sentence combining is an approach for understanding sentence structures [9]; it also provides a positive impact on the grammar structures [20]. It is believed grammar structures can also improve the learning outcome on not only reading comprehension and writing skills [13]. In order to understand grammar structures, [6] formulated the language to understand human nature. A similar study [12] was to enhance the interactivity on computers, which related to universal grammar raised by [6], that its goal is to uniform the language into a logical interpretation. The formulated sentence structure elaborates the human language in a systematic way, which implies a modularized representation as a means to help understanding the sentence pattern [6]. It is believed that learning sentence patterns could be possible to help understand paragraph structures [1], and it could enhance student's writing skill especially on the logical organizing [15]. Hence, the sentence combining approach plays a role on understanding sentence patterns, not only a imitation, transformation, and connection, but also organization, ordering, and criticizing [14].

The idea of sentence combining was originally developed as a transformation of sentences, which was referred to Mellon's transformational sentence combining [20]. Student understands the certain grammar and follows the pattern to finish the assigned tasks [20]. Going through the context in Mellon's article, it was particularly clarified that sentence combining would not only result 'complex' sentences at the end of exercises, as Christensen [7] pointed out that the result of transformational sentence combining was more than 30 words, i.e. long and complex sentences. With regard to the work by Hughes [16], who pointed out that sentence combining, could enhance the syntactic structures for reading comprehension, especially on the lower half of students. In fact, sentence combining was examined on the natural syntax of written language [16]. As it may refer to sentence organization, and organizing, the related idea on sentence re-ordering becomes a possible effect [14]. Sentence combining varies, as it involved different kinds of sentence structures.

2. Model Design

In order to link student's learning with the peer pressure, the goal of this study is to raise a model (Figure 1) for sustaining student's motivation on individual problem solving. The whole model is divided into two categories (Figure 1, upper part which is in green), the practice stage, which concentrates on individual learning in the after-class activity, is to accumulate personal cognitive knowledge. The lower category (Figure 1, lower part which is in green) stands for the presentation, and it's to show the personal effort and personal cognitive knowledge. By accumulating personal cognitive knowledge, student focuses on the understanding of certain domain, and to improve her/himself through self-realization (Johnson, 1985; Waterman, 1981). But students showed a frustrated and bored face when the same learning activities continued, so external stimulation or internal variation are needed to be designed for eliminating the problem on motivation. Based on the individual learning, students are rewarded for their effort, and they will have an identity [27] for them to compare with the other students. Each student owns an answer, and their answer will be peer-evaluated, i.e. giving ranks from the randomized 5 peers.

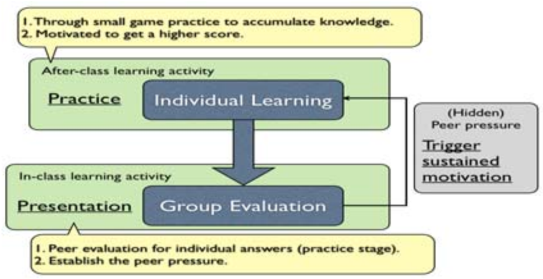

Figure 1: Model for sustaining student's motivation on sentence combining.

3. Discussion and Future Work

The current generic model emphasizes on the pedagogy design in a one-to-one classroom learning environment. Sentence combining is considered to be used as the pedagogy and the subject content for learning activity. Regarding the cognitive, affective, and motivational perspectives, this model is designed as an after-class model for motivated learning. From the cognitive knowledge accumulation, student works hard during the individual stage (practice stage) to apply classroom knowledge being taught by the school teacher. Then the student has a chance on demonstrating her/his effort and cognitive knowledge through peer-reviewed and comparison on personal effort among the other students. So it would be initiated an internal peer pressure for establishing the personal identity, and student would be motivated to practice more through this model. Although this pedagogical model adopted three perspectives as a foundation, more explorations should be developed further on the incentive models, and supportive results (e.g. questionnaires for attitude, interest, and motivation; statistical results of pre/post tests on learning effectiveness) would be supplied together in the future.

Acknowledgements

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References

[1] Alsina, A. (1996). The Role of Argument Structure in Grammar. CSLI Publications, Stanford, CA.
[2] Bentley, T. (1994). Facilitation: Providing Opportunities for Learning, Journal of European Industrial Training, 18(5), 8-22.
[3] Bindra, D. (1974). A motivational view of learning, performance and behavioral modification. Psychol Rev, 81, 199–213.
[4] Brown, B. B., Clasen, D. R., Eicher, S. A. (1986). Perceptions of peer pressure, peer conformity dispositions, and self-reported behavior among adolescents. Developmental Psychology, 22(4), 521-530.

[5] Chen, Z. H., Chou, C. Y., Deng, Y. C., Chan, T. W. (2007). Active Open Learner Models as Animal Companions: Motivating Children to Learn through Interacting with My-Pet and Our-Pet. International Journal of Artificial Intelligence in Education. 17(2), 145-167.
[6] Chomsky, N. (1968). Language and Mind, Harcourt Brace Jovanovich, New York.
[7] Christensen, F. (1968). The problem of defining a mature style. English Journal, 1968, 57, 572- 579.
[8] Csíkszentmihályi, M. (1990). Flow: The Psychology of Optimal Experience. New York: Harper and Row.
[9] Daiker, D. A., Kerek, A., Morenberg, M. (1978). Sentence-Combining and Syntactic Maturity in Freshman English, 29(1), 36-41.
[10] Dewey, J. (1943). The School and Society: &, The Child and the Curriculum, London: The University of Chicago Press.
[11] Gardiner, J. M. & Parkin, A. J. (1990). Attention and recollective experience in recognition memory. Memory & Cognition, 18(6), 579-583.
[12] Harbusch, K., van Breugel, C., Koch, U. (2007). Interactive sentence combining and paraphrasing in support of integrated writing and grammar instruction: A new application area for natural language sentence generators. Computational Intelligence, 10(4), 579-590.
[13] Hayes, J. (1996). A new framework for understanding cognition and affect in writing. In M. Levy & S. Ransdell (Eds.), The science of writing: The- ories, methods, individual differences, and applications (pp. 1–27). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
[14] Hudson, R. (2006). Language Education: Grammar. Encyclopedia of Language and Linguistics (ss. 477-480). Elsevier.
[15] Hunt, K. W. (1965). Grammatical structures written at three grade levels. National Council of Teachers of English Research Report no. 3. Champaign, Ill.: National Council of Teachers of English, 1965.
[16] Hughes, T. (1975). "What the British Tell the U.S. about Writing and Reading." Paper, Annual Great Lakes Regional Conference of the I'nternational Reading Association, 1978. ED 175 020. Hulewicz, R. R. "A Prototype for Objectively Measuring Composition Ability. " DAI 35 (1975): 7167-A.
[17] Kandel, E. & Lazear, E. P. (1992). Peer Pressure and Partnerships. The Journal of Political Economy, 100(4), 801-817.
[18] Maloney, K. B., and B. L. Hopkins. "The Modification of Sentence Structure and Its Relationship to Subjective Judgments of Creativity in Writing." Journal of Applied Behavior Analysis 6 (1973): 425-33.
[19] Markus, H. R., Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion, and motivation, Psychological Review, 98(2), 224-253.
[20] Mellon, J. C. Transformational sentence-combining: a method for enhancing the development of syntactic fluency in English composition. Report to the U.S. Office of Education, Cooperative Research Project No. 5-8418, 1967.
[21] Novak, J. D., & Gowin, D. B. (1984). Learning how to learn. New York, NY: Cambridge University Press.
[22] Piaget, J. (1926). The language and thought of the child. New York: Harcourt Brace.
[23] Quintana, C., Krajcik, J., & Soloway, E. (2001). Exploring a Description and Methodology for Learner-Centered Design. In W. Heineke & L. Blasi (Eds.), Methods of Evaluating Educational Technology (Vol. 1). Greenwich, CT: Information Age Publishing.
[24] Rea, D. W. (2000). Optimal motivation for talent development. Journal for the Education of the Gifted, 23(2), 187-216.
[25] Springer, L., Stanne, M. E., Donovan, S. S. (1999). Effects of Small-Group Learning on Undergraduates in Science, Mathematics, Engineering, and Technology: A Meta-Analysis, 69(1), 21-51.
[26] Stevens-Long, J., & Rasmussen, M. (1974). The acquisition of simple and compound sentence structure in an autistic child. Journal of Applied Behavior Analysis, 3(7), 473–479.
[27] Tajfel, H. (1982). Social Identity and Intergroup Relations. Cambridge, UK: Cambridge University Press.
[28] Vygotsky, L. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: Harvard University Press.

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Use of ICT for Training in Simultaneous Singing and Piano Playing and The Improvements it Achieves

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Abstract: As a way to exploit Information and Communication Technology (ICT) in the provision of training in simultaneous singing and piano playing, we introduced a method of requiring students to view e-learning material and to submit videos of their performance. In this paper, we evaluate how this method improves students' performance skills, based on the length of time the students spent in viewing the e-learning material, the reports submitted by the students, the videos of the students' performance taken in the course of their regular practice, and the results of their mid-term and final performance exams. It is shown that (1) the combination of the viewing of the e-learning material and the submission of performance videos, which are both non-face-to-face training, encourages the students to undertake self-training and can considerably improve their performance skills, and that (2) it is necessary to provide face-to-face training for certain skills that cannot be improved through non-face-to-face training.

Keywords: blended learning, e-Learning, University education, assurance of lecture, skill transfer

Introduction

There have been many practice-based studies on the advantages and disadvantages of group lessons as a means of teaching a musical performance skill. Yi and Takeshi[1] reported on the status of group piano lessons given in teacher training colleges in China. They undertook a questionnaire survey with 169 students in teacher training colleges in China, and found that students preferred individual lessons to group lessons in learning piano playing. The reasons given were that (1) individual lessons provide detailed instructions, and (2) students can learn a wider variety of subjects more efficiently. Studies in Japan have been inconclusive about the advantages of group lessons. Furukawa et al. [2] recognized the advantages of group lessons but indicated that ultimately it was necessary to rely on individual lessons. Nakagawa[3] suggested that group lessons have positive effects on students. The above studies indicate that is it difficult to entirely eliminate some form of group lessons for the teaching of simultaneous singing and piano playing. The authors have considered that it may be possible to make group lessons as effective as individual lessons in improving students' skills by combining them with other methods or by modifying the way they are given.

In this paper, we report on a training method in which students not only took group lessons (hereafter referred to as "face-to-face" training) but also were required to view e-learning material and to submit videos of their performance. We study the effects of the e-learning material by examining how the students' performance and perception changed after viewing the e-learning material. In addition, we indicate the limitations of non-face-to-face training and the need to combine such training with face-to-face training in what we call "blended" training.

1. Practice environment

We applied our method to the course "Music for Children I" (which was given in the first semester of the second year of study) at the Faculty of Developmental Education in K. Women's College. The course took place from April to July, 2009, and 105 students took the course. Students recorded their performance in videos using a recording device called KS20 (Yokoyama et. al.,[4]), which was installed in the performance practice room, and identified their recording by means of a bar code. If a student had recorded a performance of more than one song, he/she selected the one that they thought was the best, and submitted the bar code of the selected video.

The e-learning material consists of four parts: (1) model performance of simultaneous singing and piano playing, (2) model performance of singing, (3) musical scores with annotations, and (4) FAQs for better singing. The length of time for which each student viewed the e-learning material was recorded as part of his/her learning activity log. In this paper, we analyze the performance videos and reports submitted before and after the viewing of the e-learning material by the top 15 students ranked in terms of the length of viewing time.

2. Analysis and Discussion

We summarizes changes that occurred in the case of the 15 students after viewing the e-learning material. Two students achieved a remarkable improvement, and 9 showed some improvement while the remaining 4 made little improvement. Generally, students made more improvement in singing than in piano playing.

The characteristics of the two students who made a remarkable improvement are as follows. Student H was a beginner in the piano. Although she mastered almost everything she could learn from the e-learning material, she seemed to be lost about how to practice in the future. Student K was an advanced learner of the piano. The reports submitted by the students indicate that those students who viewed the e-learning material for a long time became aware of many important points and were anxious to learn. In their reports, the 15 students whose reports were analyzed identified 17 points that they found useful in the e-learning material.

Table 1 shows the changes in scores from the mid-term exam to the final exam. Students could be classified into three groups: a group that did not view the e-learning material, a group that viewed the material for up to 30 minutes, and a group that viewed the material for more than 30 minutes. Considering the fact that there was no significant difference in the average score in the mid-term exam between the three groups, that almost all students submitted videos of their performance at least once, i.e., they had the opportunity to review their own performance by watching their videos, and that there was a pronounced difference between the three groups in the average score and the standard deviation, σ, it can be concluded that it was useful for students to view the e-learning material before they submitted their second performance videos. While including the viewing of the e-learning material in the training of simultaneous singing and piano playing helped students improve many skills, there were certain skills that could not be improved just by viewing the

Table 1. Relationship between the results of the mid-term and final exams and the length of time of viewing the e-learning material

		Length of time spent viewing the e-learning material		
		0	Up to 30 min	More than 30 min
Number of students		34	53	18
Mid-exam results	Average	72.26	73.08	73.78
	σ	6.21	4.20	7.32
Final exam results	Average	70.32	74.85	75.39
	σ	18.56	4.07	5.76
Percentage of those whose score went up or down	Up	53%	68%	67%
	Down	29%	21%	28%

e-learning material. Improvement in these skills can be better achieved through direct advice given during face-to-face lessons.

4. Conclusions

In this paper, we introduced a method of requiring students to view e-learning material and to submit videos of their performance. In this paper, we evaluate how this method improves students' performance skills, based on the length of time the students spent in viewing the e-learning material, the reports submitted by the students, the videos of the students' performance taken in the course of their regular practice, and the results of their mid-term and final performance exams. It is shown that (1) the combination of the viewing of the e-learning material and the submission of performance videos, which are both non-face-to-face training, encourages the students to undertake self-training and can considerably improve their performance skills, and that (2) it is necessary to provide face-to-face training for certain skills that cannot be improved through non-face-to-face training.

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References

[1] Yi Li and Takeshi Kenshiro, "A Study of Piano Group Lessons in Normal Universities of the People's Republic of China: The History and the Present Situation", *Bulletin of Tokyo Gakugei University. Arts and Sports Sciences*, Vol. 57, pp. 33-46

[2] Mieko Furukawa (2003), "Considerations on music education in the training of pre-school teachers: mass training of piano beginners using children's songs", *Japan Society of Research on Early Childhood Care and Education Annual Report*, Vol. 56, pp.870–871

[3] Kouji Nakagawa (2007), "Effectiveness of group lessons on singing in teacher training colleges from the perspective of the 'effectiveness in instruction on performance skills", *Journal of Japan Association for the Study of School Music Educational Practice*, Vol. 11, pp.69-70

[4] Jyunichi Yokoyama, Shinichi Matsuda, Katsuko T. Nakahira, Yoshimi Fukumura(2004), "Development of supporting tool for teaching", *IPSJ SIG Reports*, Vol. 2004-117, pp. 61—66.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

A Feasibility Study of Applying MMS for Mobile Learning of Cardiopulmonary Resuscitation (CPR)

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Abstract: In this paper, we propose a MMS (Multimedia Message Service) -based Interactive Mobile Learning model for adult learners to update their CPR (Cardiopulmonary Resuscitation)-related knowledge and skills. Informed by N. A. Crowder's (1960) branching version of B .F. Skinner's (1958) Program Instruction approach, we designed an interactive learning process that requires the learners to make series of decisions and then be informed by the system of their consequences, thereby achieving "by making and reflecting on mistakes". A feasibility study was conducted in three phases with volunteered adult learners being engaged in the MMS learning process. Through the process of learning content development and our analysis of the learner data, we gained better understanding in the feasible activity modes and the factors that may potentially affect the learning process and learner perceptions toward the learning model.

Keywords: Mobile Learning; Cardiopulmonary Resuscitation (CPR); Multimedia Message Service (MMS); Program Instruction

Introduction

The unique characteristics of the SMS and MMS as compared with other modes of communication are the abilities to offer rapid, proactive and immediate communication. Therefore, by applying mobile technology to learning activities, SMS/MMS could "afford" learners to interact with the learning content in virtual form, and perform decision making tasks for the critical problems pertaining to the learning content. Such learning systems may offer adaptive learning support by providing SMS-based feedback to the learners' "wrong" decisions. Such feedback may result in the arousal of cognitive disequilibrium, and subsequently motivate further learning and knowledge construction through the transmission of MMS-based digital content.

1. Literature review

The notion of programmed instruction had been refined from the linear approach in earlier years to the branching approach (Crowder, 1960) which fits the characteristics of individualized learning better. The more recent approach is worked in the way of branching individual learners to different frames or paths after a common frame is delivered, thereby enabling individualized learning.

According to the simulated content for "learning by doing" as proposed by (Aldrich, 2005), the branching narrative structure is applied to draw all the decision making points and their consequences. Learners would be able to learn by doing – or learning from mistakes, i.e., a wrong decision would bring the learner to the failed consequence; the instructor would then give advice to rectify the learner's underlying misconception.

Incorporating interactivity and pushed media content into SMS and MMS, we then have SMS or MMS 2.0. In this regard, we are keen on investigating the feasibility of delivering contextualized CPR problems through SMS/MMS 2.0 for the learners' decision making practice at anytime, anywhere. According to our exploratory study (Lin & Lee, 2008) of using 3G phones to deliver our self-developed learning content, we identify four types of content communication modes potentially suitable for the MMS Mobile Learning process that we subsequently developed four communication modes of learning content.

2. A MMS-based Interactive Mobile Learning model

In general, individual SMS/MMS communication is unidirectional – from a sender to a recipient. In the context of SMS/MMS-based mobile learning program with "mass" learners, the sender (typically the instructor) could hardly sending feedback to every single response from the learners within a reasonable time frame. The multi-level questioning approach is a plausible solution to this. The lesson developer may predict a variety of possible learner responses to each question, assign unique index numbers (ID's) to these (typically multiple choice) questions and their associated responses, and specify the next question or feedback ID that the system should send to the learner upon receiving a response with a particular ID. Thus, the automation of learner-system interactions could be achieved.

3. Content Design of the MMS-based Interactive CPR Lesson

Informed by our analysis of the up-to-date CPR principles and skills as well as the design principles for mobile learning materials as proposed by Zobel (2001) and Young, Chang and Liu (2005), we worked out seven pairs plus one messages to cover the entire interactive CPR lesson. The first message is for inviting the learners to commence on the learning process. The last message pair is to inform the learners the end of the process. The six message pairs in between offer a URL each for the learners to download and study multimedia learning materials, and subsequently reply to the system with their answer (one of the multiple choices) to the associated question in SMS. The system then recognizes the learner ID and the answer ID, and sends back to the learner's appropriate feedback and the next URL to download learning materials.

4. Evaluation Tools and Methods

We developed the learner evaluation instruments based on the updated CPR principles. The instruments consist of two components. The first component is compromised of the pre- and post-tests with the same set of 13 contextualized problems respectively. Target users took the tests for us to compare and determine their learning gains. Table 1 shows that the target users of Phase 1 and 2 have improved their performances by answering 2.78 questions (or 21%) correctly in average.

Table 1 Analysis of the Phase 1 & 2 target users' learning gains

	Pre-test: correct answers/%		Post-test: correct answers/%		Improvement	
Phase 1 users (n = 18)	5.78	44%	8.00	62%	2.22	17%
Phase 2 users (n = 29)	5.90	45%	9.24	71%	3.34	26%
Mean	5.84	45%	8.62	66%	2.78	21%

The second component is a post-survey that consists of 24 questions in the Likert Scale of 5 to investigate the target users' attitudes and perceptions.(5 for "strongly agree", 4 for "agree", 3 for "neutral", 2 for "disagree", 1 for "strongly disagree"). The results show that for the items pertaining to the users' attitudes toward the learning content, the mean value of the users' positive responses is 3.7 (SD = 0.49).

5. Conclusion

In this study, we investigated various viable modes for facilitating SMS/MMS-based interactive mobile learning. In order to cater for highly varied configurations of learners' mobile devices, we recommend against adopting the more interactive .swf format and instead making use of .mp4 and .3gp to deliver the learning materials. The software for playing .mp4 and .3gp files has its control panel on the screen, which is good for full-screen playing. However, the auto-hiding of the panel buttons may often causes the learners too late to press the pause button when they need to do so to control their learning pace. The learners may alternatively use the non-full screen playing mode, though the sharing of the device screen between the video frame and the control panel will scale down the video display size. Mobile devices have been enjoying huge user base. Although the cost of MMS is considerably higher than SMS at present stage, we see the former's multimedia form of presentation having a great potential in motivating the learners and helping them to better understand the content.

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References

[1] Aldrich, C. (2005). Learning by Doing: A Comprehensive Guide to Simulations, Computer Games and Pedagogy in e-Learning and Other Educational Experiences. San Francisco: Pfeiffer.

[2] Crowder, N. A. (1960). Automatic tutoring by intrinsic programming. In A. A. Lumsdaine & R. Glaser (Eds.), Teaching machines and programmed learning (pp. 286-298). Washington, D.C.: National Education Association.

[3] Lin, C.-P., & Lee, M.-H. (2008). Feasibility study of MMS-based mobile learning of CPR skills. Paper presented at the UbiLearn 2008, Tainan, Taiwan.

[4] Skinner, B. F. (1958). Teaching machines. Science, 128, 969-977.

[5] Young, S., Chang, J.-H., & Liu, I.-F. (2005). An investigation of the incorporation of mobile technology into teaching and learning contexts. Instructional Technology and Media, 73, 62-76.

[6] Zobel, J. (2001). Mobile business and M-commerce. Deutsch: Hanser.

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Prototyping Paper-Top Interface as Note-taking Support

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Abstract: We developed a PTI prototype system for supporting note-taking. The prototype system is realized as a fusion of notebooks and digital learning materials by visual-marker-based AR (Augmented Reality). A student can take a note with pencils, viewing digital learning materials projected onto his/her notebook. It is expected that the prototype system decreases burdens in and increases learning effect by note-taking.

Keywords: Note-taking, digital learning materials, AR, classroom education

Introduction

ICT (Information and Communication Technology) has been introduced in classroom education and necessary for classes in the digital age. This is because ICT changes the traditional classes and provides new effective styles of instruction and learning.

Meanwhile in the traditional classroom, students generally write learning outcomes (e.g., their constructed knowledge, thinking process, questions, and ideas) on their notebooks—they take notes. Even if ICT is introduced more rapidly, a prevailing learning activity of students must be note-taking without ICT. It has been actively investigated and discussed how note-taking influences learning effect [1]. And now, note-taking is recognized as a universal learning activity for increasing learning effect in a classroom. For example, an investigative study focusing on university students reported that high correlations were found between the quantity of notes and examination performance [2].

In this study, we propose Paper-Top Interface (PTI for short) as note-taking support. PTI uses AR (Augmented Reality) as ICT for classroom education to fuse digital learning materials (the virtual world) into notebooks (the real world). The purpose of PTI is to decrease burdens in and increase learning effect by note-taking. We developed a PTI prototype system, which uses a visual-marker-based AR and projects digital learning materials onto the corresponding papers (pages on a notebook) on a classroom desk. In other words, PTI is a digital projector-based AR and does not require a computer display or HMD.

1. Note-Taking Support

PTI supports note-taking in a class (classroom) where digital learning materials are projected onto the front screen and students do the following learning activities.

(1) View digital learning material on the front screen.

(2) Listen to the teacher's dictation.

(3) Transcribe the content of the material on their notebooks—this is one style of note-taking.

(4) Think through (1) and (2) and write their learning outcomes on their notebook—this is another style of note-taking.

We suppose that students tend to spend a lot of time for (3) in classes where the students are not given paper handouts of the material. In addition, the teacher does not necessarily give the students enough time for (3). In other words, the teacher may switch (turn over) slides (pages) of the material before the students finish (3). Thus, note-taking is not completed if the students do not transcribe the content quickly. Therefore, the note-taking of (3) may be hard to help understand the class content smoothly and is a big burden to the students.
Meanwhile, we suppose that students tend to spend a lot of time for (4) in classes where the students are given paper handouts of the material and can annotate and/or underscore the handouts flexibly with pencils or pens. This means that the students do not have to transcribe the content of the material and are given more time for (4). Therefore, the note-taking of (4) may be easy to help understand the class content smoothly and is a small burden to the students. Our basic policy of note-taking support is to reduce a note-taking burden by shifting the note-taking style from (3) to (4).

2. Prototype System

2.1.1 System Composition

Taking account of availability in a classroom, we developed a PTI prototype system from well marketed equipments. The prototype system is composed of a projector, a video camera, and a personal computer (Figure 1). The projector is mounted on a metal frame above a student's head, being in a downward direction. The video camera is mounted beside the projector and shoots the table. The PC processes the video and generates digital learning material images to be projected onto a notebook (on the table).

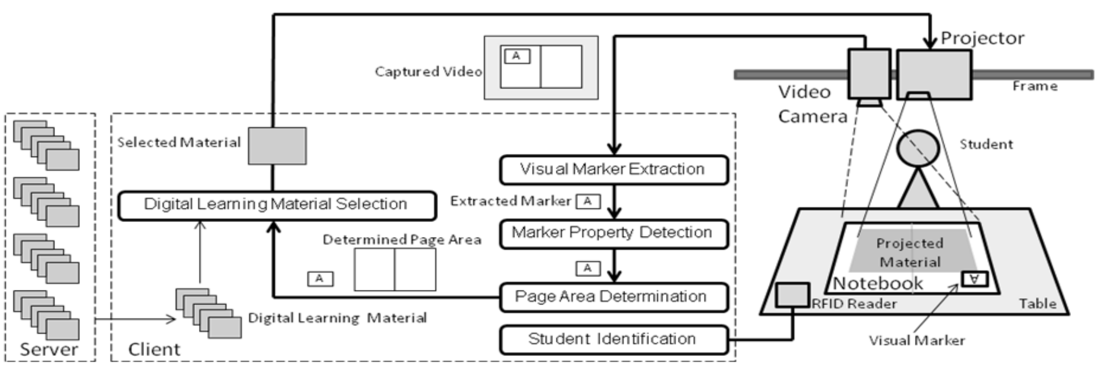


Figure 1: System Composition and Procedure

2.1.2 Procedure

The procedure of PTI is roughly divided into three phases: visual marker processing, learning material selection, and learning material projection.

2.1.3 Visual Marker Processing

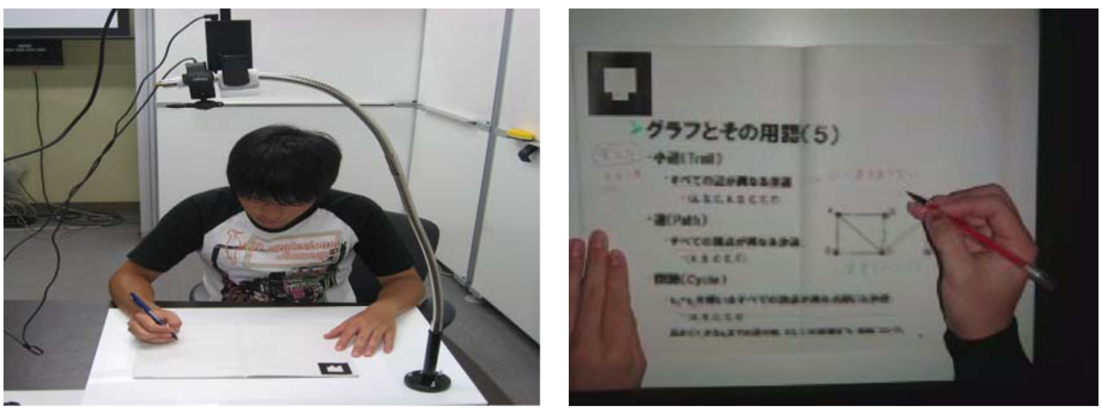
A different visual marker must be printed or pasted on every page of a notebook beforehand. Videlicet, one learning material corresponds to one page. The marker is up-down and left-right asymmetry because directions of the projected learning materials must be considered. The prototype system calculates the match degree of the detected marker and the marker registered beforehand, and then performs learning material selection if the calculated degree exceeds a threshold value.

2.1.4 Learning Material Selection

We assume that a digital learning material mainly used in classes is digital slide show (e.g., PowerPoint). Therefore, a main learning material of the prototype system is also digital slide show. If digital slide show is used as the learning material, each slide (page) is converted into one image file. The filename of a slide and the ID of a marker are linked with one to one relation.

2.1.5 Learning Material Projection

The selected learning material (slide) is projected at the lower right of the marker position within the size of a standard notebook so that the prototype system does not fail in marker recognition due to covering the marker with the projected material. As a matter of course, the prototype system can track the notebook on the table, moving and rotating the projected material from the detected markers' properties. A student turns over a page and immediately the material corresponding in the one-to-one relation is projected. Figure 2 shows snapshots of the prototype system in use and the projected material (a slide of discrete mathematics).



(a) Prototype system in use (b) Projected material

Figure 2: Snapshots of the prototype system

3. Summary

We developed a PTI prototype system, which can support note-taking by projecting digital learning materials onto a notebook on a table. Note-taking is diverse and may depend on cultural aspects including learning styles by country and region. In Japan, many students tend to transcribe the contents displayed on the classroom screen or written on the blackboard. Therefore, the PTI will work well for Japanese students.

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References

[1] Kiewra, K.A. (1987). Notetaking and Review: the ressearch and its implications. *Instructional Science*, 16, 233-249.

[2] Nye, P.A., Crooks, T. J., Powley, M., & Tripp, G. (1984). STUDENT NOTE-TAKING RELATED TO UNIVERSITY EXAMINATION PERFORMANCE. *Higher Education*, 13, 85-97.

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Delivering e-Learning Contents through Mobile Technology: UNITEN Case Study

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Abstract: E-learning had become more affordable with a cheaper but faster Internet connection. This has encouraged more applications beyond conventional e-learning technique including mobile learning. This paper presents a working prototype of SMS-based mobile learning system which allows interactive learning contents be delivered and disseminated to students using mobile phone application was developed at University Tenaga Nasional (UNITEN). Challenges and issues related to the deployment of SMS-based application are also discussed.

Keywords: e-Learning, mobile technology, short message service application

1. Introduction

Mobile communication provides enriching, enlivening and adding variety to conventional lessons or courses [5].For instance, Attewell [1] reported that many learners who taking part in mobile learning class enjoyed the opportunity of using mobile devices in their learning sessions. While mobile learning is regarded as the new promising learning paradigm; adaptation of this learning approach into Malaysian community must be done carefully [6]. One of the potential drawbacks to the success of the implementation of mobile learning approach is the delivering technology [10]. We still lacking of the develop country IT infrastructure especially the very critical broadband services (blue tooth, and WIFI) [6]. Thus, it warrants the need to study the best suitable delivering method that suits Malaysian environment. Thus, an exploratory survey was conducted amongst students of Universiti Tenaga Nasional (UNITEN) to study their perspective on mobile learning using SMS technology. There were 55 unpaid students of UNITEN involved in this study. They represent student from various degree levels, different degree program (Engineering background and IT background students). Results from the survey indicate that very significant percentage (83%) of respondents agree that using SMS to obtain information related to their study and life in university was more effective and convenient. Based on results, we develop a working prototype of SMS-based Mobile Leaning System (SMLS). The prototype allows students to request various information related to their subject such as class schedule, download assignment and obtain their assessment marks.

2. SMLS Design and Implementation

Figure 1 below shows the architecture of the SMLS prototype which uses a third party SMS gateway service. The third party SMS gateway has unique number known (shortcode) and provides the application programming interface between the SMLS and the service provider's SMS centre. The shortcode is then referred by SMS Centre of mobile service provider for routing the SMS message to the respective SMS Gateway. An example of SMS sent by a user is `sms2u cseb324 notes adam@yahoo.com.my.`

After processing the string, SMLS will return a string as below:

0,60123456789,`CSEB364%20notes%20had%20been%20sent%20to%20adam%40yahoo.com.my.`,30

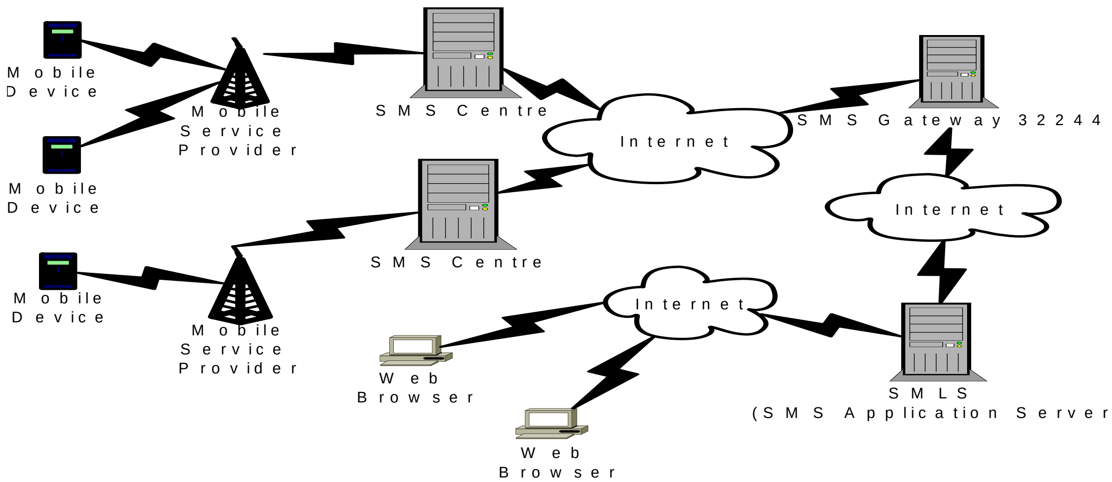

Figure 1: SMLS System Architecture

3. Result and issues of SMLS

SMLS has been implemented for CSEB324 Data Structure and Algorithms class in UNITEN for a semester. Through SMLS, student can request notes and updated schedule of the class. In addition, lecturer can send prompt message to inform his students about any updated on class activities or class notice. Although SMLS works as planned, there are several issues that need to be highlighted.

3.1 Reliability and performance issue

Based on the SMLS architecture, it depends so much on several servers – the service provider SMS Centre and the SMS gateway server before it reaches the SMLS server. It means, the availability and performance of SMLS is much depends on the performance and availability of both servers. During the trial, sometimes the Gateway server took longer than 15 seconds to reply for a SMS message. In some isolated cases, the reply even failed to reach the user. The problem was due to the unreliable network connectivity between the third party SMS Gateway and the service provider SMS centre. We propose two solutions to this problem. First, university can choose a better and reliable third party SMS gateway that can offer reliable services. However, this simple option is only a short term solution. A better option is for the university to setup its own SMS gateway server. Although the initial setup cost is expensive, the university can recoup its investment from the charged imposed by the service provider to the user.

3.2 Cost of implementation issue

Since SMLS is using a third party SMS gateway, cost of sending SMS message is charged at a premium rate with minimum of RM0.30 per message. This amount is on top of standard SMS rate imposed by the respective service provider. As such, students with financing constraint were a bit reluctant to use the system, unless they have no choice. To address this issue, several steps could be done by the respective party. About 40% to 60% of the of the SMS premium charges goes to the service provider. Whatever remains will be shared between the third party SMS gateway and the content provider (in this case the university). If the university owns the gateway server, almost half of the cost can be subsidized by the university. Furthermore, the mobile service provider could play their role in reducing premium charged for education purpose as part of their corporate social responsibility project.

4. Conclusion

SMLS was developed with the intention to enrich student learning experience with a very minimal infrastructure – a hand phone. However, we acknowledge more research and work need to be done to improve the system. Thus includes the ability of the SMLS to send more complicated content such as multimedia content. It is hoped that this project will not only generate new knowledge to us, but will also provide a new learning paradigm as it could improve students' learning interest and eventually contribute to the improvement of their performance

References

[1] Attewell, J, 2005: Mobile technologies and learning A technology update and m-learning project summary: Learning and skills development agencies: http :// www.LSDA.org.uk, retrieved on 30 /10/2009

[2] Attewell J, Savill-Smith C (eds) (2004). Learning with mobile devices: research and development –a book of papers. London: Learning and Skills Development Agency.At www.LSDA.org.uk/files/PDF/1440.pdf, accessed Nov 2009.

[3] Johnsen ET (2004).Telenor on the EDGE. 3G Americas at www.3gamericas.org/English/ PressReleases/PR200469682.html, accessed Nov 2009.

[4] NRPB (2004). Mobile Phones and Health 2004: Report by the Board of NRPB.Didcot, Oxfordshire: National Radiation Protection Board.

[5] Prensky M (2004). What Can You Learn from a Cell Phone? – Almost Anything.At www.marcprensky.com/writing/ Prensky-what_Can_You_Learn_From_a_Cell_Phone-FINAL.pdf, accessed November 2009.

[6] Malaysian Communications and Multimedia Commission (SKMM), 2009 Brief Industry Trends Report: 2H 2008 http://www.skmm.gov.my, assesses April 2010

[7] Albanese, M and Mitchell, S (1993).Problem-based learning: a review of the literature on its outcomes and implementation issues. AcademicMedicine, 68: 52-81

[8] Corlett, D, Sharples, M, Chan, T and Bull, S (2004). A mobile learning organiser for university students. Proceedings of the 2nd International Workshop on Wireless and Mobile Technologies in Education. JungLi, Taiwan: IEEE Computer Society, 35-42

[9] Lonsdale, P, Baber, C, Sharples, M and Arvanitis, TN (2003). A context-awareness architecture for facilitating mobile learning. Proceedings of MLEARN 2003: Learningwith Mobile Devices. London, UK: Learning and Skills Development Agency, 79-85

[10] Lonsdale, P, Baber, C, Sharples, M,Byrne, W, Arvanitis, T, Brundell, P and Beale, H (2004). Context awareness for MOBIlearn: creating an engaging learning experience in an art museum. Proceedings of MLEARN 2004. Bracciano, Rome: LSDA

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Exploration Study on Group Work with Interactive Whiteboard and Computer Feedback System for Primary Students

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Abstract: This paper presents a case study of one teacher and 28 first-grade primary students utilizing the interactive whiteboard (IWB) and computer feedback system (CFS) to improve the group works in their language learning activities. The classroom observation and a content analysis method were conducted for investigating the teaching and learning interactions, and total 72 instructional events were considered to be the data in the coding procedure. The results indicated that 44.44% of instructional events embraced students' learning interest, active participation, and peer cooperation behaviors, which reveal the students were very engaged in the cooperative group works. Consequently, the IWB plus CFS improved the teaching and learning interactions, especially on whole-class discussion and cooperative group work, in which student's concept was constructed by those efficient dialogic interactions among teacher and students.

Keywords: group work, interaction, interactive whiteboard, computer feedback system

Introduction

In traditional whole-class discussion activities, the interactions usually focus on a few students those were clear thinking and expeditious decision-making. The other students are often lack of interest in this kind of whole-class discussion due to their slow responses, which may lead to a lack of learning interactions between teacher and students [1].

In order to increase the interaction between teacher and students, Newhouse [3] emphasized the importance of adaptive interactive design that stimulates the interactions among teacher and students in activities. Hence, the purpose of this study is to investigate whether the interactive technologies support teaching and learning interaction design could improve the group work efficiency in a primary school.

The application of interactive technology in group work

The classroom feedback system (CFS; [1]) is a computer-mediated feedback system that could improve the interaction problem of the teacher is limited to interact with several students in one time. It enabled the one-way, two-way, even multi-way interaction to carry out seamlessly among teacher and students. A number of studies aimed at different demands to develop various CFSs, e.g., *Classtalk*, *ActivClass*, *Dyknow*, *WiTEC*, and *Classroom Presenter*. The main purpose of these CFSs is to support the interaction between teacher and students. With the CFS supporting, teachers can deeply realize the student's concept developments and problems. These systems promote students participating in discussions, and the peer cooperation becomes more engaged in-group discussion. Thus, this study utilized the interactive technologies including an IWB and a CFS to improve the group interaction between teacher and students.

Case study

This paper conducted a case study to examine the teaching and learning interactions from classroom observation in an interactive-based learning environment. The teacher who participated in this study has four years of IWB instructional experience in teaching. The 28 students who participated in study are primary first-grade students; they have a half year of IWB experience in learning, and are able to utilize the IWB in tasks.

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The teacher opened the file and explained a sentence structure, and then proceeded with a whole-class discussion. Some students were oral presented their ideas.

IST1	IST2	IST3	TSL1	TSL2	TSL3	ISL1	ISL2	ISL3	SIL1	SIL2	SIL3
1	0	0	1	1	1	0	1	0	1	1	0
IST =IST1+IST2+IST3 =1+0+0=1 (pattern 100, in scale 1)			**TSL** = TSL1+TSL2+TSL 3 =1+1+1=3 (pattern 111, in scale 3)			**ISL** =ISL1+ISL2+ISL3 =0+1+0=1 (pattern 010, in scale 0)			**SIL** =SIL1+SIL2+SIL3 =1+1+0=2 (pattern 110, in scale 2)		

Figure 1 Analysis of an instructional event.

This study utilized a digital camcorder to record the teacher instructing a Mandarin subject for two lessons (about 80 minutes of video material was collected). Afterwards, this study adopted one minute as the analytic unit for one instructional event. Meanwhile, we asked the teacher to give a brief description of every instructional event (as shown in the upper part of Figure 1) and eliminated those (e.g. working on assignments, class management) which were not classified as the instructional events. The total instructional events (n=72) were then used as data to conduct the coding procedure in this study.

In the coding procedure, this study adopted an interaction factor category which defines four IWB supported teaching and learning interaction factors: IWB Supported Teaching (IST), IWB Supported Learning (ISL), Teacher Supported Learning (TSL), and Student Interactive Learning (SIL). This category was developed based on a review of the literature, and every interaction factor is subdivided into three subcategories. Afterwards, the expert teachers separately reviewed and coded the behavior attributes of 12 subcategories between *appearance* (1) and *disappearance* (0) for each instructional event. The reliability of coding results is .89, and then if the coding results had any disagreement, the expert teachers would discuss the event and achieve consensus on it.

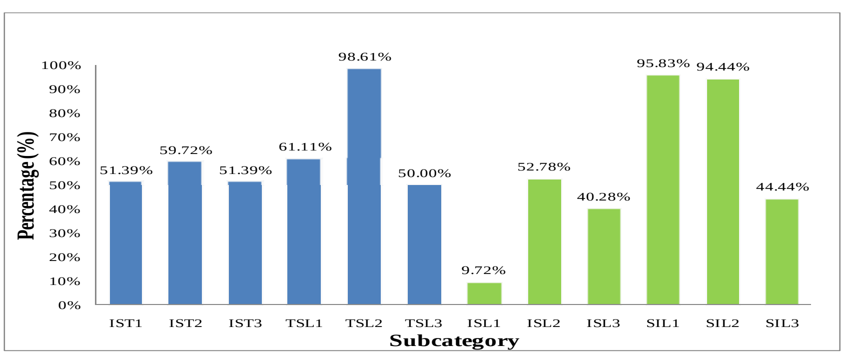

Figure 2 Results of the instructional event analysis of the 12 subcategories.

Results

Figure 2 presents the percentage of the instructional event analysis results of 12 subcategories, the blue bars represent teaching behaviors, and the green ones represent learning behaviors. Table 1 presents the results of the subcategory patterns in a joint distribution of interaction scales in four interaction factors.

Table 1 The descriptive statistics of the results of the instructional events analysis in a joint distribution of scales and factors.

Interaction scales	Subcategory patterns ***1	***2	***3		Interaction factors IST	TSL	ISL	SIL	Scale marginal
0	0	0	0		29	0	34	3	
				Count	29	0	34	3	66
				Column %	40.28%	0.00%	47.22%	4.17%	22.92%
				Row %	43.94%	0.00%	51.52%	4.55%	100.00%
1	1	0	0		0	1	0	1	
	0	1	0		6	28	9	0	
	0	0	1		0	0	0	0	
				Count	6	29	9	1	45
				Column %	8.33%	40.28%	12.50%	1.39%	15.63%
				Row %	13.33%	64.44%	20.00%	2.22%	100.00%
2	1	1	0		0	7	0	36	
	1	0	1		0	0	0	0	
	0	1	1		0	0	22	0	
				Count	0	7	22	36	65
				Column %	0.00%	9.72%	30.56%	50.00%	22.57%
				Row %	0.00%	10.77%	33.85%	55.38%	100.00%
3	1	1	1		37	36	7	32	
				Count	37	36	7	32	112
				Column %	51.39%	50.00%	9.72%	44.44%	38.89%
				Row %	33.04%	32.14%	6.25%	28.57%	100.00%
Factor marginal				Count	72	72	72	72	288
				Column %	100.00%	100.00%	100.00%	100.00%	100.00%
				Row %	25.00%	25.00%	25.00%	25.00%	100.00%

Note. The first column represents the interaction scale set (0, 1, 2, and 3) of this study. The second column represents the results of the subcategory coded composition, with item ***1 representing IST1/TSL1/ISL1/SIL1. For example, the composition of the 000 pattern means ***1+***2+***3=0+0+0=0 was classified to scale 0; the 010 pattern means ***1+***2+***3=0+1+0=1 was classified to scale 1. The other columns represent the coded results' calculation with regard to the four interaction factors.

Conclusion

This study explored the primary students' group works in terms of the usage of IWB and CFS. We conducted a case study and analyzed the instruction events by a content analysis method. The results found the IWB plus CFS improved the teaching and learning interactions, especially on whole-class discussion (teacher-student) and cooperative group work (student-student). While these activities were seamlessly proceeding, student's concept is simultaneously constructed by efficient dialogic interactions between a teacher and students. Just as the suggestions of Dhindsa and Emran [2] that the technology itself has little bearing on the learning of students. In this study, we concluded that the teacher is still a key to construct an environment enabling students' active, cooperative and responsible learning. In the manner, the concept development can occur through the learners' observation, response and interaction process, enhancing the knowledge construction. Thus, the ultimate goal of the ICT supported interactive learning is that teachers and students can indulge themselves with reciprocal interactions in all activities through the technology.

Acknowledgements

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References

[1] Anderson, R. J., Anderson, R., Vandegrift, T., Wolfman, S., & Yasuhara, K. (2003). *Promoting interaction in large classes with computer-mediated feedback.* Paper presented at the Proceedings of CSCL 2003.

[2] Dhindsa, H. S., & Emran, S. H. (2006). *Use of the interactive whiteboard in constructivist teaching for higher student achievement*. Paper presented at the Proceedings of the Second Annual Conference for Middle East Teachers of Science, Mathematics and Computing., Abu Dhabi.

[3] Newhouse, C. P. (2002). *The Impact of ICT on Learning and Teaching*. Retrieved June 29, 2006, from http://www.det.wa.edu.au/education/cmis/eval/downloads/pd/impactreview.pdf

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Evaluation of TERAKOYA Learning System Linking Multi-point Remote Users as Supplementary Lessons

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Abstract: This paper discusses the effectiveness of the new TERAKOYA learning system in remedial education. This system provides both interactive lessons and a small private school environment similar to the 18th-century Japanese basic schools called TERAKOYA. It helps students study actively anywhere on a local area network linking multipoint remote users, and it provides an interactive evening lesson using tablet PCs and custom-built applications both in the dormitory and at home, so students and teachers can stay in their own living spaces. The proposed learning system was implemented in a girl's dormitory with a teacher at home or in a teacher's room on campus over one year. The implementation employed a handwritten electric whiteboard with verbal communication through a headset. After this test was conducted, the effectiveness of the system in helping students study actively and willingly as an example of "right time, right place" learning was verified.

Keywords: Interactive system, Active learning, Remedial education

Introduction

In the present scenario where computers are ubiquitous, promoting the use of computers in school is very important. E-learning and learning through web content, however, are passive methods, and it is difficult to cultivate comprehensive active learning which has recently gained prominence. Because active learning requires learner participation, computers, which are becoming increasingly ubiquitous, are expected to complement classroom lectures given by teachers to students.

The present study aims to motivate learning and foster study skills, cooperation, and a sense of responsibility through remedial and developmental education. The purpose of the study is to realize and test a computer-supported learning system that cultivates a faculty for active learning [1][2]. We discuss here the new collaborative TERAKOYA learning system for remedial education, which helps students study actively anywhere on a local area network (LAN) linked to multipoint remote users, as shown in Figure 1. The TERAKOYA learning system provides both interactive lessons and a small private school environment similar to the 18th-century Japanese basic schools called TERAKOYA. In particular, the system provides an interactive evening lesson that uses tablet PCs on a wireless LAN (WLAN) and custom-built applications, linking students in the dormitory and the home with a teacher in the school or at home. In this new system, the students and teacher cooperate and interact in real time, as in some existing systems using a personal digital assistant (PDA). This system can be used to submit and store lecture notes or coursework using one tablet PC.

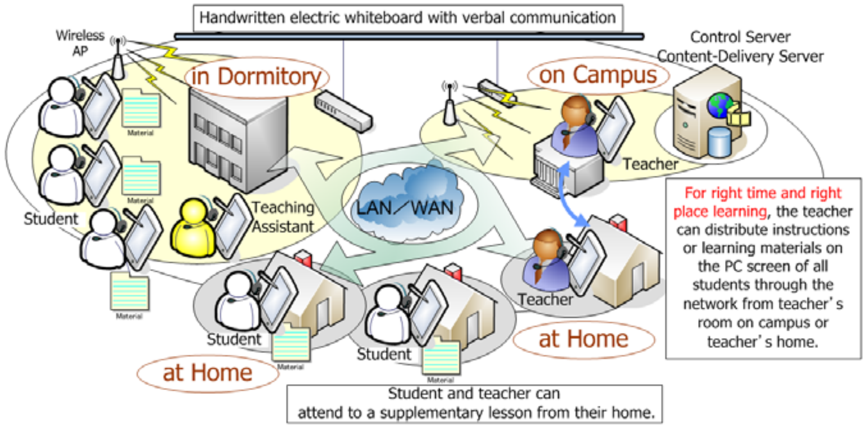


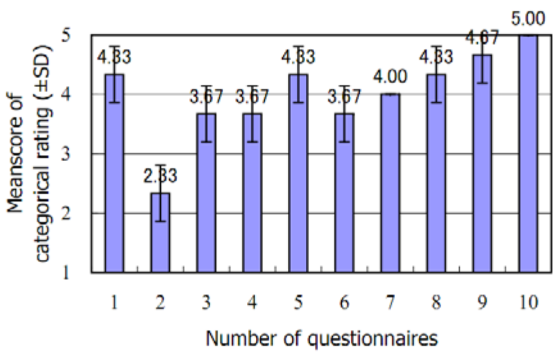
Figure 1: Conceptual structure of TERAKOYA learning system.

1. Practice and Evaluation

This system is optimized to work smoothly between 1 server PC and 50 client PCs, each with a 12-inch XGA display for one lesson, and the network speed was maintained at 500 kbps or less for each connection. Furthermore, this system interconnects via a Gbit LAN for the server on our campus via an IEEE 802.11a/g/b WLAN for the target hosts in our dormitory and via an IP virtual private network (VPN) for a teacher in his/her home.
As a prototype for applying this system to a real lesson for students in dormitories divided by sex (i.e., male and female dormitories), we assembled 25 computers: a Windows server, a client host for the teacher, and 23 client hosts for students. The proposed learning system was implemented in a pilot evening class as shown in Figure 2. After conducting this class, the feasibility and practicality of the system in helping students study actively and willingly was verified by observation and questionnaires.

(a) For a teacher at home *(b) For students in dormitory*
Figure 2: Snapshot of the practice when using in dormitory and at home.

We conducted a questionnaire survey to investigate subjective impressions of the prototype system. The test subjects were six teenage students in the Department of Electrical Engineering in a girl's dormitory. The subjects became familiar with operating the tablet PC over the course of the year. While test subjects attended the lessons from the girl's dormitory, the teacher conducted the lessons from his room on campus for the first six months; he also conducted the lesson from home via VPN. The intent of the investigation was clarified before they filled out the questionnaire. The questionnaire included the 10 questions as shown in Figure 3. The questionnaires evaluated subjective impressions using a five-point rating scale: Better = 5, Slightly better = 4, Fair = 3, Slightly worse = 2, and Worse = 1. Table 1 indicates the results of the questionnaire, where the mean score and standard deviation (SD) are calculated for each question. Subjects evaluated this system favorably. Subjects' rating of the ease of use of the system was high at 4.3 points, whereas the comparison with using a notebook was low (less than 3 points). However, other evaluations of our system by these users indicated greater effectiveness. In particular, subjects' rating of their wish to continue the supplementary lessons using this system was quite high at 5 points. The ratings regarding the ability to concentrate during the supplementary lesson (questions 3, 4, 5, 7), showed that, because it is possible to concentrate on the teacher's explanations without taking notes and to concentrate on hearing the teacher's voice from the headphones without other noises, this system helped students concentrate better. As freely provided advice in the subjective evaluation, we got useful comments such as "The response of the stylus pen is slightly slow," "It is inconvenient that the voice is interrupted sometimes," "It may take some time before a student's question gets a response from the teacher," and "We want more time to do a lot of exercises." These ratings of the supplementary lesson provided by using this system suggest that this system could have the same outcome as a face-to-face class if the supplementary lessons are provided as multipoint remote interactive lessons. A further investigation of the subjective impressions of the prototype system is necessary. We would like to discuss the evaluation of the system in more detail later because we need to analyze the effectiveness of the small private school environment that uses the prototype system through the tablet PC [3].



Question 1: Is pen-based input better than keyboards?
Question 2: Is pen-based input better than using a notebook?
Question 3: Is it possible to concentrate on the content of the class?
Question 4: Is it possible to concentrate on writing the answers to questions?
Question 5: Is it easy to immediately correct your mistakes, because you can directly ask the teacher?
Question 6: Can your study activities become more efficient?
Question 7: Do you believe that this system is beneficial, and do you actively learn the supplementary lessons?
Question 8: Is it possible to use the system easily with brief training?
Question 9: How effective do you think this system is compared to a face-to-face supplementary lesson?
Question 10: Do you want to continue the supplementary lessons using this system?

Figure 3: Questionnaire results.

2. Conclusions and Further Work

This paper describes an implementation of our proposed learning system framework in a dormitory. The system was implemented in a girl's dormitory with a teacher at home or in a teacher's room on campus for one year. After this test with the students in this dormitory, the feasibility of the system in helping them study actively and willingly by employing the handwritten electric whiteboard with verbal communication through a headset was verified. Because the PC screens of students were viewable on the teacher's PC screen, the teacher could check the students' work and support their thinking process by online collaboration. The teacher could also clarify any misperceptions in their thinking processes, providing appropriate support for each student.

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References

[1] Matsuuchi, N., Shiba, H., Yamaguchi, T. and Fujiwara. K. (2008). The Practice and the Evaluation of a New Campus Wide Collaborative Active Learning System. *IPSJ Journal*, 49(10), 3439-3449.
[2] MedicQuest http://www.mqsys.jp/
[3] Ando, M. and Ueno, M. (2010). Effect analysis of handwritten input environment to e-learning contents that uses tablet PC, *JSiSE research report* 24(5), 60-67.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Meta Analysis on the Digital Textbook's Effectiveness on Learning Attitude

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Abstract: This study was applied the digital textbook's effectiveness on the learning attitude to the reports about 24 schools for research designated by the MEST(Ministry of Education, Science & Technology) and local Education Offices in 2008 and 2009. From the report data, the researcher calculated the overall effect size on learning attitude and respective effect size on the subjects of Korean, Mathematics, Sociology, Science and English. The result of this study is as follows: First, in terms of the digital textbook' effect on learning attitude, its overall, average effect size was 0.20 and 57.5% in the U3 index. The digital textbook appeared 7.5% improvement in the learning attitude compared to that of paper-printed textbook. Second, its effect on each subject was appeared in order of Korea(0.28), Sociology(0.27), Science(0.25), Mathematics(0.08), and English(0.08). According to Cohen's interpretation method, it can be said 3 subjects of Korean, Sociology and Science have small-sized improvement effects. But the subjects of English and Mathematics seemed not to have any change in learning attitude depending a kind of textbook.

Keywords: Digital Textbook, Learning Attitude, Meta-Analysis

1. Introduction

Existing teaching & learning systems centering the paper-printed textbook hinders the curriculum's often revision, which essentially needs due to the rapid social changes and the knowledge's shorten life span. Also seasonable supplement of educational cost much time and money[5]. Furthermore, with its limited contents, the paper-printed textbook reveals its limits in meeting learners' various learning needs and in raising more creative personals[4]. Therefore, there are increased the request on the digital textbook to fit in the U-learning Environment as well as to overcome above limits (the paper-printed textbook's limits) for rearing talented personnel required in the knowledge-information society[1][2][3].
To meet the needs of this age, Korean government suggested its vision for developing and commercializing high-quality textbook to suitable in the future educational environment[6] through the 'Digital Textbook's Commercialization Plan' in 2007, and started the development of model digital textbook[7][8]. And By designating 5 schools for researching in 2007, 20 schools in 2008 and 112 schools in 2009 respectively, the government tries to evaluate the learning effects of digital textbooks by applying them to real school situations.

Figure 1. Comparison of the two classrooms

2. Purpose and Methods

The purposes of this study are to estimate how much influence the digital textbook has on the learning attitude per subject compared with the paper-printed textbook's effects and to draw some suggestions for the digital textbook's effective application. For these purposes, this study conducted the metal-analysis targeting 24 reports about the research-schools designated by the MEST(Ministry of Education, Science & Technology) and local Education Offices in 2008 and 2009. And this study set following research matters:

First, How much size of overall average effect the digital textbook influences on the learning attitude?
Second, What subject is the digital textbook's influence on learning attitude appeared in?

This study was analyzed the operational reports of 24 schools currently designated for researching the digital textbook.

Table 1. 24 Field Research Reports' Current Situation about Research Targets

Number of Schools	24 Elementary School		
Number of Classes for Research	5th Grade	40 Classes	80 Classes
	6th Grade	40 Classes	
Number of Students for Research	Experimental Group	2205 people	5255 people
	Compared Group	3050 people	
Subject for Research	Korean, Sociology, Mathematics, Science, and English		
Application Period	2008 - Current(7 researches), 2009 - Current(17)		
Designating Institution	the MEST(11 schools), Local Education Offices(13)		

The study used some self-evaluation questions asking about the learning attitude, the subject preference, the learning pattern and learning-spent time. The questionnaire was produced by school after selecting some of KERIS' Learning Attitude Standard Questions. In this study, the survey results were calculated in the standardized unit of effect size.
In measuring and interpreting the digital textbook's effect sizes, this study used Cohen(1977)'s scale(standard).

3. Results and Discussion

As the result analyzing the cases acquired from the 24 reports selected for this study, digital textbook's overall, average effect size was the same as that of [Table 2].

Table 2. Digital Textbook's Overall, Average Effect Size (Improvement Level of Learning Attitude)

Kind	N	M(ES)	SD	U3%
Digital Textbook	24	0.20	0.458	57.5%

According to the [Table 2], the digital textbook's overall, average effect size was 0.20. Using Cohen(1977)'s interpretation standard for size effect, the result means that there was the 'small effect'. The overall effect's U3 index was 57.5%, and the figure means that the experimental group applying the digital textbooks improved its learning attitude of 7.5% more than that of the paper-printed textbook group.

For the classes using the digital textbooks, it was identified that students' learning attitudes in the subjects of Korean, Sociology and Science improved bigger than those of Mathematics and English. The self-evaluation questions were composed of the subject preference, the understanding level about class lesson, the concentration level, the initiative level, and the existence of class preparation & review. To get the responses, this study used various methods such as gathering data, communicating with students and setting some simulation situations. It is judged that the digital textbook's effect size on learning attitude was relatively bigger in the subjects of Korean, Sociology and Science which the students feel less, cognitive burden. For the subject of Mathematics and English, it can be interpreted that the digital textbook's effect size didn't have any big difference from that of paper-printed textbooks. This no difference may be considered that the digital textbook's strengths couldn't overcome the cognitive burdens which the subjects English and Mathematics have.

Table 3. Digital Textbook's Effect Size on Learning Attitude by Subject

Subject	N	M(ES)	SD	U3%
Korean	24	0.28	0.387	61.0%
Sociology	24	0.27	0.466	60.6%
Science	24	0.25	0.584	59.8%
Mathematics	24	0.08	0.474	53.1%
English	24	0.08	0.262	57.5%

4. Conclusion

In this study, we performed robot-aided education in a real classroom and surveyed the Digital textbook's model application has some important meaning in that students have naturally experienced a future-type teaching-learning pattern through various activities. However, for drawing common conclusion that a class utilizing the digital textbook improved student's academic achievement level or other cognitive powers, some researches with enough data from long viewpoint must continually be delivered. The digital textbook's efficiency needs to be proved in longer viewpoint. In addition of the digital textbook's cognitive effect, its definitive efficiency must steadily be reviewed.

References

[1] Allport, G.(1935). Attitude toward mathematics, Review of Educational Research, 551-596.

[2] Byoungil Son. (2004). *2004 digital textbook pilot schools result analysis research* . Keris.

[3] D. W. Lewis. (2009). How to Make Good Affordable Textbooks, Open access publishing, *Creative Commons license*, 1-18.

[4] Galitz, W. O. (1989). *Handbook of screen format design(3rd)*. Wellesley, MA : QED information Science, Inc.

[5] M. R. Nelson, (2008). E-Books in Higher Education : Nearing the End of the Era of Hype?, *EDUCAUSE Review*, 43(2), pp.40-56.

[6] Young-Sik Jeong. (2008). Development of Evaluation Criteria on Digital Textbook. *Journal of Korean Association of Computer education.* 11(3).

[7] Young Y, Seri Kim. (2008). Class step based Digital Textbook aided teaching . learning activity analysis research. *Journal of Education Information and Media*, 14(4), pp.111-140.

[8] Younghoon Park. (2007). *A Study on Authorization Procedure of Digital Textbooks.*

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Design of New Electronic Blackboard Management System for A Japanese teaching style

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Abstract: In this paper, we describe the new electronic blackboard management system design for A Japanese teaching style. This system is using IC-tags and networks. Handwriting data which written on electronic blackboard is tagged by using IC-tags automatically and data is sending to the management server. In Japan, teachers move the classroom at the class. Thus, teachers 'handwritten data is saved without division in a usual electronic blackboard. In this case, it is necessary to search out handwriting data at only the file name and the written date. Therefore, it is difficult to use handwriting data. The other side, someone understands easily the person who wrote the handwriting data in our designed system, because the system tags handwriting data automatically using IC-tags. Moreover, saved handwriting data can be used from any classroom, because the system unitary manages handwriting data by using networks.

Keywords: Electronic Blackboard, Pen-based Interface, IC-tag, Classroom Design

1. Introduction

A computer is used for the various places, and it is used for education now. The blackboard demonstration begins to be computerized with an electronic board, too. In late years in Japan, the introduction of the electronic blackboard begins slowly in the elementary and junior high school. However, many of current electronic blackboard systems are aimed for the use in the meeting in the company. Therefore it is difficult to use these systems by a class in a classroom. Some experimental classes such as Classroom 2000 [1] has held, but electronic blackboard system is not using at usual classes.

The general electronic blackboard system is small in comparison with the former blackboard physically. In addition, the design of the current electronic blackboard system has the problem that does not match Japanese education-style. As for many of classes-style such as U.S.A. and Europe, a student gathers in the classroom where a teacher is. Because a teacher is in the same classroom, the teacher is for exclusive use and can use the electronic blackboard system. A teacher does not confound the blackboard demonstration data that the teacher recorded in an electronic blackboard system with data of other teachers. Accordingly the data reduction is simple. The introduction of the electronic blackboard system in the U.K. really advances [2]. In the Japanese classroom, the teacher moves a classroom. Therefore the electronic blackboard system in the classroom is shared with plural teachers. The digitization of blackboard demonstration data is possible, but the data is incomprehensible because the data of plural teachers coexist which teacher wrote it. We describe design of a new electronic blackboard management system that utilized an IC tag and a network in order to solve a problem to be difficult in this paper.

2. Design and prototyping of new electronic blackboard management system

2.1 System overview

Fig. 1 shows constitution of a system. A system is made from 3 components; an electronic blackboard component, a management handwritten data component, data view client component. An electronic blackboard component consists of electronic blackboard unit control part and handwriting software part. Electronic blackboard unit control part detects electronic styles position and a kind and transmits to OS (Operating system) or handwriting software part as a blackboard device driver. Handwriting software part is draw on electronic blackboard surface by stylus kind and position which is transmitted by electronic blackboard component. This part reads writer’s ID card, and then attaches this information and blackboard identifier to the handwriting data and transmits this attached data to a management handwritten data component. A management handwritten data component receives handwritten data from electronic blackboard components, and stores it to database. And a data view client component outputs handwritten data, which is stored in a management handwritten data component database.

2.2 System prototyping

I install two electronic blackboard units in the classroom (Fig.2). These electronic blackboard units are installed side by side for same size of current blackboard. It is four kinds of electronic styluses and an electronic eraser for change color shifting it. This prototyping system uses StarBoard F-75 made by Hitachi Software Engineering as electronic blackboard unit. Both electronic blackboards are connected to one PC with USB-serial port converters. In addition, DualHead2Go of Matrox company is used for outputting two screens from one PC to project two electronic blackboards surface.

Software for an electronic blackboard obtains the mouse events and position/kind of an electronic stylus that are sent from the control units, and draws lines on the screen in colors corresponding with the kind of an electronic stylus. Information of drawn lines are sent to the handwritten data management servers with sending date of mouse events, identifiers of an electronic blackboard, the date that an electronic blackboard is full-screen-erased in previous time, additionally with XY coordinate columns, colors of a pen, width of lines by each stroke (up of an electronic pen). Since a full-screen-erase function is used when the new item is wrote, it is utilized as a separation of an electronic blackboard data.

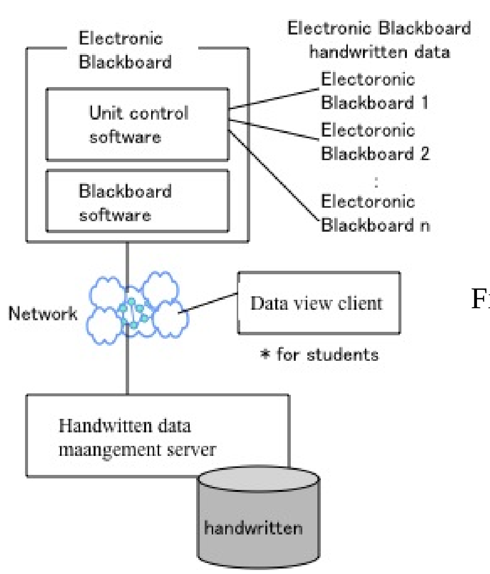

Figure 1. System overview

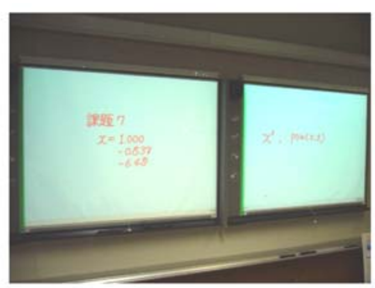

Figure 2. Electronic whiteboards in the classroom

Figure 3. IC-card R/W and IC-card

For web browser utilized client, the blackboard demonstration data is displayed with VML (Vector Markup Language). Browsers have increased to correspond with VML in standard, it is possible for client-side to view data without such preparation as to install the specific client soft and is less reliant on environment. It is available in case the students browse the blackboard demonstration data for self-study and so on.

2.3 Reading IC cards

An IC tag is necessary to use the ID of the teacher for binding with handwritten data. By this prototype system, I use an IC card as an IC tag. Fig.3 shows IC card and IC card reader. Our university distribute IC card using Felica made by SONY to faculty. Because an ID number assigned to each staff of university is stored in the IC card, this system reads this. When the student whom it is not distributed an IC card to by the university uses the system, the system can read IC card of Felica standard. Many people have IC card of Felica standard, SUICA, PASMO, EDY in Japan to use you as a train and a bus, the payment of the shop. Because there is peculiar number IDm (Manufacture ID Block), as for Felica IC card, the system can use this as ID. Because this system using IC card, it is very simple operation; put an IC card to IC card reader when a user uses an electronic blackboard, take the card from IC card reader if a user finishes using it. I build it with low cost and use Sony RC-S320 to raise versatility.

2.4 Test usage of the system and system enhancement

The constructed system in this paper has installed in usually used classroom. With considering the adequate timing, I have a plan to release all functions gradually. In current, the system can be retrieved by the date/writer ID/identifier of electronic blackboard only. I have already studied the frameless handwritten characters recognition servers [3]. To embed them to the system, it becomes possible to input handwriting of keyword for searching blackboard demonstration data.

3. Conclusion

In this paper, I described studies in the new electronic blackboard management system utilizing IC tags and network. By using the method described in this paper, it becomes easier to use the electronic blackboard that is equipped in the classroom for Japanese classroom style. Since blackboard data is tagged automatically with an IC card that teachers have, it is easy to find and reuse the data later. These data are centralized with handwritten data management serve, it becomes possible for students to use of self-study, or for teachers to continue the class by retrieving the blackboard demonstration data of the previous session even when the class room has been changed.

Acknowledgements

This research was partially supported by the Ministry of Education, Science, Sports and Culture, Grant-in-Aid for Young Scientists (B), 21700802.

References

[1] Gregory D. Abowd.: ”Classroom 2000: An Experiment with the Instrumentation of a Living Educational Environment,” IBM Systems Journal, Special issue on Pervasive Computing, Volume 38, Number 4, pp. 508-530, 1999.

[2] Keisuke Shimizu: “Denshi Kokuban de Jyugyou ga kawaru (in Japanese),” ISBN 4771106576, 2006.

[3] Mitsunori Yorifuji, Takeshi Sakurada, Naoki Kato, Masaki Nakagawa: “ A Frame-less Handwritten Character Recognition system through network using Client-Server method,” Proceedings of the 65th Annual Convention IPS Japan vol.3, pp.523-524, 2003.

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Cultivating the Performance of Presentation through Monitoring Presenter's Action

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Abstract: This paper describes a supporting method of academic presentation and a developed system to improve the presentation performance. We focus on the motor skill, whose analysis is based on presenter's gesture and gaze-direction. We design the framework to improve presentation skill and develop the prototype system that detects gestures and gaze-directions.

Keywords: Presentation, Gesture, Gaze-direction, Physical skill

Introduction

The importance of presentation is getting higher. Therefore presentation skill is regarded as one of essential skills for everyone. It's very worthy to support developing presentation skill. Presentation skill consists of three factors: presence, scenario and delivery skill [1]. We think presentation is a kind of live performances. Therefore we focused especially on delivery skill. Delivery skill is how to inform to other people. For example, it includes how to speak, how to draw attention of audiences and so on.
We designed the framework to improve the performance. Generally, we get some significant information from the direction of speaker's eyes, facial expressions, body motion and so force. We focus on gesture and gaze-direction.

1. The framework

1.1 Purpose

The framework is designed to make our presentation better by developing our delivery skill. The purpose of presentation is to give convey something. Therefore the presenter needs to inform what she / he conveys and impresses her / his presentation.

1.2 Gesture

Gesture is very powerful for communication. Gesture can inform many information and support to think [2]. When we convey to others anything, we use not only verbal language but also body language. Therefore we expect gesture helps to convey some information and to draw attention of audiences.
At the first step to use gesture effectively in presentation, we need to get used to using gesture in presentation. Many Japanese people have a feeling of resistance to make gesture. Therefore we develop a gesture recognizing system.

1.3 Gaze-direction

Gaze-direction is one of the important factors in delivery skill. We expect controlling gaze-direction makes the connection between a presenter and audiences. Therefore the presenter needs to control her / his gaze-direction to show faith.
Gaze-direction has the expressive function. Dr. Fukayama described the longer a person gazes others, the stronger others think about her / him [3].
Therefore we designed the system that supports to control gaze-direction. The system detects where a presenter is looking. In addition, the system advises where the presenter should look. The presenter can improve her / his presentation by the advice.

2. Gesture Recognition System development

The system we developed distinguishes a gesture of a presenter. It also controls an application associated with the presentation: Power Point, Open Office Impress and Apple Keynote. In addition, it has some extra functions to show some effects (describe in 2.2).

2.1 Algorithm

This system distinguishes a gesture of a presenter with least square method.
A presenter wears a wireless 3D acceleration sensor on her / his right hand. The sensor sends acceleration data on the wireless network and the system receives the data. The stored data in such a way are used to detect one of the preset patterns. The system adapted least square method in this process. When the system successfully detects the action pattern, it starts to control the OS and applications.

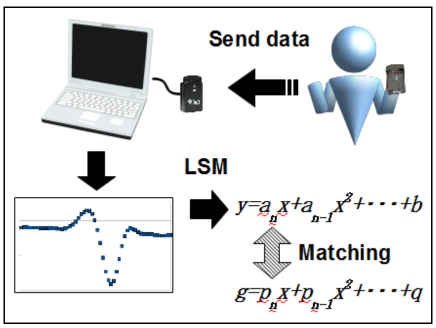

Figure 1. The gesture recognizing system

2.2 Gesture patterns

Our system distinguishes several gestures and functions. This paper describes 2 pairs of gestures and functions as follows.

1. “Push” – Update slide
‘Push’ is a basic motion that a presenter hold out her / his hand to side. Then the system changes a slide to next one.

2.‘Tap’ – Sound Effect
‘Tap’ is a motion that a presenter taps screen 2 times. Then the system makes a sound. This function draws audience’s attention and informs importance of slide at that time.
We expect this function is different from other functions. Other functions operate the presenter’s PC and an application on it. On the other hand, the system with this function doesn’t only operate the PC but also expressly draw attention of audiences.

3. Gaze-direction support system

We expect that gaze-direction control is as important as gestures in a presentation. Gaze-direction impresses to audiences. Some presenters gaze her / his pc or screen. We think it is not good in terms of interaction. The presenter needs to look at audiences.

3.1 Devices

Our system uses Wii Remote Controller as IR sensor and wireless network device.
The presenter wears LED glasses we developed. It has LED lights on its both edges.

3.2 The System

The system distinguishes the direction of a presenter's face by trace LED Glasses. If a presenter takes a glance on screen or PC, the system suggests that the presenter should look at other points. We expect that the presenter will be able to control the direction of the face without the system through experiences of using this system.
This system uses multiple Wii Remote Controllers. They are installed in a conference room (see below figure). The PC receives IR data and recognizes the direction of the presenter's face. The system suggest moving the point the presenter looking if the presenter is looking amiss point, for example, Screen or PC.

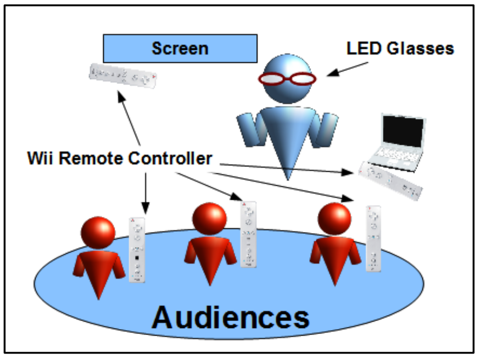

Figure 2. Gaze-direction support System

4. Conclusions

We described the framework for sake of cultivating a performance in a public presentation. The framework is designed based on gesture and gaze-direction. We developed the gesture recognizing system and gaze-direction control system. We'll improve these systems for the feasible use for the preparation phase and the real.
We expect it fascinates our presentation by way of improvement of our delivery skill. This study has a great potential to be able to improve presentation skill.

Acknowledgements
This work was partially supported by Grant-in-Aid for Young Scientists (B) No.20700641 and Grant-in-Aid for Scientific Research (B) No.22300291.

References
[1] H.R.Institute. (2000). *Know-How Do-How of Presentation*. *PHP Business sensyo*, 28-29.
[2] Sotaro.K. (2000). why do people gesture?. Ninchikagaku [Cognitive Studies], 7(1), 9-21.
[3] Atsushi.F, Takehiko.O, Naoki.T, Minako.S & Norihiro.H. (2002). Gizinka agent no shisen niyoru insyousousa. IPSJ-Interuction2002. pp.93-100.

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Changing Classroom into Exciting Learning Space by Entertainment Computing Approach

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Abstract: In this paper, we describe an attempt to increase students' learning motivation in a classroom lecture. Our idea is to change a classroom into an exciting learning space by entertainment computing approach. The prototype system called "UbiDoor" aims at increasing learning motivation by giving students irregular external cues such as image, audio, temperature, and light.

Keywords: Classroom, classroom lecture, learning motivation, entertainment computing

Introduction

Education should change along with not only technological progress but also social situations. Nowadays in Japan, it is said that students' learning motivation is declining. Learning motivation is considered to be quite important for successful learning [1]. Therefore, increase of learning motivation should be addressed as a matter of first priority. The purpose of this study is to increase students' learning motivation in a classroom lecture from the viewpoint of learning space. The Learning space can influence not only learning efficiency and efficacy but also students' learning activities, attitudes, and motivation [2]. A classroom is a principal learning space in a school/university setting and classroom design covers a wide variety of issues (e.g., desks, chairs, black/white boards, lights, electric/digital equipments, and learning support software). We think that the conventional classroom design is too serious and the future classroom design should focus more on exciting classrooms—classroom lectures where students can be immersive and infused in learning. Our idea is to change a classroom into an exciting learning space by entertainment computing approach, which focuses on "fantasy" identified by Manole and Lepper [3] as an important factor for an exciting classroom.

1. Learning Motivation Model

In this study, we propose a learning motivation model that is applied to classroom lectures and consists of three layers. Figure 1 shows the model overview.

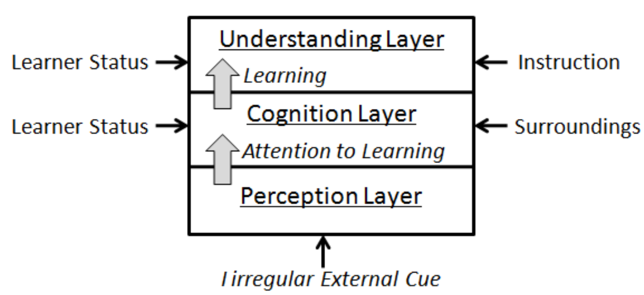

Figure 1: Learning motivation model

1.1 Perception Layer

This layer is positioned at the model's bottom and handles whether an irregular external cue makes a student pay attention to the current classroom lecture. Here, the attention is not necessarily paid to the content of learning (the lecture). For example, all of sudden a teacher begins to explain in a loud voice and at that moment students may pay attention to the teacher or the blackboard.

1.2 Cognition Layer

This layer is positioned at the model's middle and handles whether the student's attention transitions to learning actions. Here, the leaning actions mean listening to the teacher's explanation, looking at the content of the blackboard or learning material (e.g., textbooks and digital slide show on the classroom screen), note-taking, asking a question, etc.

In this layer, the student recognizes his/her internal states (e.g., understanding level, learning process, and curiosity) and surrounding situations (e.g., the teacher's words and facial expression, other students' learning attitude, and the classroom atmosphere) and then judges whether he/she takes a learning action. For example, if a teacher says "this part is on the test" and a student has not understood the part, the student will take a learning action.

1.3 Understanding Layer

This layer is positioned at the model's top and handles whether the student can understand the content of learning as a result of his/her learning actions. Here, his/her understanding depends on his/her internal states and the teacher's instruction. Once the student feels the satisfaction of understanding, he/she may pay attention to learning continually without an irregular external cue.

2. Prototype System

We developed a prototype system called "UbiDoor", focusing on the perception layer in the above model. This prototype system, which changes a classroom into an exciting learning space by entertainment computing, aims at increasing students' learning motivation in a classroom lecture from the perception layer. Currently, UbiDoor does not ensure increasing learning motivation on the cognition layer and the understanding layer.

2.1 Concept

UbiDoor makes students pay attention to learning by giving them irregular external cues. Irregular external cues are given on a predefined time schedule and/or at events in a classroom and stimulate their visual and auditory senses. For example, digital slide show of the lecture's trailer is projected onto the classroom screen a few minutes before the lecture. In another example, opening music is played at the moment when a teacher enters the classroom. In a different standpoint, UbiDoor helps teachers to give a classroom lecture different than usual, that is, helps to introduce fantasy into the classroom lecture.

In this study, we regard such introduction of fantasy as "entertainment". Whether students' learning motivation is increased from the perception layer depends on how a teacher can make effective use of UbiDoor— comprehensive instructional design including entertainment aspects.

2.2 System Composition

The prototype system has client-server architecture and is composed of the following subsystems: entertainment executor and entertainment manager. Figure 2 shows the system composition.

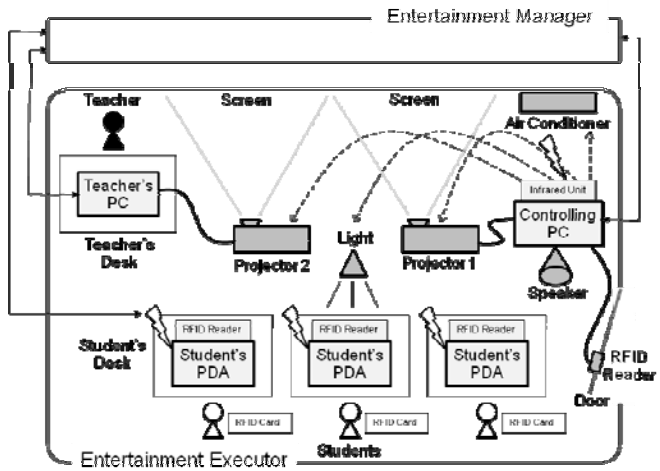

Figure 2: System composition

The classroom we assumed has digital projectors, screens (available as whiteboards), an air conditioner, and a spotlight. One of the projectors, speakers, an infrared unit, and an RFID reader are connected with the controlling PC via wired lines. The infrared unit is used for transmitting infrared commands (e.g., on/off) to the air conditioner and the spot light. The RFID reader is embedded in the classroom door (beside the doorknob) to detect a teacher's entry to the classroom. A wireless-network-enabled PDA equipped with an RFID reader is put on every student's desk to detect a student. A teacher's personal computer whose display output is transmitted to a projector is put on a teacher's desk. The prototype system controls image, audio, video, slide show, temperature, and light in a classroom.

2.3 Example of Entertainment

We think that UbiDoor can work well for learning topics (lectures) such as geography, history, and literature. To take the learning topic of "Malaysia" for example, the classroom temperature has been raised to around 30 degrees Celsius by an air conditioner before a student has a seat and a Malaysian traditional music is played when having the seat.

3. Summary and Future Work

This paper described an attempt to increase students' learning motivation in a classroom lecture by giving the students irregular external cues such as image, audio, etc. A future work is to examine whether UbiDoor increases learning motivation and learning effect.

Acknowledgements

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References

[1] Dede, C., Clarke, J., Ketelhut, D., Nelson, B. & Bowman, C. (2005). Fostering Motivation, Learning, and Transfer in Multi-User Virtual Environments. *Proc. of the American Educational Research Association Conference 2005*.
[2] Oblinger, D.G. (Eds.) (2006). Learning Space. EDUCAUSE. http://www.educause.edu/learningspaces (accessed on Sept. 14, 2010)
[3] Malone, T. W. & Lepper, M. R. (1987). Making Learning Fun: A Taxonomy of Intrinsic Motivations for Learning, *Aptitude, Learning and Instruction* (pp. 223-253), Hillsdale, NJ.

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Pronunciation Instruction using CG Animation based on Articulatory Features

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Abstract: We describe a pronunciation instruction system that dynamically generates CG animations to express the pronunciation from speech based on articulatory features. Specifically, the system displays the results of phoneme recognition and animation of the pronunciation movements of both the learner and teacher from their speech in order to show in what way the learner's pronunciation is wrong. Learners can thus understand their wrong pronunciation and the correct pronunciation method through specific pronunciation animations. Experiments confirmed the effectiveness of the animations.

Keywords: Pronunciation instruction, animation, articulatory feature, speech recognition

Introduction

In pronunciation education, face-to-face lectures are ideal. The teacher teaches accurate pronunciations to students by explaining the movement and relative location of the tongue and palate when making utterances. The teacher also points out each learner's pronunciation mistakes and how to correct them. However, it takes time to acquire correct pronunciation and learners typically do not have enough time to attend face-to-face lectures. In Japan in particular, there is not enough time to study pronunciation at school. Therefore, computer-based pronunciation training systems are very useful as they allow learners to study pronunciation at any time.

With this background, Computer Assisted Language Learning (CALL) systems have been introduced for English language education in recent years [1][2]. CALL systems typically analyze a learner's speech by using speech recognition technology, and point out pronunciation problems with specific phonemes in words and automatically score the pronunciation quality [3][4][5]. However, although the learner can thus realize that his/her speech is different from the teacher's, the learner cannot understand how to correctly move the appropriate articulation organ. The system should show how to do this when the learner makes a wrong pronunciation, in the same way that teachers do. The proposed system provides several interactive methods for learners, not only pointing out their individual pronunciation problems, but also visually representing the teacher's and learner's articulatory movements (movement of the tongue, palate, and lips) by using CG animation. The system provides guidance on the learner's wrong pronunciation movement as well as the correct pronunciation movement, appropriately and in real-time. As a result, the learner can study how to move an articulatory organ while visually comparing their mispronunciation animation and the correct pronunciation animation. Such animations are easy to understand. Although other studies have examined making correct pronunciation animation and video in advance [6][7], they do not dynamically produce animations of the learner's wrong pronunciation. To represent the teacher's and learner's articulatory movements, the proposed system directly extracts articulatory features (place of articulation and manner of articulation) from their speeches.

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1. Outline of Pronunciation Training System

Figure 1 shows an outline of the system. The system consists mainly of articulatory extraction, phoneme recognition, and pronunciation instruction functions. As for articulatory extraction and phoneme recognition, we use existing technologies we have already developed. The CG animation is generated by using the phoneme sequence, phoneme boundary and articulatory features extracted using these technologies.

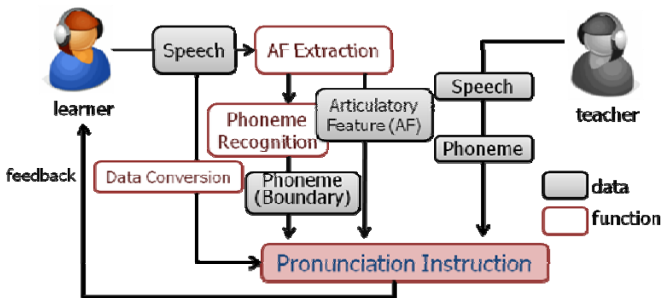

Fig. 1: System outline

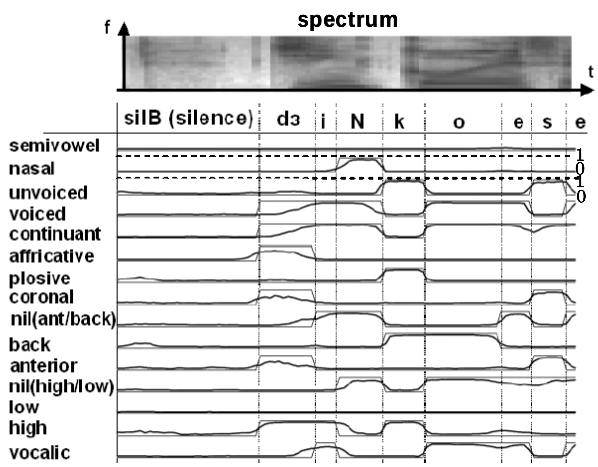

Fig. 2: Articulatory feature sequence: /jiNkoese (artificial satellite)/

2. Articulatory Feature Extraction

2.1 Articulatory Features

In order to vocalize, human beings change the shape of the vocal tract and move articulatory organs such as the lips, teeth, alveolar arch, palate, tongue and pharynges. This is called articulatory movement. Each attribute of the place of articulation (back vowel, front vowel, palate, etc.) and manner of articulation (fricative, plosive, nasal, etc.) in the articulatory movement is called an articulatory feature (AF). In short, articulatory features mean information (for instance, closing the lips to pronounce "m") on the movement of the articulatory organ that contributes to the articulatory movement. In this paper, articulatory features are expressed by assigning +/- as the feature of each articulation in a phoneme. For example, the articulatory feature sequence of "/jiNkoese (Space satellite)" in Japanese is shown in Figure 2. Because phoneme N is a voiced sound, "voiced" in Figure 2 is given [+]. (Actually, [+] is given a value of "1" (right side of Figure 2).) Because phoneme k is a voiceless sound, “voiced” in Figure 2 is given [-]. Actually, [-] is given a value of “0” (right side of Figure 2)) and “unvoiced” in Figure 2 is given [+]. We generated an articulatory feature table of 28 dimensions corresponding to 42 English phonemes. We defined the articulatory features based on distinctive phonetic features (DPF) involved in English phonemes in international phonetic symbols (International Phonetic Alphabet; IPA)[8].

2.2 Articulatory Feature Extraction

We also used our previously developed articulatory feature (AF) extraction technology [9]. The extraction accuracy is about 95 %. Figure 3 shows the AF extractor. An input speech is sampled at 16 kHz and a 512-point FFT of the 25 ms Hamming-windowed speech segment is applied every 10 ms. The resultant FFT power spectrum is then integrated into a 24-ch BPFs output with mel-scaled center frequencies. At the acoustic feature extraction stage, the BPF outputs are first converted to local features (LFs) by applying three-point linear regression (LR) along the time and frequency axes. LFs represent variation in a spectrum pattern along two axes. After compressing these two LFs with 24 dimensions into LFs with 12 dimensions using a discrete cosine transform (DCT), a 25-dimensional (12 Δt, 12 Δf, and ΔP, where P stands for the log power of a raw speech signal) feature vector called LF is extracted. Our previous work shows that LF is superior to MFCC as the input to MLNs for the extraction of AFs, or distinctive phonetic features (DPFs). LFs are then entered into a three-stage AF extractor. The first stage extracts 45-dimensional AF vectors from the LFs of input speech using two MLNs, where the first MLN maps acoustic features, or LFs, onto discrete AFs and the second MLN reduces misclassification at phoneme boundaries by constraining the AF context. The second stage incorporates inhibition/enhancement (In/En) functionalities to obtain modified AF patterns. The third stage decorrelates three context vectors of AFs using the Gram-Schmidt (GS) orthogonalization procedure before connecting with the HMM-based classifier.

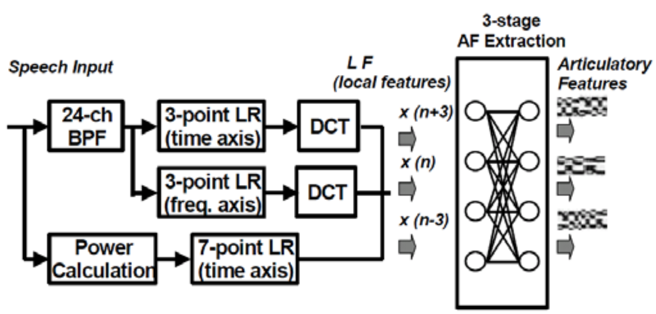

Fig. 3 Articulatory feature extraction

2.3 Phoneme Recognition

For recognizing phonemes, we utilize the phoneme recognition technology using AFs that we have developed [10]. The phoneme boundary and phoneme sequence are obtained by inputting AFs extracted as described in Section 2.2 to the Hidden Markov Model (HMM). The score of each phoneme is calculated by comparing the correct AF with the extracted AF based on the phoneme boundary. Additionally, correct phonemes and wrong phonemes are decided by comparing each AF. Finally, the results of evaluating the learner’s speech such as the score and whether each phoneme and phoneme sequence are correct or wrong are fed back to the learner.

3. Pronunciation Instruction based on CG Animation

A CG animation of the inside of the mouth of the teacher and learner is generated based on the AFs, phoneme sequence, and phoneme boundary obtained from their speech. Because the CG animation is generated immediately as their speech is input, the learner can confirm the motion of pronunciation in real time.

3.1 Articulatory Feature Analysis

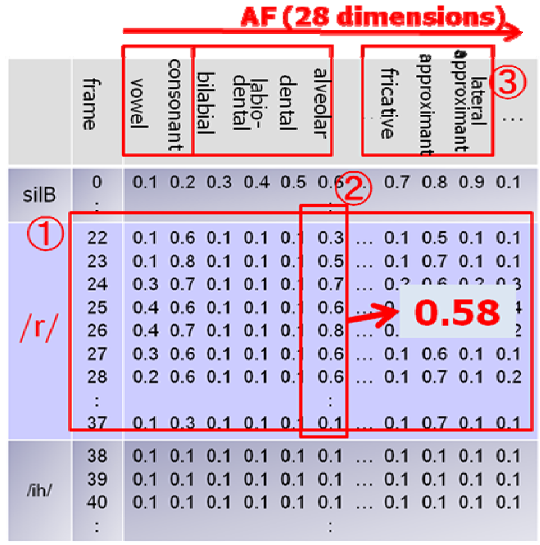

Fig. 4: Example of AF table ("read")

The phoneme sequences, phoneme boundaries and value [0 or 1] of each articulatory organ (AF) are obtained as described in Section 2.2. Figure 4 shows part of the results of AFs for the word "read". The system recognizes the phoneme /r/ from frame 22 to frame 37 of the speech. One frame corresponds to 10 ms. The phoneme boundaries (frame to frame of each phoneme) are used for the reproduction timing of the animation. The AF sequence in this paper is defined based on the AF values of 28 dimensions (place of articulation and manner of articulation) in each frame (Figure 4①). In this section, we describe how to decide the articulation motion to generate the animation based on AFs. The order is as follows:

1. The AFs of each phoneme are extracted. In the example of Figure 4, the AFs from frame 22 to frame 37, which is the phoneme boundary of /r/, are extracted (Figure 4①).
2. The mean value of each AF is calculated in the section. In the example, the mean value of "alveolar" in the section of /r/ is 0.58 (Figure 4②).
3. AFs are classified according to the point of articulation or manner of articulation based on the articulatory phonetics shown in Table 1. For instance, nasal, fricative, approximant**,** lateral approximant, etc. are classified as manners of articulation (consonant) (Figure 4③). Next, one effective AF is chosen from each category, which is the AF whose mean value becomes the maximum in the category. That is, the articulatory organ that moved when the learner pronounces is specified. Because the mean value of "alveolar" is the maximum in the "point of articulation (consonant))" category in the /r/ section, the alveolar registers as one AF of /r/ in Figure 4. That is, it is judged that the speech was an alveolar movement (the tip of the tongue pressed against the alveolar ridge behind the teeth) when the learner pronounced /r/.

Table 1: Examples of AF categories

Category of AF	AF
vowel / consonant	vowel, consonant
voice band	voiced, unvoiced
manner of articulation (consonant)	plosive, nasal, fricative, flap, approximant**,** lateral approximant
point of articulation (consonant)	labial, labiodental, dental, alveolar, postalveolar, glottal, palatal
lip (vowel)	raised, half-closed, half-open, lowered
place of tongue (vowel)	front vowel, back vowel, central vowel
other (vowel)	round, tense, R-colored vowel

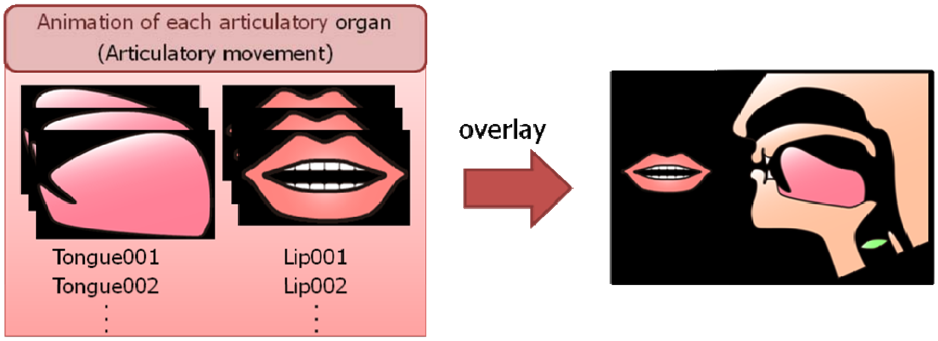

Fig. 5: Animation generation for each phoneme

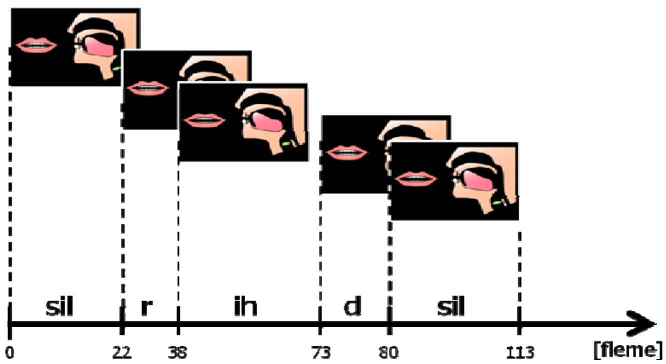

Fig. 6: Animation joint between each phoneme

3.2 Animation Generation

It is necessary to present the movement of the mouth cavity viewed from the side and the lips viewed from the front in order to clearly show the pronunciation method to the learner. It is also necessary to express the movement of each articulatory organ accurately. We generate beforehand some animations independently for each articulatory organ, and then overlap these animations. The order of animation generation is as follows:

1. The movement pattern of each articulatory organ is made with Adobe Illustrator CS3 beforehand. Various animations of movements such as alveolar (fricative), alveolar (plosive), postalveolar (approximant) of the tongue (consonant), closed, open, narrowness of lips, bilabial, etc. are made. The animation movements are made based on phonology.
2. We use the "shape tween" ActionScript for the animated motion. The shape tween is a function which changes the shape of an object gradually whenever one frame advances by matching the top of the object in the first frame with that in the last frame for each articulatory organ. The animation for one articulatory organ is about 15 frames (15 ms), and is assigned a unique ID.
3. The animation of the mouth cavity and lips is generated by overlapping respective animations corresponding to the AF of a phoneme decided in Section 3.1 (Figure 5). The animations are generated for all phonemes using the same method.
4. Next, the animations of respective phonemes are connected. The shape of an articulatory organ would change too rapidly if the previous phoneme's animation that has finished changing is simply connected to the default animation of the following phoneme. The system therefore connects the vector (feature point) of the next phoneme's animation and the vector (feature point) of the previous phoneme's animation five frames earlier, respectively. This method makes the connection between phoneme animations more natural.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

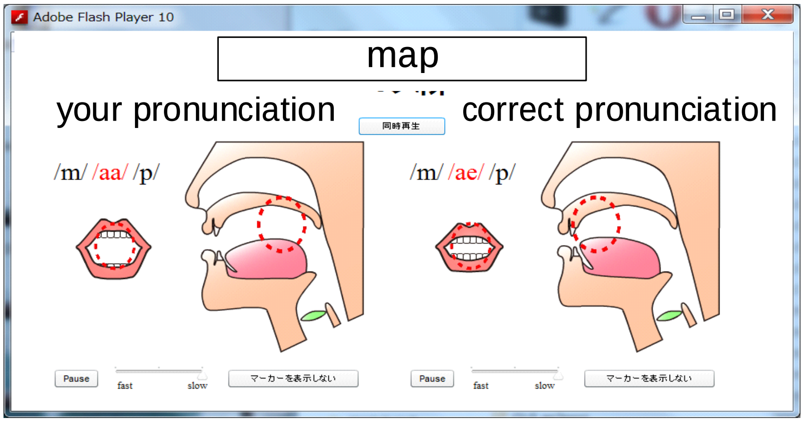

Fig. 7: Example of pronunciation instruction

3.3 Pronunciation Instruction Functions

To show the learner's mispronunciation movement and the correct pronunciation movement appropriately and specifically, the following functions are included.

- When the play button on the screen is clicked, the animation of the mouth cavity and lips is reproduced with the learner's voice. When the play button on the correct pronunciation side is clicked, the animation is reproduced with the voice of the teacher who was recorded beforehand. When the simultaneous button is clicked, both the learner's animation and the correct animation are reproduced at the same time. The learner can thus visually compare their own pronunciation with the correct pronunciation.
- To teach how and where the learner should make corrections, the system highlights the wrong articulation organs with a red circle by comparing the AFs of the learner and the teacher if the learner's pronunciation is wrong (red circle in Figure 7). As a result, the learner can see which articulatory movement is wrong, and how the articulatory organs should be moved to pronounce correctly. In Figure 7, because the movement of the lips and the tongue for /æ/ of "map" is different (the learner pronounces /aa/), a marker is displayed on the lips and tongue of both the learner and teacher.
- It is also important to confirm the correct pronunciation method in each phoneme. Therefore, the pronunciation animation of the phoneme can be played by clicking on the phonemic symbol (/m/,/æ/,/p/) on the screen.
- Slow-motion replay of the voice and animation at three speeds, ×1, ×0.5, and ×0.25, is possible, allowing the learner to see the pronunciation in slow-motion by adjusting the play speed. We built a speech rate conversion function for adjusting the speed of the voice.

4. Experimental Evaluation

4.1 Experimental Setup

To show the effectiveness of the proposed system, we compared it with an existing system by experiment. The existing system was a mounted speech recognition technology which shows correct/wrong phonemes by text. The subjects were 11 Japanese native speakers, who were in a beginner's class for English pronunciation. The order of the experiment was as follows.

1. Eight English words including a phoneme that Japanese people are not good at were prepared. The eight words were divided into two groups of four words each.
2. We recorded the subject's pronunciation voice before the experiment, and recorded the score evaluated by the system.
3. To avoid subject bias, the subjects were divided into group 1 and group 2.
4. To avoid word bias, the words were divided into word group A and word group B.
5. After group 1 studied using the existing system, they pronounced word group A. Meanwhile, after group 2 studied using the proposed system, they pronounced word group B. Next, each group changed systems and pronounced the other word group. We explained how to use the system before the experiment. The system calculated the score for all the voices.

   We also used TIMIT [11] as training data set for MLN and HMM.

Table 2: Change of pronunciation scores

	Group 1	Group 2
Existing system	Word group A 51.4 points → 55.8 points (↑ 8.40%)	Word group B 65.2 points →76.0 points (↑ 16.7%)
Proposed system	Word group B 62.5 points → 73.8 points **(↑ 17.9%)**	Word group A 50.1 points → 65.3 points **(↑ 30.5%)**

Word group A: "read", "bird", "good", "think", Word group B: "map", "sea", "sing", "bought"

Table 3: Evaluation of English pronunciation instruction system
(5: Very good; 4: Good; 3: Fair; 2: Poor; 1: Very poor)

Explanation	Average
Q1. Was the system easy to use?	2.7/5.0
Q2. Was the system interesting?	3.7/5.0
Q3. Did you realize your weakness?	3.2/5.0
Q4. Did you understand the difference between your pronunciation and the teacher's pronunciation?	3.5/5.0
Q5. Did you think that your pronunciation animation described your wrong pronunciation accurately?	2.5/5.0
Q6. Did you think that the correct pronunciation animation described the correct pronunciation accurately?	2.8/5.0
Q7. Was the slow-motion replay function useful?	3.7/5.0
Q8. Was the phoneme animation function useful?	3.7/5.0
Q9. Were the comparison display and highlighting of pronunciation movement useful?	3.8/5.0
Q10. Would you like to use the system again?	3.3/5.0

4.2 Experimental Results

Table 2 shows the results of the experiments. The improvement in pronunciation score with the proposed system was double that with the existing system. Especially, the score increased by about 30% when group 2 used the system, even though the score for word group A in both groups was low before the study. With the existing system, the learners could not understand how to correct mistakes in pronunciation even though they noticed wrong phonemes. On the other hand, with the proposed system which visually showed the correct pronunciation movement and the learner's pronunciation movement, the learners could clearly and efficiently understand how to correct their wrong pronunciations. However, the score was low even when using the system because the duration of the experiment was short. We therefore intend to conduct a long-term experiment with many words because too few words were used in this experiment. We obtained a five-stage evaluation as shown in Table 3, for questions focusing on ease of use and the usefulness of the system. Q2, Q7, Q8 and Q9 received good evaluations, showing that the system is a useful method of studying pronunciation. However, Q5 and Q6 received low evaluations, perhaps due to lack of smoothness of connecting the animation between phonemes. In the future, we will construct animations that use a physical model. Moreover, we plan to generate more natural animations by using magnetic resonance imaging (MRI) data for Japanese speakers and native speakers. Longer-term testing in actual lectures is also necessary.

Conclusions

We developed a system to dynamically generate CG animations to express pronunciation from speech based on articulatory features, and conducted experiments which confirmed the effectiveness of the pronunciation animations. Learners can understand their wrong pronunciations and the correct pronunciation method through specific pronunciation animations. We will improve the system to make the animation motions more natural, and study more effective ways of teaching pronunciation in the future.

Acknowledgements

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References

[1] Delmonte, R. (2000). SLIM prosodic automatic tools for self-learning instruction. *Speech Communication*, *30*(2-3), 145–166.
[2] Gamper, J. and Knapp, J. (2002). A Review of Intelligent CALL Systems. *Computer Assisted Language Learning*, *15*(4), 329–342.
[3] Neumeyer, L ., Franco, H., Digalakis, V. and Weintraub, M. (2000). Automatic scoring of pronunciation quality, *Speech Communication*, *30*(2-3), 83–93.
[4] Witt, S. M. and Young, S. J. **(**1995). Phone-level pronunciation scoring and assessment for interactive language learning. *Speech Communication*, *30*(2-3), 95–108.
[5] Deroo, O., Ris, C., Gielen, S. and Vanparys, J. (2000). Automatic detection of mispronounced phonemes for language learning tools, *Proceedings of ICSLP-2000*, vol. 1, 681–684.
[6] Wang, S., Higgins, M. and Shima, Y. (2005).Training English pronunciation for Japanese learners of English online, *The JALT Call Journal, 1*(1), 39–47.
[7] Phonetics Flash Animation Project: http://www.uiowa.edu/~acadtech/phonetics/
[8] Morris, H. (1983). On distinctive features and their articulatory implementation, *Natural Language & Linguistic Theory*, *1*(1), 91–105.
[9] Huda, M.N., Kawashima, H. and Nitta, T. (2009). Distinctive Phonetic Feature (DPF) Extraction Based on MLNs and Inhibition/EnhancementbNetwork, I*EICE Transactions on Information and Systems, 92*(4), pp. 671–680
[10] Huda, M.N., Katsurada, K. and Nitta, T. (2008). Phoneme recognition based on hybrid neural networks with inhibition/enhancement of Distinctive Phonetic Feature (DPF) trajectories, *Proc. Interspeech'08,* pp. 1529–1532.
[11] TIMIT Acoustic-Phonetic Continuous Speech Corpus http://www.ldc.upenn.edu/Catalog/CatalogEntry.jsp?catalogId=LDC93S1

Real World Edutainment Based on Flexible Game Story

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Abstract: Real World Edutainment (RWE) is story- game-based learning in the real world, which aims at increasing learning motivation. In RWE, learners can learn through interacting with real objects and human based on a game (learning) story, referring to digital learning materials presented on a handheld computer. In this study, in order to improve flexibility of the game story, we extended the RWE system by implementing the functions of branched game story interpreter, etc. Then, we designed a flexible game story for learning disaster prevention and considered its advantages.

Keywords: Edutainment, game story, sensor device, disaster prevention, real world

Introduction

The learning effect of video games has attracted increasing attention [1]. A current focus is on Edutainment (often called "Serious Game" in these days), which is software that unites learning and fun derived from video game and aims mainly at increasing children's learning motivation. There have been many Edutainment systems, which mainly work on personal computers. In other words, learning (game) is done in the virtual world. This means that learners cannot learn through seeing and touching real objects. In addition, Edutainment is not necessarily flexible. This is because it often focuses on visual and auditory effects and does not give proper information (e.g., hint, feedback, and instructions) to each learner. These points can be regarded as the weaknesses in Edutainment.

To remove the above weakness we proposed Real World Edutainment (RWE for short) and developed the RWE system [2]. RWE is realized as the fusion of the virtual world and the real world, and the RWE system works on a PDA (Personal Digital Assistant) that can be used everywhere. Therefore, learners can learn from real objects (e.g., creatures, artifacts, and human) and virtual objects (e.g., digital learning materials) with diverse interaction.

The RWE system, which uses RFID (Radio Frequency Identification) and GPS (Global Positioning System), may be categorized as not only an Edutainment system but also a ubiquitous/mobile learning system. A project called "AMULETS" bridges outdoors and indoors educational activities by using smartphones, PDAs and GPS devices [3]. In language learning systems RFID tags or visual markers are attached to real objects (including places) and the learning materials (e.g., quizzes) about the corresponding objects are presented to learners [4][5]. In museum learning not only route guide but also the learning materials to help visitors (learners) understand exhibits are presented in location-aware and game-based manners [6][7]. The use of ubiquitous/mobile devices may help make learning fun as learners can learn in different settings.

RWE attaches great importance to a game (learning) story and Human-Human Interaction (HHI) to increase learning motivation. We adopt story-based learning in the real world; that is, apply a role-playing game in the real world. Klopfer & Squire developed an augmented reality game that had a game story revolved in the real world and furnished students with scientific augmentation skills [8]. In this game a learner role-plays an 'environmental detective' and identifies the source of the pollutant, receiving location-based fictitious environmental data and advisory messages from virtual characters. Another idea involves human actors as active characters in the game story. Human actors can provide flexible instruction in various ways considering student's characteristics (e.g., understanding level and preference) and the environmental conditions (e.g., place and time). Schwabe & Göth have developed a mobile game for university orientation (for learning university life) adopting the same idea of HHI [9]. In this game, learners have to find not only places but also people to get important information by interviewing them.

We practiced RWE at educational events for elementary school students and confirmed that many student participants had fun, learning motivation, and learning efficacy through RWE. At the same time, however, we felt that RWE was still far from flexible because the RWE system could not work based on flexible game stories such as a branched story. For example, it cannot guide a learner who answered a quiz incorrectly to the next learning (game) scene proper for his/her understanding level. Although human actors can be competent instructors, they are not allowed to change the game story itself.

From this background, we are extending the RWE system so that it can work based on a flexible game story.

1. Real World Edutainment System

1.1 System Overview

The RWE system has standalone architecture and works on a PDA. The system recognizes learning scenes by RFID and/or GPS then presents learning materials corresponding to the scenes.

To play the game―to learn referring to the learning materials in the real world―, learners have to find specific real objects and/or visit specific locations.

1.2 Fundamental Functions

(1) Learning scene recognizer

This function recognizes learning scenes according to a game story loaded and interpreted on a PDA. The game story is described in XML and has linear structure. Location data (latitude and longitude) is gathered from GPS at a regular interval. A learner reads an RFID tag using the PDA and immediately the object ID data recorded in the tag is gathered. When the gathered data matches the data (location and object ID) specified in the game story, the corresponding scene ID is given.

(2) Learning material presenter

The system presents two kinds of learning materials: expository text (with one image) and a single selection quiz (with one image). This function presents the learning material corresponding to the scene ID on the PDA.

1.3 Learning Flow

Initially a learner (or a learner group) is given one PDA with an RFID tag reader and/or GPS receiver, and subsequently starts game (learning). A typical learning flow is as follows.

i. The learner is briefed on the game story by a human actor(s).
ii. He/she looks for an RFID tag attached to a real object or move to a specific location.

iii. He/she finds the RFID tag and read it using the PDA or visits the location. Then, the quiz corresponding to the scene ID is presented.
iv. He/she deduces the correct answer to the quiz while observing real objects and surrounding situations.
v. If having difficulty in determining the correct answer, he/she is given hints for the quiz by and has discussions with the human actor(s) — this is HHI.
vi. When the correct answer is input, expository text including information about the next learning scene (e.g., the location of the next learning scene) is presented.
vii. When he/she correctly answers all of the prepared quizzes, the learning game is completed.

1.4 Weaknesses

The RWE system has the following weaknesses that decrease flexibility and learning effect.

(1) A branched game story is not supported.

The system supports only the linear structure story and cannot switch the next learning scene according to a learner's characteristics (e.g., understanding level) and behaviors in a game story. For example, a learner is forced to move to the same next learning scene whether he/she answers correctly or incorrectly. This weakness, which can be true of most ubiquitous/mobile learning systems, means that the next learning scene cannot be tailored to each learner, and learners cannot learn flexibly and effectively.

(2) Learning scene recognition is limited.

The system recognizes learning scenes only by RFID and GPS. For more effective learning, the system should recognize more various learning scenes. In some cases, it is important to observe real objects or surrounding situations in terms of not only a learner's current location but also his/her direction of eyes and point of gaze.

Moreover, the learning scene recognition by RFID is limited in range of use because an RFID tag must be attached to real objects being within arm's reach so that learners can read the tags.

(3) Low expressiveness of learning materials.

The learning materials composed of text and image are not enough in expressiveness. For more effective learning, the system should present learning materials composed of not only text and image but also animation, sound and video.

2. Extended Real World Edutainment System

In this study, we extend the RWE system to work based on a flexible game story in order to remove the weaknesses described in Section 1.4. First of all, we adopted not a PDA but a UMPC (Ultra Mobile PC) as the platform to obtain high extendibility, processing speed and capacity of memory and disk. Figure 1 illustrates the composition of the extended system and a snapshot in experimental use of the extended system.

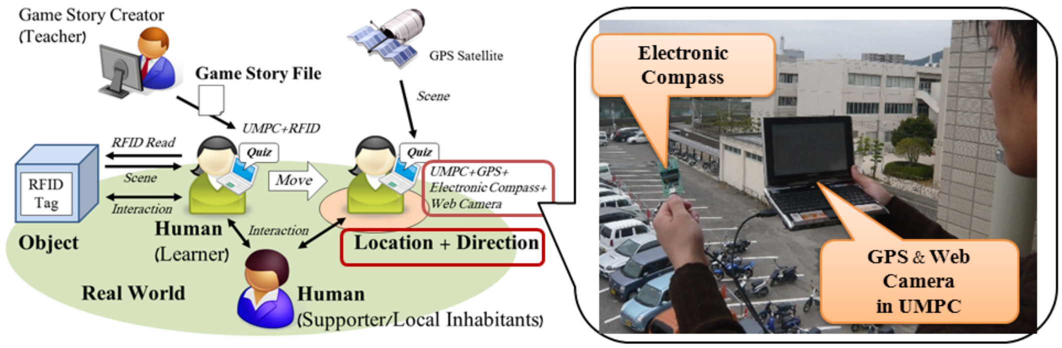

Figure 1: Extended system

2.1 Implemented Functions for Extension

2.1.1 Branched Game Story Interpreter

This function can switch the next learning scene tailored to each learner based on a branched game story. The branched game story deals with the two kinds of branches (river-current branch and reversible branch) as shown in the examples in Figure 2 and consists of some acts (learning themes). Each act consists of some learning scenes. Two learning scenes are connected with a directed link (one or two directions).

Chang et.al. have also stressed the importance of flexibility in game-based learning and proposed a method of personalizing a learning path (sequenced learning spots and learning objects) based on individual learner's characteristics [10]. The personalized learning path can be regarded as a flexible game story focusing on the learner side. On the other hand, the branched game story of the extended RWE system can be regarded as personalization fairly organized from the teacher side and will often be more suitable for child learners.

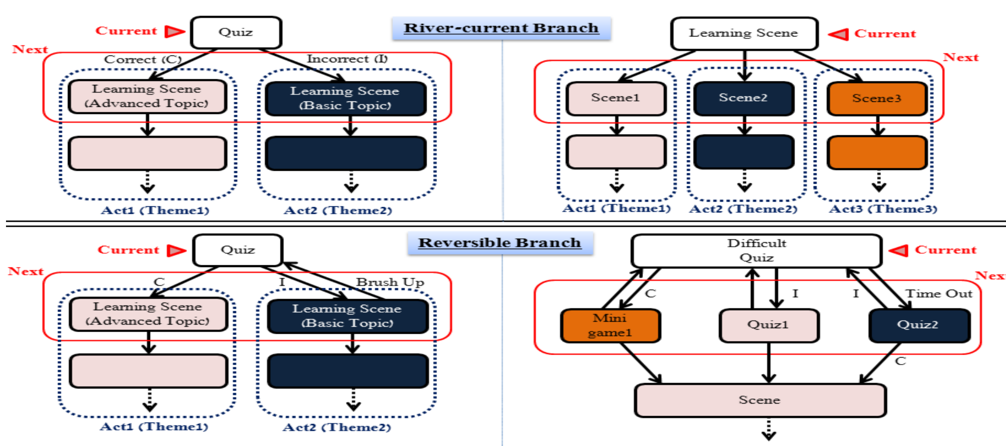

Figure 2 : River-current branch and reversible branch

(1) River-current branch

The river-current branch does not have backtracking and loop in the story. Two and more learning scenes can be included in the next learning scene. Learners are not allowed to move to the previous learning scene or to alternate learning scenes (to move to the other next learning scenes that they did not move to).

In a typical branch the next learning scene corresponds to a learner's answer to a quiz. For example, if the answer is correct, he/she is directed to move to the advanced topic. If the

answer is incorrect, he/she is directed to move to the basic topic. The learner is expected to understand learning topics steadily. Moreover, the river-current branch allows a learner to choose the next learning scene from some candidates. In other words, the game story changes depending on the learner's choice and provides self-directed learning and multi-ending. These characteristics of the river-current branch can increase learning motivation because learners often hope to experience all cases of learning (ending).
To achieve maximum effect of the river-current branch, a game story creator (e.g., teacher) has to forecast a variety of learners' characteristics and behaviors for story design.

(2) Reversible branch
The reversible branch has backtracking and loop in the story and allows learners to alternate learning scenes. For example, a learner with wrong answer can move back to the previous learning scene to brush up his/her understanding. If being given some locations (detected by GPS) as the next learning scene, a learner can move to every location.
The reversible branch can provide supplementary or secondary learning scenes such as a special learning scene (e.g., mini game) for learners who answered a difficult quiz correctly so that high flexibility of learning can be offered.

2.1.2 Extended Scene Recognizer

To recognize more various learning scenes, we extended the learning scene recognizer by introducing an electronic compass and a Web camera.

(1) Electronic compass
An electronic compass plugged into a UMPC can sense the direction so that the extended recognizer can recognize a learning scene in terms of a learner's direction of eyes at the current location. For example, the next learning scene is recognized when a learner visits a specific location and furthermore looks at a direction with a real object of a learning topic. The compass helps make the learning scene recognition more exact and increase learning effect. Learners will point the compass to various directions to find the next learning scene.

(2) Web camera
A UMPC built-in Web camera can capture pictures and video. The extended recognizer processes the captured data and recognizes a learning scene. To be more precise, it executes feature-point matching for a picture (including one frame in video) that a learner is now shooting with the Web camera and pictures of real objects that were shot beforehand by a game story creator. Even if a real object is without arm's reach, the extended recognizer can recognize a learning scene from the real object shot by the Web camera.

2.1.3 Extended Learning Material Presenter

To enhance expressiveness of learning materials, we extended the learning material presenter so that it can handle multimedia learning materials and increase answering (inputting) methods for a quiz. The extended presenter helps make learning more various and effective. For example, a learner deduces the correct answer to a quiz watching a video given as the hint. In another example, a learner answers a quiz by pointing the compass to a direction (e.g., "Point the direction of the oldest temple in this park.")

2.2 User interface

Figure 3 shows the user interface of the extended system and a snapshot in its experimental use. In this figure, when a learner visits a temple, the extended system recognizes the next learning scene by GPS and the electronic compass and presents a quiz about the temple. The learner being in front of the temple is answering the quiz while observing the temple. The user interface aims at simple design so that even children can easily use it.

Figure 3: User interface of the extended system and a snapshot

3. Experimental Design of Flexible Game Story

Undoubtedly nothing is better than the real world in terms of reality and natural surroundings can increase learning effect through authentic learning. In RWE, therefore, a game story should focus on reality and provide learners with educational experience. Especially, a branched game story can encourage learners to think and learn autonomously. We think that RWE is well suited for learning "disaster prevention" because a disaster is immediate threat that can happen in the real world at any time. Learners should know thorough experience in the real world how they should act in a disaster to survive and help others.

3.1 Learning Flow

We designed a game story for learning proper evacuation activities in a large earthquake. The game story, which takes place at a school, is composed of six learning scenes. Figure 4 shows the learning flow of the game story.

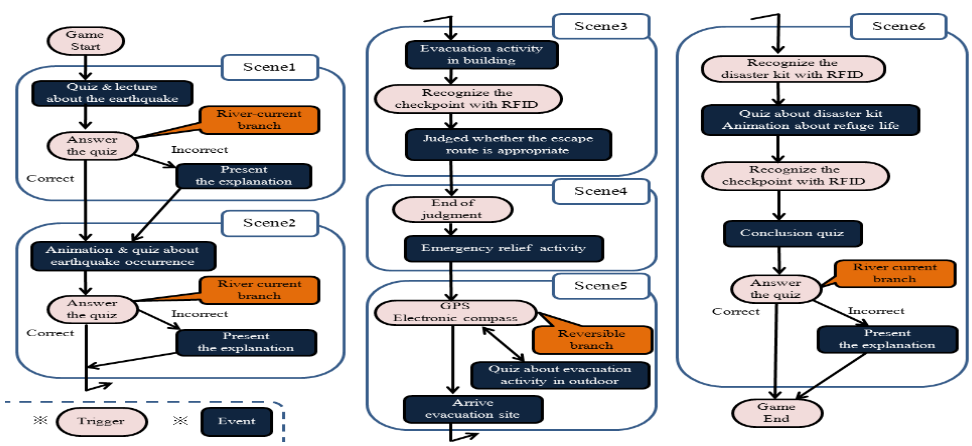

Figure 4: Learning flow of "disaster prevention" game story

i. Attending a class (Scene 1)

This game story begins from the scene where learners attend a class in a school building and a quiz about basic knowledge of earthquake is presented. If answering the quiz incorrectly, a learner must move to the next learning scene after reading the expository text. If answering the quiz correctly, the learner can move to the next learning scene immediately— this is the river-current branch.

ii. Earthquake occurrence (Scene 2)

As a matter of course, real earthquake never happens in the game story. In this scene, video of earthquake is presented to let the learner know terror of earthquake. After that, a quiz and animation about danger avoidance in a classroom are presented.

iii. Evacuating from the building (Scene 3)

The learner is directed to evacuate from the building through the proper evacuation route. RFID tags are attached to some spots on the route as checkpoints, and he/she reads the tags while evacuating. When he/she goes out of the building, his/her evacuation route is judged based on the checkpoints he/she passed.

iv. Emergency treatment activity (Scene 4)

An injured person (human actor) is calling for help near the building exit and the learner has to give emergency treatment to the injured person, referring to learning materials presented. At this time, real objects used for emergency treatment are put near the injured person.

v. Moving to a specified evacuation site (Scene 5)

The learner moves freely to a specified evacuation site. His/her current location is gathered from GPS and two learning scenes (location A and B) are recognized. At the location A on a narrow path between buildings, potential danger caused by building collapse is presented with composite pictures. At the location B near a river, potential danger caused by Tsunami is presented with composite video. The learner can move to either location of A or B, or move quickly to the evacuation site without visiting A or B— this is the reversible branch.

vi. Learning refuge life (Scene 6)

On the evacuation site, finally, the learner learns refuge life. RFID tags are attached to tools available as a disaster kit and he/she learns how to use the tools by referring to learning materials. Finally, he/she answers a conclusion quiz and the game (learning) finishes.

3.2 Advantages of the "Disaster Prevention" Game Story

A promising approach for learning disaster prevention is to introduce ICT, especially GIS (Geographic Information System) and simulation systems [11][12]. In some cases, however, ICT is used as just a media for one-sidedly showing evacuation plans to local residents. Therefore, ICT should be used to encourage learners (especially, local child residents) to think of disaster prevention autonomously and seriously. We think that RWE and the designed game story have the following advantages in learning disaster prevention.

- Learners who had no interest in disaster prevention will learn autonomously with fun because they can learn through playing the game.
- Learner will learn seriously because the game story can take place in their living place and the branched game story allows them to choose their own behaviors.
- Learners can learn effectively thorough experiences of evacuating, helping the injured person, observing surrounding situations, etc.
- Learners can know fear of the disaster by multimedia learning materials.

4. Conclusion

This paper described the extended RWE system that can handle flexible game stories and showed a game story example for learning "disaster prevention". The river-current branch and the reversible branch will improve the flexibility of a game story (learning) and contribute especially to making learning more fun. The scene recognition by an electronic compass and a Web camera and also the multimedia learning materials will diversify learning scenes and increase learning effect.

A current weakness of the extended RWE system is that the branching conditions are not diverse. A learner's answer to a quiz is the fundamental easy-to-use branching condition but does not cover authentic learning sufficiently. For example, there is need to branch a game story based on passing of time, a learner's surroundings (e.g., temperature and luminance), and other learners' current situations (e.g., location and learning scene). Another weakness is that the multimedia learning materials are not well integrated with the real world and do not make learning more real. As a challenge to increasing the reality, for example, the learning materials should be superimposed on real-time camera images using markerless AR (Augmented Reality) technology.

We are conducting an experimental practice of the "disaster prevention" game story to evaluate its learning effect and the system's usability. Through the experimental practice, moreover, we would like to investigate whether disaster prevention to be seriously learnt should involve game (entertainment) aspects.

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References

[1] Kafai, Y. B. (2006). Playing and Making Games for Learning: Instructionist and Constructionist Perspective for Game Studies. *Games and Culture*, 1 (1), 36-40.

[2] Mitsuhara, H., Hirakawa, Y., Kanenishi, K., & Yano, Y. (2007). Real World Edutainment Focusing on Human-Human Interaction. *Proc. of the 2nd international conference on Technologies for E-Learning and Digital Entertainment (Edutainment 2007)*, 527-538.

[3] Kurti, A., Spikol, D., & Milrad, M. (2008). Bridging Outdoors and Indoors Educational Activities in Schools with the Support of Mobile and Positioning Technologies. *International Journal of Mobile Learning and Organizatio*n, 2(2), 166-186.

[4] Ogata, H., Akamatsu, R., Mitsuhara, H., Yano, Y., Matsuura, K., Kanenishi, K., Miyoshi, Y., & Morikawa, T. (2004). TANGO: Supporting Vocabulary Learning with RFID tags. *International Workshop Series on RFID 2004*.

[5] Liu, T.Y. (2009). A context-aware ubiquitous learning environment for language listening and speaking. *Journal of Computer Assisted Learning*, 25, 515–527.

[6] Ghiani, G., Paternò, F., Santoro, C., & Spano, L.D. (2009). UbiCicero: A location-aware, multi-device museum guide. *Interacting with Computers*, 21 (4), 288-303.

[7] Sung, Y.T., Chang, K.E., Hou, H.T., & Chen, P.F. (2010). Designing an electronic guidebook for learning engagement in a museum of history. *Computers in Human Behavior*, 26 (1), 74-83.

[8] Klopfer, E. & Squire, K.D. (2008). Environmental Detectives—the development of an augmented reality platform for environmental simulations. *Educational Technology Research and Development*, 59 (2), 203-228.

[9] Schwabe, G. & Göth, C. (2005). Mobile learning with a mobile game: design and motivational effects. *Journal of Computer Assisted learning*, 21, 204–216.

[10] Chang, M., Wu, S., & Heh, J.S. (2008). Making the Real World as a Game World to Learners by Applying Game-Based Learning Scenes into Ubiquitous Learning Environment. *Transactions on Edutainment*, 261–277.

[11] Kobayashi, K., Narita, A., Hirano, M., Tanaka, K.,Katada, T., & Kuwasawa, N.(2008). DIGTable: A Tabletop Simulation System for Disaster Education. *Proc. of the Sixth International Conference on Pervasive Computing (Pervasive2008)*, 57-60.

[12] Katada, T. & Kanai, M. (2008). IMPLEMENTATION OF TSUNAMI DISASTER EDUCATION FOR CHILDREN AND THEIR PARENTS AT ELEMENTARY SCHOOL. *Proc. of the Solutions to Coastal Disasters Congress 2008*, 39-48.

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The Effect of Scaffolding Support on Programming Performance and the Use of Self-regulation in Learning Computer Programming

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Abstract: The present study is to explore the students' use of self-regulation and their learning performance of computer programming under the framework of Experiential-based Learning of Computer Science (ELCS) in learning computer programming in an elementary school. The problem-solving support (PS group) and the procedural support (PR group) are regarded as two different scaffolding supports to guide learners to learn computer programming concepts. The result shows that the PS group has better performance in both advance and entire concept learning of computer programming. And the PR group asks more help to assist themselves than the PS group.

Keywords: self-regulation, computer programming, problem-solving, experiential learning

Introduction

Computer science is regarded as an advanced and significant ability for learners to adapt to today's digital and information world, but the knowledge and skills of it lack of the link to learners' life experience and prior knowledge [2, 23]. To bridge the gap between the abstract knowledge of computer science and learners' concrete life experience, the instructional framework of Experiential-based Learning of Computer Science (ELCS) based on the experiential learning perspective may support learners to learn abstract concepts of computer science through learning activities employing examples of concrete experiences, contexts for reflective observation, conceptual models for abstract conceptualization and contexts for active experimentation [2].

Moreover, computer science in school education should focus mainly on the learning of conceptual, strategic and even problem-solving knowledge and skills, and it also means to emphasize the valuable learning activities of logic, design, problem-solving, critical reflection, and self-expression [3, 24]. And it is critical for learners to acquire a coherent and broad understanding of principles, methodologies and applications of computer science and develop the computer science skills of algorithm development, problem-solving, and programming [22]. And especially, programming language instruction has been shown to enhance a variety of specific problem-solving skills [15]. Thus, computer programming learning should be that learning to program may have benefits from teaching general-purpose problem-solving and thinking skills and may help learners appreciate and understand how computers work [20].

In the process of learning programming problem-solving, training and experience in the metacognitive skills may increase learners' problem-solving ability [15]. And self-regulation is a learning cycle of metacognition in learners' learning process. It focuses attention on how learners personally activate, alter and sustain their learning practices in specific contexts and includes self-monitoring of one's activities, applying personal standards for judging and directing one's performances, enlisting self-reactive influences to guide and motivate one's efforts, and employing appropriate strategies to achieve success [25, 26, 28]. So due to the support of the framework of ELCS, learners may apply the self-regulation skills to enhance the programming problem-solving learning.

Thus, in the present study, the learners were provided an instruction to learn computer programming through two different scaffolding supports, one of which was based on the framework of ELCS. And the learners' learning performance of computer programming and their use of self-regulation would be the important factors to investigate.

1. Literature review

1.1 Learning Computer Programming problem-solving

Computer programming involves the design and development of problem-solving algorithms and is treated as a valuable medium to develop problem-solving skills [3, 15]. However, while computer programming is considered as a valuable learning activity, it is also a complex and difficult task for novices to master [10]. Due to computer programming regarded as a problem-solving activity, it emphasizes that learning programming should be placed on the problem to be solved and the steps required for the solution [11, 13]. And computer programming mainly consists of three activities: problem identification and analysis, programming to tackle problems, and program representation in a computer coded language [21]. So an adaptable instructional framework could be treated as a learning support for learners and is necessary to use in learning computer programming [15].

However, computer science concepts contain abstract concept so that many learners are unable to achieve these learning goals because they are left with a fragile knowledge of programming [12, 23, 24]. And on the other hand, because of the absence of the link to learners' life experience and prior knowledge, their motivation and enthusiasm are diminished [24]. Thus, the design and development of learning support based on ELCS in learning programming problem-solving could be the challenging, and problem-bounded design activity includes abstract cognitive activities and involves complex cognitive processes as it requires the solving of continuous problems during execution [2, 21].

1.2 Self-regulation in ELCS

Self-regulation emphasizes how learners personally activate, alter, and sustain their learning practices in specific contexts, and even high-ability learners often do not achieve ideally because of their failure to use or control contextually specific cognitive, affective, and behavioral learning processes [4, 26]. It also means that learning by using strategies and goals, regulating and monitoring certain aspects of cognition, behavior, and motivation, and modifying behavior to achieve a desired goal [16]. Thus, while proceeding the design and development of computer programming regarded as the complex and abstract problem-solving process, learners may be conducted into the subprocesses in self-regulation: forethought, performance, and self-reflection, which stress on the learners' metacognitive control in the whole process of learning [14, 27].

However, learners are rarely given choices regarding academic tasks to pursue, methods for carrying out complex assignments, or study partners, and few teachers tend to encourage learners to establish specific goals for their academic work or teach explicit study strategies [27]. Also, learners are hardly asked to self-evaluate their work or estimate their competence on new tasks. But in learning computer programming, metacognitive skills is critical for learners to become aware of the appropriate and effective strategies that are needed to solve a variety of problems [5, 15].

Furthermore, the framework of ELCS shown in Figure 1 is based on the experiential learning theory, a four-stage learning cycle, including abilities-concrete experience, reflective observation, abstract conceptualization, and active experimentation [6]. It also mainly focuses on providing flexible-to-adopt, ease-of-use, from-concrete-to-abstract, and from-observation-to-experimentation digital instructional materials to strengthen technology infusion in high school classrooms [2].

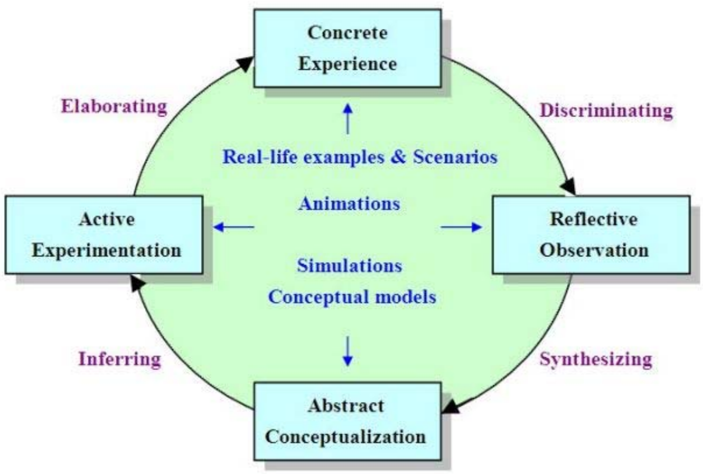

Fig. 1 The framework of Experiential-based Learning of Computer Science

As a result, the purpose of the study is to investigate learners' learning performance of computer programming and their use of self-regulation under the scaffolding support of framework of ELCS while learners face of difficulties, stressors, or competing attractions in learning computer programming.

2. Methodology

2.1 Participants

Seventy-seven sixth-grade students (37 males and 40 females) from north Taiwan participated in a five-week computer programming learning activity in this study. And the students were assigned to two conditions: Problem-solving Support Group (PS group; n = 38; 18 males and 20 females) and Procedural Support Group (PR group; n = 39; 19 males and 20 females). The domain knowledge for the participants was computer programming learning in Stagecast Creator. And the participants had little prior knowledge of the topics for computer programming.

2.2 Research Design

This study was intended to exam the students' learning performance of computer programming and their use of self-regulation under two scaffolding supports, one of which, the PS group, was based on the framework of ELCS, in learning computer programming. Thus, two different scaffolding supports (PS group and PR group) were independent variables, and the dependent variables were the students' learning performance of computer programming and their use of self-regulation.

2.3 Procedure

Before the treatment, the students were offered a 40-minute instruction for learning basic operational concepts and skills of Stagecast Creator. And a five-week instruction (respectively designed as two different scaffolding supports: problem-solving support and procedural support) was conducted and viewed as a scaffolding support for the students to learn computer programming in Stagecast Creator. After the instruction, *Computer Programming Test* was adopted to examine the computer programming learning performance of the students in two different groups. Besides, both groups had to self-report their individual use of self-regulation after the five-week instruction through *Self-regulation Learning Questionnaire.*

In *the Problem-solving Support Group*, the students would be guided by the instruction designed according to problem-solving support based on ELCS. Thus, the four steps of the instruction were conducted: observe the problems in the learning task, plan the solving strategy, practice the solving strategy and exam the result and reflect the solving strategy. Figure 2 was the screenshot of the instruction of the problem-solving support.

In *the Procedural Support Group*, the instruction was demonstrated to the students. And the three steps of the instruction were included: explain the concepts of programming, practice programming, and exam the results. Figure 3 was the screenshot of the instruction of the procedural support.

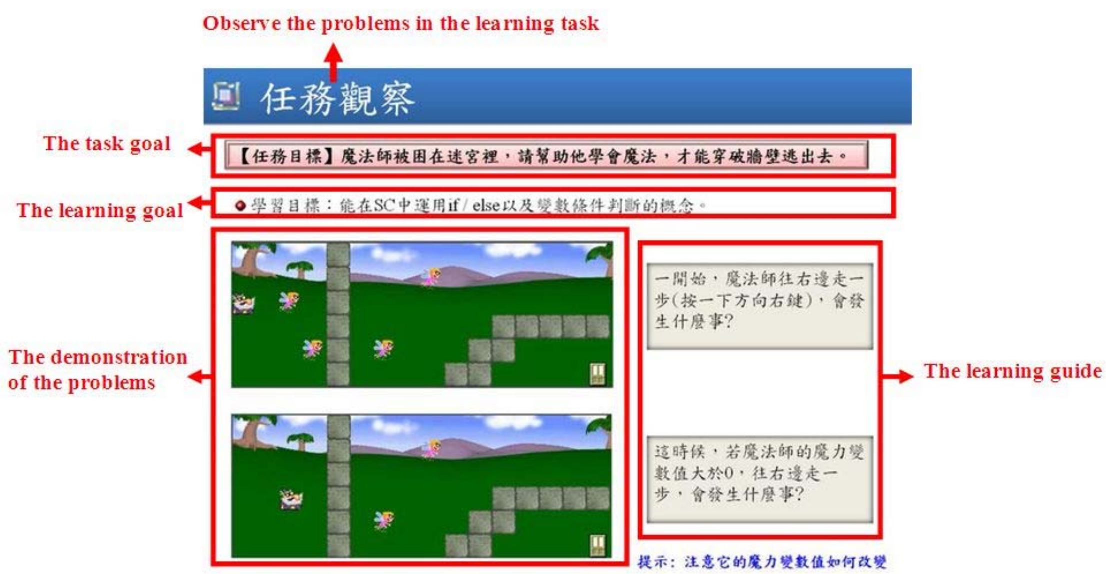

Fig. 2 The instruction of the Problem-solving Support

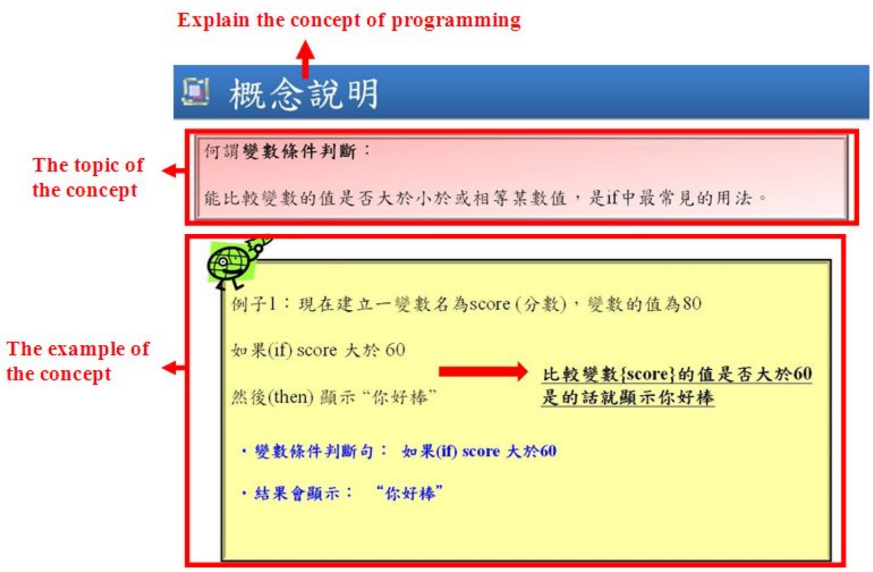

Fig. 3 The instruction of the Procedural Support Group

2.4 Instruments

Computer Programming Test (CPT) was comprised of two parts: basic concepts (9 items) and advance concepts (9 items) for examining the students' learning performance of computer programming. The internal consistency of CPT measured by the Cronbach's α was .88 for all scales. And the content validity of it was also conducted before test.
Self-regulated Learning Questionnaire for Computer Programming (SLQCP), which was modified from *Motivated Strategies for Learning Questionnaire* (MSLQ)[18, 19], was a questionnaire for the students to self-report their use and performance of self-regulation at the end of the treatment for learning computer programming. Three scales of SLQCP were cognitive, motivational, and resource management scale. The 54 items on SLQCP were scored on a 6-point Likert scale, from 1 (not at all true of me) to 6 (very true of me). The cognitive scale consisted of 29 items that assessed students' cognitive strategies (rehearsal, elaboration, organizational, and critical strategies; totally 19 items) and metacognitive strategies (planning, monitoring, and regulating strategies; totally 10 items). And the motivational scale included 16 items: 8 items about students' value components (intrinsic and extrinsic goal orientations) and 8 items about their expectancy components (self-efficacy for learning and expectancy for success). The third scale was resource management contained 9 items, which assessed students' effort management, peer learning, and help-seeking behavior. And Cronbach's α scores of SLQCP was .95.

3. Results

The result shows two parts: one is the students' learning performance of computer programming, and the other is their use of self-regulation.
The mean scores of the learning performance in CPT between PS group and PR group are shown in Table 1. In both of the basic and advance concepts in CPT, the PS group scores higher than the PR group.

Table 1. The mean scores of the learning performance in CPT

Learning performance	Scaffolding support	Mean	SD	*n*
Basic concepts	PS group	8.18	1.468	38
	PR group	7.64	1.871	39
	Total	7.91	1.695	77
Advance concepts	PS group	7.42	2.262	38
	PR group	5.95	2.625	39
	Total	6.68	2.547	77
Total	PS group	15.61	3.515	38
	PR group	13.59	4.166	39
	Total	14.58	3.965	77

As shown in Table 2, one-way ANOVA summary of the learning performance in CPT is used to examine the effect of two different scaffolding supports on the learning performance of computer programming concepts learning. In basic concepts learning, the PS group and the PR group have no significant difference ($F_{(1, 75)} = 2.003$, $p = .161$). However, in advance learning, the PS group is significantly higher than the PR group ($F_{(1, 75)} = 6.936$, $p < .05$). Besides, in total learning performance in CPT, the PS group is also significantly higher than and the PR group ($F_{(1, 75)} = 5.252$, $p < .05$).

Table 2. ANOVA summary of the learning performance in CPT

		Sum of Squares	df	MeanSquae	*F*	Sig.
Basic concepts	Between Groups	5.679	1	5.679	2.003	.161
	Within Groups	212.685	75	2.836		
	Total	218.364	76			
Advance concepts	Between Groups	41.723	1	41.723	6.936*	.010
	Within Groups	451.161	75	6.015		
	Total	492.883	76			
Total	Between Groups	78.186	1	78.186	5.252*	.025
	Within Groups	1116.515	75	14.887		
	Total	1194.701	76			

Note: **p* < 0.05.

The ANOVA summary of the use of self-regulation after the five-week instruction is shown in Table 3. There is only significant difference in help-seeking behavior ($F_{(1, 75)} = 6.813$, $p < .05$), and the PR group (mean = 13.871) is significantly higher than the PS group (mean = 12.000). Besides, in both critical strategies ($p = .061$; PS mean = 18.684; PR mean =20.692) and intrinsic goal orientation ($p = .066$; PS mean = 17.105; PR mean = 18.743), the PR group is nearly significantly higher than the PS group.

Table 3. ANOVA summary of the use of self-regulation after the five-week instruction

		SS	df	Mean Square	F	Sig.
Cognitive Scale	Between Groups	1008.741	1	1008.741	1.972	.164
A.Cognitive Strategies	Between Groups	463.286	1	463.286	2.022	.159
A-1.Rehearsal strategies	Between Groups	20.972	1	20.972	1.372	.245
A-2. Elaboration strategies	Between Groups	44.759	1	44.759	1.657	.202
A-3. Organizational strategies	Between Groups	2.087	1	2.087	.104	.747
A-4.Critical strategies	Between Groups	77.612	1	77.612	3.610	.061
B. Metacognitive strategies	Between Groups	104.788	1	104.788	1.309	.256
B-1 Planning strategies	Between Groups	14.947	1	14.947	.978	.326
B-2. Monitoring strategies	Between Groups	.313	1	.313	.058	.810
B-3. Regulating strategies	Between Groups	33.768	1	33.768	2.021	.159
Motivational Scale	Between Groups	.148	1	.148	.001	.980
C. Value components	Between Groups	29.701	1	29.701	.520	.473
C-1. Intrinsic goal orientation	Between Groups	51.660	1	51.660	3.469	.066
C-2. Extrinsic goal orientation	Between Groups	3.020	1	3.020	.143	.706

D. Expectancy	Between Groups	25.654	1	25.654	.341	.561
D-1. Self-efficacy for learning	Between Groups	10.392	1	10.392	.286	.594
D-2.Expectancy for success	Between Groups	3.390	1	3.390	.301	.585
Resource management scale	Between Groups	76.883	1	76.883	1.543	.218
E. Effort management	Between Groups	1.213	1	1.213	.223	.638
F.Peer learning	Between Groups	.297	1	.297	.017	.897
G.Help-seeking behavior	Between Groups	67.433	1	67.433	6.813*	.011

Note: *$p < 0.05$.

4. Conclusion and Discussion

The aim of the study is mainly to explore the students' use of self-regulation and their learning performance of computer programming under the framework of ELCS in learning computer programming. This framework emphasizes the experiential learning processes and attempts to facilitate elementary school learners' acquisition of computer programming learning through scaffolding support based on ELCS.

And computer programming learning is abstract and complex concept for school students to understand, apply, and even transfer it in different learning contexts. According to the attributes of this instructional framework, the abstract and complex concepts and knowledge will be visualized, concreted and simplified through interactive animations, simulations and instructional games.

According to the results of the students' learning performance of computer programming through CPT, the PS group has better performance than the PR group. This proves that problem-solving scaffolding support enhances the elementary school students' learning in both the advance and entire concept learning of computer programming. Many researchers also find out that learners are merely aware of the problems that can be solved by a computer and the benefits to be had from using programming, so it is important to provide an appropriate support to guide and lead them to express their problem-solving strategies in order to progress smoothly to the formation of the appropriate code [1, 9]; Brooks, 1999; [7, 8].

On the other hand, in the students' use of self-regulation, the result shows that the PR group tries to ask others for help frequently higher than the PS group. Computer programming is always treated as a complex task, and learners need to have access to understanding of the task, method finding, coding, testing and debugging of the resulting program (Brooks, 1999). But for novices, without using a suitable support (for example, providing daily-life problems to solve), it would be hard to perceive the target attributes of the abstract concepts and reflect their observations to link with related prior knowledge [2]. The students in the PR group need to ask more help to assist themselves to understand and comprehend computer programming concepts.

In the future, learners' learning performance in computer programming project will be the target to investigate further. And in the process of the project, their use of SRL will also need to explore deeper to find out the fluctuation of cognition, motivation and attitude under the instructional framework of ELCS in learning computer programming.

References

[1] Brooks, R. (1999). Towards a theory of the cognitive processes in computer programming. *International Journal of Human Computer Studies, 51*, 197–211.

[2] Chen, M. P., Wu, C. C., Chiu, C. H., Lee, H. L. & Chen, M. C. (2009). Teaching abstract computer science concepts to high school students: A multiple-perspective approach. *International Journal on Digital Learning Technology, 1*(4), 266-286.

[3] Crews, T., & Butterfield, J. (2002). Using technology to bring abstract concepts into focus: A programming case study. *Journal of Computing in Higher Education, 13*(2), 25-50.

[4] Dresel, M., & Haugwitz, M. (2008). A computer-based approach to fostering motivation and self-regulated learning. *Journal of Experimental Education, 77*(1), 3-18.

[5] Flavell, J. H. (1979). Metacognition and cognitive monitoring. *American Psychologist, 34*(10), 906-911.

[6] Kolb, D. A. (1984). *Experimental learning*. Englewood Cliffs NJ: Prentice-Hall.

[7] Komis, V. (2001). A study of basic programming concepts within a constructivist teaching approach. *Themes in Education, 2*(2-3), 243-270.

[8] Kordaki, M. (2007). Modeling and multiple representation systems in the design of a computer environment for the learning of programming and C by beginners. In T. Bastiaens, S. Carliner (Eds.), *Proceedings of world conference on e-learning in corporate, government, healthcare & higher education (e-learn 2007), October, 15–19, Quebec, Canada, USA* (1634–1641). Chesapeake, VA: AACE.

[9] Lemone, K. A. & Ching, W. (1996). Easing into C: Experiences with RoBOTL. *ACM SIGCSE Bulletin, 28*(4), 45-49.

[10] Malik, M. (2000). Technical opinion: On the perils of programming. *Communications of the ACM, 43*(12), 95-97.

[11] Mayer, R. E. (1992). *Thinking, problem solving, cognition*. New York: W. H. Freeman.

[12] McGill, T. J & Volet, S. E. (1997). A conceptual framework for analyzing students' knowledge of programming. *Journal of Research on Computing in Education, 29*(3), 276-297.

[13] Milbrandt, G. (1999) Computer problem-solving and programming: some number theory examples. *Journal of Computer Science Education, 13*(3&4), 18-26.

[14] Moos, D., & Azevedo, R. (2008). Exploring the fluctuation of motivation and use of self-regulatory processes during learning with hypermedia. *Instructional Science, 36*(3), 203-231.

[15] Palumbo, D. B. (1990). Programming Language/Problem-Solving Research: A Review of Relevant Issues. *Review of Educational Research, 60*(1), 65-89.

[16] Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In Boekaerts, M., Pintrich, P. R., and Zeidner, M. (eds.), *Handbook of Self-Regulation*, Academic Press, San Diego, CA, 451-502.

[17] Pintrich, P. R., Smith, D. A. F., & McKeachie, W. J. (1989). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)*. MI: National Center for Research to Improve Postsecondary Teaching and Learning.

[18] Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A manual for the use of the Motivated Strategies for Learning Questionnaire (MSLQ)*. MI: National Center for Research to Improve Postsecondary Teaching and Learning.

[19] Pintrich, P. R., Smith, D. A., Garcia, T., & McKeachie, W. J. (1993). Reliability and predictive validity of the Motivated Strategies for Learning Questionnaire (MSLQ). *Educational and Psychological Measurement, 53*(0), 801-813.

[20] Soloway, E. (1993). Should we teach students to program? *Communications of the ACM, 36*(10), 21-24.

[21] Thomas, R. A. & Upah, S. C. Jr. (1996) Give programming instruction a chance. *Journal of Research on Computing in Education, 29*(1), 96-107.

[22] Tucker, A., Deek, F., Jones, J., McCowan, D., Stephenson, C., & Verno, A. (2006). *A model curriculum for K-12 computer science: Final report of the ACM Task Force Curriculum Committee* (2nd ed.). NY: Association for Computing Machinery.

[23] West, M., & Ross, S. (2002). Retaining females in computer science: A new look at a persistent problem. *JCSC*, *17*(5), 1-7.

[24] Yuen, A. H. K. (2006). Learning to program through interactive simulation. *Educational Media International, 43*(3), 251-268.

[25] Zimmerman, B. J. & Martinez-Pons. M. (1986). Development of a structured interview for assessing student use of self-regulated learning strategies. *American Educational Research Journal, 23*(4), 614-628.

[26] Zimmerman, B. J. (1986). Becoming a self-regulated learner: Which are the key subprocesses? *Contemporary Educational Psychology, 11*(4), 307-313.

[27] Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory into Practice,41*(2), 64-70.

[28] Zimmerman, B. J., & Martinez-Pons, M. (1988). Construct validation of a strategy model of student self-regulated learning. *Journal of Educational Psychology, 80*(3), 284-290.

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The Significance of Emotional Support to Students in Game-based Learning

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Abstract: VISOLE (Virtual Interactive Student-Oriented Learning Environment) is a teacher-facilitated pedagogical approach to empower game-based learning. In combination with scaffolding, near real-life gaming participation, reflection, and debriefing, VISOLE aims at providing students with opportunities to acquire subject specific knowledge in a multi-disciplinary fashion and sharpen their higher-order thinking skills for problem solving. Farmtasia is the first online game developed based on this approach. We carried out a qualitative case study in Hong Kong for investigating students' learning process in VISOLE. This paper discuses a part of the entire study, focusing on delineating (1) an impeding phenomenon, *unsustainable gaming*, which emerged in an "angry" student's learning process, and (2) how the teacher's emotional support mitigated this phenomenon. The findings shed light on the enhancement of the current design of VISOLE.

Keywords: VISOLE, game-based learning, educational games, teacher facilitation

1. Introduction

Piaget [1] regarded curiosity as the best driving force for learning. He believed that keeping learners curious by engaging them in play-like activities is a desirable approach to education, and thus games are an important avenue toward learning. Papert [2] argued games can facilitate deep learning. He observed that students are more willing to spend time and effort on game-based activities, and more conscious of the objects and contexts that they interact therein.

The discussion of harnessing computer games (hereafter referred as games) in education has been launched since the widespread popularity of Pac-Man in the early 1980s [3]. In the recent decade, along with the advancement of multimedia and Internet technology, as well as the pervasive promotion of student-centred educational paradigms, how to utilize the ability of games to facilitate constructivist learning has been one of the important foci in game-based learning research (e.g., [4], [5], [6]).

On the other hand, there has been a worry that, in games, students may not learn anything more than clicking a set of buttons to receive desired gaming outcomes [7]. Moreover, students often have difficulties in making connections between a game and the referent real-world system that the game is intended to represent [8]. In view of the limitation, we proposed *VISOLE* (Virtual Interactive Student-Oriented Learning Environment) [9]—a constructivist pedagogical approach to empower game-based learning. *Farmtasia* [10] is the first online game developed based the VISOLE approach. The content of this game was developed based upon topic, *Agriculture*, in the senior secondary Geography curriculum in Hong Kong.

1.1. Preliminary Investigation on VISOLE

In 2006, we conducted an evaluative study on VISOLE (with Farmtasia) in Hong Kong [11]. The research was carried out in the form of a competition (as an extra-curricular activity), involving 28 teachers and 254 secondary-4 (K-10 equivalent) students from 16 schools. A quantitative research approach was adopted to evaluate whether VISOLE could "yield" the new learning opportunities as purposed in its original design. Apart from that, we also conducted a number of student interviews for gaining more understanding of their learning process in VISOLE.

We got positive quantitative findings in the study, such as the students' positive perceptions of VISOLE, and their advancement in the knowledge and high-order thinking skills concerned. However, the interviews revealed that some phenomena, which emerged during the VISOLE process, impeded the students' learning process. A number of "plausible" factors leading to these impeding phenomena were identified; one of them was the students' negative emotions aroused during the course of their gaming.

Through this study, some preliminary understanding of students' learning process in VISOLE was gained, but the findings were far from being "in-depth." Besides, since the research was carried out in the context of a competition, "what happens when VISOLE enters a 'real' classroom" was still unknown.

1.2. Aim of the Paper

In 2009, we conducted an in-depth qualitative case study for understanding the "inner-workings" of students' learning process in VISOLE (with Farmtasia) in Hong Kong. Specifically, we aimed at probing into the impeding phenomena emerging during students' learning process, and observing whether teacher facilitation could help to mitigate or overcome these phenomena. The research was carried out in the context of formal curricular learning and teaching, involving 1 teacher and 40 secondary-4 students.

This paper discusses a part of the entire study, focusing on delineating

(1) an impeding phenomenon, *unsustainable gaming*, which emerged in an "angry" student's learning process in VISOLE;
(2) how the teacher's emotional support mitigated this phenomenon.

The rest of the paper is organized as follows. To facilitate readers to understand the study, we provide brief descriptions of VISOLE and Farmtasia in Sections 2 and 3 respectively. Section 4 will delineate the research design while Section 5 will discuss the findings. Finally, we will give our concluding remarks in Section 6.

2. VISOLE

Framed by the theoretical foundation of *scaffolding* [12], *intrinsic motivation* [13], *situated learning* [14], *student reflection* [15], and, VISOLE [9] is composed of three operable pedagogical phases, namely *Multi-disciplinary Scaffolding* (Phase 1), *Game-based Situated Learning* (Phase 2), and *Reflection and Debriefing* (Phase 3).

Phase 1. A VISOLE teacher acts as a cognitive coach to activate VISOLE students' initial learning motive. The teacher assists the students in gaining some preliminary high-level abstract knowledge (as their prior knowledge to the next learning phase) based upon a selected multi-disciplinary framework through some face-to-face scaffolding lessons. In this phase, the students are equipped with "just enough" knowledge, and given only some initial “knowledge pointers.” They have to go on acquiring the necessitated knowledge and skills on their own in the next learning phase, not only from the designated learning resources but also a wider repertoire of non-designated resources, such as the Internet.

Phase 2. This phase deploys an online multi-player interactive game portraying a virtual world in which each student plays a role to shape its development. The missions, tasks and problems therein are generative and open-ended, and there is no prescribed solution. Since every single action can affect the whole virtual world, the students have to take account of the overall effects associated with their strategies and decisions on others contextually and socio-culturally. Being situated in this virtual world, the students need to acquire the subject-specific knowledge involved. Apart from that, they also need higher-order thinking skills to *analyze* problems occurring therein, as well as *create* and *evaluate* different possible solutions to solve the problems.

Phase 3. This phase interlaces with the activities in Phase 2. After each bout of gaming, the students are required to write their own journal to reflect on their learning experience formatively. On the other side, the teacher monitors closely the progress of the students’ development of the virtual world at the backend. He/she looks for and tries to act on “debriefable” moments to “lift” the students out of particular situations in the game. In this phase, the teacher extracts problematic and critical scenarios arising in the virtual world, and conducts case studies with his/her students through some face-to-face debriefing lessons. At the end of this phase, the students are required further to write their own summative report to conclude their overall learning experience.

3. Farmtasia

Farmtasia [10] is the first online game created to facilitate Phase 2 of VISOLE. The content of the game was developed upon a multi-disciplinary topic, Agriculture, in the senior secondary Geography curriculum of the Hong Kong Certificate of Education Examination (HKCEE)[1] [16]. This topic involves eight areas of subject knowledge, including *natural environment*, *biology*, *economics*, *government*, *production systems*, *technology*, *natural hazards*, and *environmental problems*.

Farmtasia features interacting farming systems which cover the domains of *cultivation*, *horticulture*, and *pasturage*. In this virtual world, each student acts as a farm manager to run a farm. Each of them competes for 2 quantified outcomes, i.e., *financial gain* and *reputation*, with 3 other students who are also running their own farm simultaneously somewhere nearby.

Farmtasia operates in a bout-based manner (consisting of 12 bouts of gaming, 1 hour per bout), and in accelerated mode (every bout equates to 6 months in the virtual world). In this game, students have to formulate and implement various investment and operational strategies to yield both quality and abundant farm products for making a profit (the financial gain) in the market. Besides, they should always keep an eye on the contextual factors (e.g., temperature, rainfall, wind-speed, etc.) of the virtual world so as to perform just-in-time actions (such as cultivating and reaping crops at appropriate time). In spite of the competition for the financial gain, the richest may not be the final winner. Students’ final reputation in the virtual world is another crucial judging criterion. This reputation is governed by good public policies and is determined by students’ practice in sustainable development and environmental protection.

For enabling teachers to review students’ performance and extract their gaming scenarios for conducting debriefing lessons (Phase 3 of VISOLE), we implemented a *teacher console*

[1] HKCEE is an important public examination in Hong Kong secondary education, equivalent to O-level examination in the United Kingdom.

in Farmtasia. When students are running their farm in the virtual world, the game server will *record* their every single gaming action. Through the teacher console, teachers can *replay* students' gaming proceedings in the form of video playback.

An online *knowledge manua*l, which covers all underlying knowledge employed to model Farmtasia, was created to serve two purposes. Firstly, it is a reference guide for teachers to prepare and frame their scaffolding lessons (Phase 1 of VISOLE). Secondly, it is a learning resource bank for students to look up when they meet some insolvable problems arising in the virtual world (Phase 2 of VISOLE).

In addition, a *blogging platform* was developed to facilitate students' reflection exercise in Phase 3 of VISOLE. After each bout of gaming, students are required to "blog" their own reflective journal in the platform. By reading students' blogs, teachers can grasp more clues about each student's gaming/learning progress. These clues can assist teachers in selecting more critical debriefing content (students' gaming proceedings) to be discussed with their students.

4. Research Design

In the present study, a critical beginning task was to invite Geography teachers who were willing and experienced to implement VISOLE in their teaching practice. In fact, this was not an easy task, because VISOLE (even game-based learning) has been a rather new pedagogical idea to the education community in Hong Kong.

Our initial invitation scope focused on the 5 Geography teachers from those 28 teachers who had participated in the previous evaluative study in 2006 [11]. Eventually, only one female teacher, *Tracy* (pseudonym), was willing to participate in this research. The reasons for the rejection given by the other four teachers were similar, and frank indeed. They did not want to take "risk" to teach a formal curriculum with a new educational innovation[2]. Owing to the practical constraint on recruiting additional suitable teacher participants, we adopted a single-case study approach. This case involved Tracy's implementation of VISOLE (with Farmtasia) in teaching her Geography class of 40 secondary-4 students on the topic of Agriculture.

4.1. Setting

There were two 70-minute Geography lessons every week in the school. Tracy used 6 weeks (namely, Weeks 1 to 6) implemented the VISOLE approach. The implementation was composed of 3 scaffolding lessons (Phase 1), 1 game-trial lesson, 12 bouts of gaming (Phase 2, namely Bouts 1 to 12), and 4 debriefing lessons (Phase 3). The game-trial lesson was to help the students get familiarized themselves with the operation of Farmtasia. We observed all of the lessons within these 6 weeks.

One week before the implementation, we visited the class twice to start developing a friendly rapport with the students. The scaffolding and game-trial lessons were completed in the first 2 weeks. The students started playing Farmtasia in Week 3. They played 1 bout every 2 to 3 days until Week 6. Tracy conducted the debriefing lessons after Bouts 2, 4, 7, and 12 respectively. Due to the insufficiency of the lesson time, the students were asked to play the game at home mainly. Nevertheless, in order to facilitate us to observe their "physical" gaming behaviours, we required them to play some bouts (Bouts 2, 4, and 10) during some lessons (namely, gaming lessons).

[2] Nevertheless, those teachers remarked that, if the study had been held in the form of an extra-curricular activity, they would have joined it without much hesitation.

4.2. Data Collection and Analysis

Three weeks before the VISOLE process started, we administered a student questionnaire to gather the students' information related to the plausible factors (identified in the previous evaluative study) that might lead to the emergence of the impeding phenomena. The data collected helped us identify initially a number of focal units of analysis [17] in the present study.

During the VISOLE process, we adopted multiple data collection means to probe into the students' learning process. Apart from the participants' self-reported data and our own observational data, the documentary evidence also played a significant role in this research. Table 1 shows a summary of the data types (in the left column) and the corresponding collection means (in the right column) involved.

We analyzed the data collected with Maxwell's qualitative data analysis approach [18] which incorporates *coding*, *categorizing*, *memoing*, and *contextualizing*. We also followed Creswell's thematic development technique [19] to layer and interrelate the research findings. Further, Denzin's [20] triangulation approach (data sources / methods / investigators / theories) was adopted to verify the findings from multiple angles.

Table 1. Data Collection

Data Type	Data Collection Means
Participants' Self-reported Data	▪ Just-in-time researcher-student and researcher-teacher chats ▪ Multiple purposive student / teacher interviews ▪ Tracy's think-aloud records after the scaffolding / debriefing lessons
Observational Data	▪ Observations on scaffolding / gaming / debriefing lessons
Documentary Data	▪ Students' gaming proceedings ▪ Students' knowledge manual access logs ▪ Students' blog

4.3. Identification of an "Angry" Student

David (pseudonym) was one of the focal units of analysis in the study. Unlike other units of analysis[3] who had been chosen before the VISOLE process started, David was selected at the beginning of Week 5, owing to his behaviour in the third debriefing lesson (after Bout 7). He bellowed angrily that Farmtasia was so unfair, and he claimed that he would not play this game anymore. An impeding phenomenon—unsustainable gaming emerged in David's learning process in VISOLE.

5. Findings

Figure 1 shows the bouts that David participated in Farmtasia. He stopped playing the game from Bout 8 to Bout 10, but resumed his gaming in Bout 11. Table 2, which displays David's gaming results in the first 7 bouts, shows that his accumulated capital increased progressively. Before David stopped playing the game, the operation of his farm had been "on the right track." He also documented his enjoyable feelings and achievements in these bouts in his blog (reflective journal). According to the access logs of the knowledge manual, he read the manual one or two times before playing each bout. He "copied and pasted" a considerable amount of content from the manual onto his blog. In the later interview with David, he told us that the content was his gaming preparation notes. The following

[3] Other focal units of analysis included a non-gamer student, a gamer student, and an examination-oriented student.

sub-sections will spell out why and how the unsustainable gaming phenomenon emerged in David's learning process in VISOLE.

Table 2. David's Gaming Results from Bout 1 to Bout 7

Rout	Accumulated Capital
1	$22,041
2	$30,127
3	$35,297
4	$41,541
5	$56,622
6	$64,112
7	$73,910

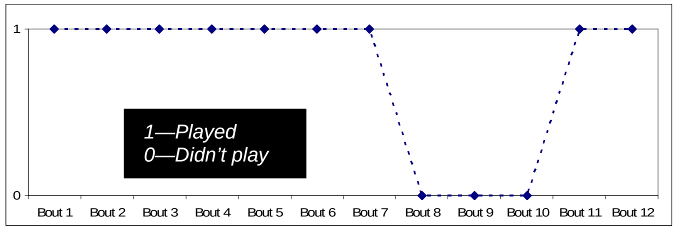

Figure 1. Bouts Played by David

5.1. Emergence of Anger

Figure 2, which displays the gaming results with respect to the 4 students in David's group in the first 7 bouts, shows that David led other 3 students from Bout 1 to Bout 5. However, one of the students' (namely, Student D3) accumulated capital surged suddenly in Bout 6. Another student's (namely, Students D1) capital also grew dramatically in Bout 7. After the completion of Bout 7, David's rank among the group dropped to the third.

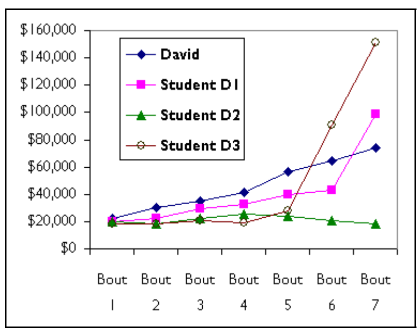

Figure 2. Accumulated Capital among 4 Students in David's group

Besides David's group, Tracy also observed that there were also a number of "sudden bloom" cases in other groups. After reviewing their gaming proceedings through the teacher console, Tracy found that these students discovered an *exploit*[4] in the game and developed a *degenerated strategy* [5] on this exploit. The students named this strategy "cattle-scalping"—buying cattle and then reselling them immediately at a higher price. According to the gaming proceedings of Student D3, he did nothing except scalping cattle in Bout 6 and 7. Student D1 also conducted the same cattle-scalping exercise in Bout 7. This exploit revealed a fault inside the economic model implemented in Farmtasia. In real life, the price of cattle should drop when the cattle are available largely in the market.

Tracy realized that the cattle-scalping exercise was meaningless to learning. In the third debriefing lesson (after Bout 7), she asked the class to stop doing it again in the game. After David had learned the cattle-scalping issue, he was angry in the lesson. He shouted out that the game was so unfair, and he would not play it anymore. According to the access logs, David did not play the game unit Bout 11 (see Figure 1).

[4] Exploits [21] refer to weaknesses or loopholes in a game that allow players to advance in the gaming effortlessly.

[5] Degenerate strategies [21] are ways of playing a game that ensure victory every time.

5.2. Teacher's Emotional Support

Tracy was keeping an eye on David after the third debriefing lesson. She noticed that he did not play the game since Bout 8, and wrote about his unhappiness on his blog. Bout 10 was scheduled being played during the lesson time. Other students were playing the game; however, David did not turn on his computer. He just took out and read his Geography textbook. At around one third of the lesson, Tracy approached David and chatted with him. After the lesson, we interviewed Tracy to ask about her chat with David.

Tracy told David that she understood and empathized his feeling about the unfairness of the game. However, she explained to him that refusing to play the game would make him miss some valuable learning opportunities and experiences. She encouraged David to resume his gaming in the coming bouts. Furthermore, Tracy also replied to David's blog to comfort him with some supporting and encouraging messages.

Eventually, David resumed playing the game in Bout 11. The access logs of the knowledge manual revealed that David read the manual twice before playing Bout 11. According to David's gaming proceedings in Bout 11, he started commanding some workers to carry out the tasks of ploughing, sowing, irrigating etc. in the cropland. At the same time he commanded other workers to do the tasks of irrigating, fertilizing, fruit-thinning etc. in the orchard. Moreover, he bought 2 cattle and 2 sheep, and kept them in the pasturage. Before the end of the game (Bout 12), David was able to harvest the crops and fruit, and sell them together with the livestock to the market. The trade brought him good financial gain. Although David did not win in Farmtasia finally, Tracy realized his summative report was one of the best reports in the class. In the interview with David after the VISOLE process, he apologized for his rudeness in the third debriefing lesson, and appreciated the learning opportunities provided for him those weeks.

6. Conclusion and Discussion

Mishra and Foster [22] argued that although the educational potential of "learning through gaming" has been discussed widely and with strong theoretical arguments, there is still a distance to put it in place, particularly from the pedagogical perspective. We have attempted to address this issue by proposing VISOLE.

Notwithstanding the inclusion of the "off-the-game" elements (such as scaffolding, debriefing, and reflection), a critical part of the learning in VISOLE relies on students' gaming participation. If they stop their gaming, they will miss considerable learning opportunities and experiences offered in VISOLE.

Players hate to lose; they are even willing to "cheat" in gaming by using degenerate strategies [23]. The unfairness stemming from these "cheats" may irritate other players. In the present study, we witnessed that a student's emotion (David's anger), which was aroused during the course of his gaming, leaded him to refuse to go on his gaming participation. The teacher's emotional support, however, was able to mitigate this impeding phenomenon. The findings provided insight into the enhancement of VISOLE.

In the current design of VISOLE, the debriefing exercise focuses mainly on students' cognitive aspect (learning and transfer of experience), without paying attention to the emotions aroused in their gaming process. We suggest that, in Phase 3 of VISOLE, besides monitoring the progress of students' development of the virtual world, teachers also need to be aware of the emergency of students' negative emotions when reviewing their reflective journals and conducting debriefing lessons. If necessary, just-in-time emotional support should be given to students for relieving their emotions.

Acknowledgement

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References

[1] Piaget, J. (1970). *Science of education and psychology of the child*. New York: Oxford University Press.
[2] Papert, S. (1993). *The children's machine: Rethinking school in the age of the compu*ters. New York: Basis Books.
[3] Squire, K. R. (2003). Video games in education. *International Journal of Intelligent Games & Simulation*, *2*(1). Retrieved July 30, 2009, from www.cyberfest.us/Education/Video_Games_in_Education-MIT_Study.pdf
[4] Gee, J. P. (2007). *What video games have to teach us about learning* (2nd ed.). New York: Palgrave.
[5] Shaffer, D. W. (2006). *How computer games help children to learn*. New York: Palgrave Macmillan.
[6] Jong, M. S. Y., Tse, A. W. C., Zhou, Y. Z., Chen, W. Q., Lee, F. L., & Lee, J. H. M. (2008). Using posting templates for enhancing students' argumentative elaborations in Learning Villages. *Proceedings of the 2nd IEEE International Conference on Digital Game and Intelligent Toy Enhanced Learning* (pp. 180-187). Banff, Canada. Los Alamitos, CA: IEEE Computer Society.
[7] Halverson, R. (2005). What can K-12 school leaders learn from video games and gaming? *Innovate*, *1*(6).
[8] Clegg, A. A. (1991). Games and simulations in social studies education. In J. P. Shaver (Ed.), *Handbook of research on social studies teaching and learning* (pp.523-528). New York: Macmillan.
[9] Jong, M. S. Y., Shang, J. J., Lee, F. L., & Lee, J. H. M. (2010). VISOLE—A constructivist pedagogical approach to game-based learning. In H. Yang, & S. Yuen (Eds.), *Collective intelligence and e-learning 2.0: Implications of web-based communities and networking* (pp. 185-206). New York: Information Science Reference.
[10] Cheung, K. K. F., Jong, M. S. Y., Lee, F. L., Lee, J. H. M., Luk, E. T. H., Shang, J. J., & Wong, M. K. H. (2008). FARMTASIA: An online game-based learning environment based on the VISOLE pedagogy. *Virtual Reality*, *12*(1), 17-25.
[11] Shang, J. J. (2007). *Virtual Interactive Student-Oriented Learning Environment (VISOLE): Design and Application* (in Chinese). Unpublished dissertation, The Chinese University of Hong Kong.
[12] Vygotsky, L (1978). *Mind and society*. Cambridge: MIT Press.
[13] Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science, 4*, 333-369.
[14] Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
[15] Dewey, J. (1938). *Experience and education*. New York: Macmullan.
[16] Hong Kong Examination and Assessment Authority (2008). *HKCEE Syllabus: Geography*. HKSAR: HKEAA. Retrieved September 10, 2008, from http://eant01.hkeaa.edu.hk/hkea/redirector.asp?p_direction=body&p_clickurl=exam_syllabuses.asp%3Fp_exam%3DHKCEE
[17] Yin, R. K. (2003). *Case study research: Design and method (3rd ed.)*. Thousand Oaks, CA: Sage.
[18] Maxwell, J. A. (2005). *Qualitative research design: An interactive approach* (2nd ed.). Thousand Oaks, CA: Sage.
[19] Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches* (2nd ed.). Thousand Oaks, CA: Sage.
[20] Denzin, N. K., & Lincoln, Y. S. (1994). *The handbook of qualitative research*. Thousand Oaks, CA: Sage.
[21] Salen, K. (Ed.) (2008). The *ecology of games: Connecting youth, games, and learning*. London: The MIT press.
[22] Mishra, P., & Foster, A. N. (2007). The claims of games: A comprehensive review and directions for future research. *Proceedings of Society for Information Technology and Teacher Education Interactional Conference 2007* (pp. 2227-2232). San Antonio, Texas.
[23] Koster, R. (2005). *A theory of fun for game design*. Scottsdale, Arizona: Paraglyph.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

AR-Supported Sketch Learning Environment by Drawing from Learner-Selectable Viewpoint

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Abstract: We constructed a sketch learning Environment. Instead of a real bowl and a real glass, virtual objects represented as 3D CG objects in a computer are used as motifs and are displayed in real space using augmented reality techniques. Consequently learners are able to compose freely. We conducted an evaluation experiment. The experimental results obtained from an experimental group and a control group were compared, revealing that the learning effect was more pronounced in the experimental group.

Keywords: Sketch, augmented reality, learning environment

1. Introduction

Numerous tools and software, ranging from software used for case studies to commercial software, have been produced to support drawing of pictures and diagrams on a virtual plane in computers. Bill Baxter and others, for instance, have developed a system to draw pictures on a virtual canvas by operating a paintbrush in virtual space. It uses a force display device, a Phantom, as the interface and operates a stylus pen as the paintbrush [1]. The system can be positioned at the highest point in conventional painting tools. However, the system provides only tools sufficient for drawing pictures within a virtual space and does not present information to support learning to draw.

Before we started our study, no system had been reported as supporting the learning of sketching or drawing by providing information about the correctness of a sketch or picture. Our group has been producing learning support environments for about 10 years to fill the role of supporting a drawing teacher when beginners are learning to sketch or draw.

To date, we have proposed and constructed various learning support environments for sketching and drawing [2–7]. They are designed and constructed based on cognitive scientific considerations when learners draw a sketch.

In the process, with the intention of offering advice during drawing, we developed an area information display system as a supportive environment for recognition [4,5]. It is a system with drawings produced by fixing a drawing paper on a graphics tablet (intuos2; Wacom), and using a pen with an attached pencil lead on the tip of an associated stylus pen. This produces a system that enables detection of the pen tip position on the drawing paper. When motifs, a bowl and a glass, are arranged in a designated position and a viewpoint is also fixed in a predetermined position, it will be determined what should be depicted in which area on the drawing paper. By making correspondence between information about a drawing to be drawn and a learner’s drawing, it offers audio advice on what should be drawn at the position of the learner’s pen tip. Results of an evaluation experiment about the system verified the effectiveness of the advice in learning drawing with a predetermined viewpoint.

In this system, a real bowl and a real glass are used as motifs for a drawing. In addition, a learner's viewpoint is also predetermined for drawing. Therefore, a learner needs to adjust the height and position of the chair according to the learner's own physical status, such as height and sitting height. This procedure is necessary to assign a drawing to be drawn uniquely and to take correspondence with a learner's drawing because the vision of motifs is not determined unless the viewpoint is determined.

This study was undertaken to design and develop a new system enabling setting of a viewpoint freely, not by which a learner adjusts to the system, but by which the system adjusts to a learner.

Instead of a real bowl and a real glass, virtual objects represented as three-dimensional computer graphics (3-D CG) objects in a computer are used as motifs and are displayed in real space using augmented reality (AR) techniques. A learner sketches those virtual motifs. The learner can then determine a viewpoint freely and set part of the field of vision as a composition using a drawing scale that is virtually defined. The system can instantly acquire shape data of the motifs for a determined composition and output audio advice based on the data. A learner can study with a composition set independently while receiving advice from the system.

Although we conducted an evaluation experiment for the trial system using only a glass motif, now a bowl motif has been implemented in addition to the glass motif. It has become possible to learn sketching using both motifs simultaneously.

2. System configuration and principle

2.1 Configuration of the system

The constructed learning support environment comprises a computer main body, an immersive head-mounted display (HMD), a handy video camcorder, and a graphics tablet. The CG models of a glass and a drawing scale are displayed in virtual space. The drawing scale is a tool to determine a composition. The small video camcorder is fixed on the HMD. This enables realization of a video see-through AR. Left picture of figure 1 portrays the way the learning support environment is used.

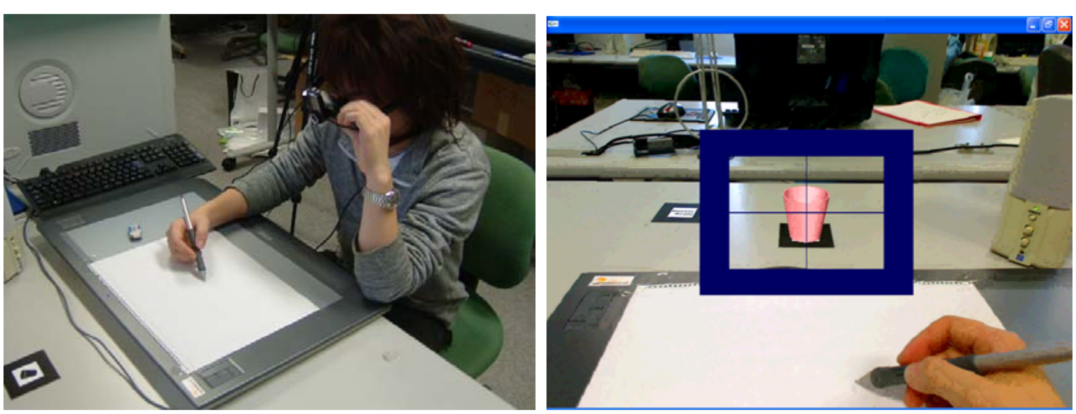

Figure 1 Using the learning support environment.

(Left: A scene of using the learning support environment, Right: Image presented to a learner by AR.)

2.2 Use of AR

Using the ARToolKit, make correspondence between the shape of a marker and a glass created by CG in advance. Then, put the marker on the desk. When capturing the marker using a video see-through method, a learner can see the image as through the glass were set on the desk (Right, Fig. 1).

Because ARToolKit calculates and displays an attitude of motifs from the vision of the marker, when a learner's head moves while wearing the camera, the vision of the motifs changes in conjunction with the vision of the marker.

2.3 Acquisition principle of the outline seen from a viewpoint

The CG models to be used as motifs are assigned feature points with short intervals on the line which could be the outline. The 3-D coordinate values are stored and managed in the PC as data. A learner decides the position of a viewpoint by moving the head. Determination of a viewpoint is conducted by typing keys on the keyboard under the conditions of maintaining the determined viewpoint. The system calculates the positions of each feature point through the drawing scale from the viewpoint with transparent transformation and renders the shape of the motif into a 2-D image.

2.4 Corresponding with a sketch on a drawing paper

For the present study, we used a graphics tablet (Intuos3; Wacom). This is a device to acquire the position of tip of the associated stylus using an electromagnetic induction method. After attaching a pencil lead on the tip of this associated stylus, a learner draws a drawing on a paper fixed to the graphics tablet. Because it is an electromagnetic induction method, the pen tip position is detectable even through the drawing paper. This makes it possible to make correspondence between the 2-D shape of the motif acquired as explained in the previous section and a learner's drawing on the graphics tablet (Fig. 2).

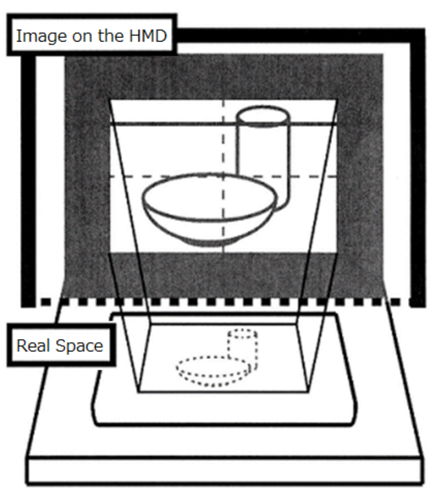

Figure 2 Image presented to a learner by AR.

2.5 Presenting a method of advice

When a learner puts the pen on the drawing paper, audio advice is given on what should be drawn there according to the position. In advance, correspondence is made to all feature points of the 3-D CG models with advisory sentences; they are input into the system. Those advisory sentences are presented by reading them out with text-to-speech software when making correspondence between the 2-D shape and the pen tip position, as described in the previous section.

3. Evaluation experiment

We conducted an evaluation experiment to examine how much of an effect on learning would be achieved using the system. We use a simple glass as a motif. Subjects were 10 students who had learned drawing in a class. They were divided into the following two groups of five each: a group using no system (control group), and a group using it (experimental group).

3.1 Procedures

First, we asked subjects to draw a sketch using a real glass and a drawing scale. At that time, images of the determined compositions were taken using a digital camera.

Next, we asked subjects to practice sketching several times. With the assistance of the learning support environment, the experimental group was asked to sketch a virtual glass using a virtual drawing scale in the system. Instead of using the learning support environment, the control group was given a document about the composition setting with a drawing scale and asked to practice using a real glass and a drawing scale with reading. Because the control group uses no learning support environment, when a drawing that is drawn deviates from a real motif in terms of shape, they cannot obtain advice to point it out.

Finally, we asked both groups to draw a sketch using a real glass and a drawing scale. In the same manner as the first sketch, we shot determined compositions using a digital camera. The shape of a glass used in the final sketch differed from that in the first sketch.

3.2 Results

In a picture created by superimposing a photograph of the composition shot with a digital camera and a sketch that was drawn, we found the degree of coincidence of the edges, base widths, heights, and positions of the glasses by ratio. When the value is 100%, they are perfectly consistent; as the value becomes less than 100%, a sketch that is drawn differs from a photograph of the composition to a greater extent.

Table 1 shows comparison values of the lengths between a photograph of the composition and a sketch drawn before and after practicing in the control group (Subjects A–E) and in the experimental group (Subjects F–J). The values in the columns of “Before” present the ratios of the lengths between a sketch drawn before practicing and a photograph of the composition. The values in the columns of “After” present the ratios of the lengths between a sketch drawn after practicing and a photograph of the composition. When a comparison value becomes larger after practicing than before practicing, the sketch comes to resemble a photograph of the composition more closely. Compared to the control group, the values rose more frequently in the experimental group.

Table 1 Comparison of ratios of the lengths before and after practicing in the control group and the experimental group [%]

Control group		Edge	Base Width	Height	Position (Long)	Position (Wide)	Experimental group		Edge	Base Width	Height	Position (Long)	Position (Wide)
A	Before	82.7	92.3	100	95.9	94.7	F	Before	86.7	90	88.2	58.8	96.9
	After	98.3	90.9	91.6	98.2	100		After	83.3	100	95.2	85	97.3
B	Before	97.1	88.9	94.1	91.2	96.7	G	Before	96.4	90.9	90.5	87.4	90.8
	After	86.7	87.5	94.7	95.6	96.7		After	94.5	100	94.1	95	94.5
C	Before	50	100	88.9	96.3	96.7	H	Before	80	100	100	82.9	85
	After	71.4	90	70.4	91.6	94.3		After	100	100	100	98.7	98.3
D	Before	70	100	88.9	94.2	98.9	I	Before	63.3	100	92	88	95.6
	After	83.3	80	86.7	92.2	94.4		After	85.6	100	84.1	97.1	97.3
E	Before	100	77.8	92.9	86.2	96	J	Before	62.5	76.9	81.8	85.6	81.4
	After	55.4	100	100	89.5	98.5		After	85.8	100	100	82	97.1

4. Conclusions

As described in this paper, we proposed a sketch learning support environment that uses CG models as motifs and displays a superposition visualization of them on the desk using AR techniques. It allows learners to determine a viewpoint freely. After constructing a trial system, we conducted an evaluation experiment. The experimental results obtained from an experimental group and a control group were compared, revealing that the learning effect was more pronounced in the experimental group.

In the future, taking further advantage of a high degree of freedom for viewpoint setting, we plan to implement supportive functions for composition learning, and to increase usable motifs.

References

[1] Baxter, W., Scheib, V., Lin, C. M., & Manocha, D. (2001). DAB: Interactive Haptic Painting with 3D Virtual Brushes, Proc. of the 28th Annual Conference on Computer Graphics and Interactive Techniques, 461-468.

[2] Soga, M., Taki, H., Matsuda, N., Takagi, S., & Yoshimoto, F. (2005). Skill Learning Support and a Framework for the Learning Support Environment (in Japanese), *Journal of Japanese Society for Artificial Intelligence, 20*(5), 533-540.

[3] Takagi, S., Matsuda, N., Soga, M., Taki, H., Shima, T., & Yoshimoto, F. (2003). An Educational Tool for Basic Techniques in Beginner's Pencil Drawing, *Proc. of Computer Graphics International 2003*, 288-293.

[4] Soga, M., Matsuda, N., & Taki, H. (2008). A Sketch Learning Support Environment that Gives Area-dependent Advice during Drawing the Sketch (in Japanese), *Transactions of the Japanese Society for Artificial Intelligence*, *23*(3), 96-104.

[5] Iwaki, T., Tsuji, T., Maeno, H., Soga, M., Matsuda, N., Takagi, S., Taki, H., & Yoshimoto, F. (2005). A Sketch Learning Support System with Automatic Diagnosis and Advice, Int. Conf. of Computers in Education 2005 (ICCE2005), 977-979.

[6] Soga, M., Maeno, H., Koga, T., Wada, T., Matsuda, N., Takagi, S., Taki, H., & Yoshimoto, F. (2007). Development of the sketch skill learning support system with real time diagnosis and advice showing learner's arm motion animation (in Japanese), *Transactions of Japanese Society for Information and Systems in Education*, *24*(4), 311-322.

[7] Soga, M., Kuriyama, S., & Taki, H. (2009). Sketch Learning Environment with Diagnosis and Drawing Guidance from Rough Form to Detailed Contour Form, Lecture Notes in Computer Science, Volume 5940/2009, Transactions on Edutainment, Volume III, pp. 129-140, Springer Berlin / Heidelberg.

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Detection and Improvement of Low Efficient Learning Game Made by Automatic Generator

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Abstract: We have already proposed and implemented an automatic generation method of learning games. However, we also found that a few generated learning games were not useful for learning. Therefore, we propose detection method of the low efficient learning games and improvement method of the detected games in this paper. Automatic detection function has been implemented. We also report the results of experimental evaluation of the detection function and the improvement method of the detected games.

Keywords: Learning game, Automatic Generation, Design method, Authoring

Introduction

Although we have proposed automatic generation method of learning games [1], a few generated learning games had the least effect in learning. In this paper, we propose how to detect and improve the low efficient learning games.

A learning game is a game where the activity to play is not only attractive as a game but also useful for learning. A lot of computer-based learning games have been implemented [2]. However, it is difficult to develop a learning game, therefore many researchers suggested design method of learning games [3-5].

Although there are several investigations for the design methods of learning games, most of them deal with only restricted part of the design process. Therefore, we have investigated concrete methods to embed problem solving exercises into an existent card game. We call this method as EPIC method. We have already implemented an application to generate computer-based learning games automatically based on EPIC method, and experimental confirmed that the application generated many useful learning games [6].

We also found, however, that a few generated learning games were not useful for learning. Therefore, we propose detection method of the low efficient learning games and improvement method of the detected games in this paper. Automatic detection function has been implemented. We also report the results of experimental evaluation of the detection function and the improvement method of the detected games.

1. Epic method

1.1 Concept of EPIC method

EPIC method is a design method of simple learning games by embedding problem solving exercises into a card game. Figure 1 shows the concept of EPIC method.

A card game is a game using cards, for examples, “Poker”, “Blackjack” or “UNO”.

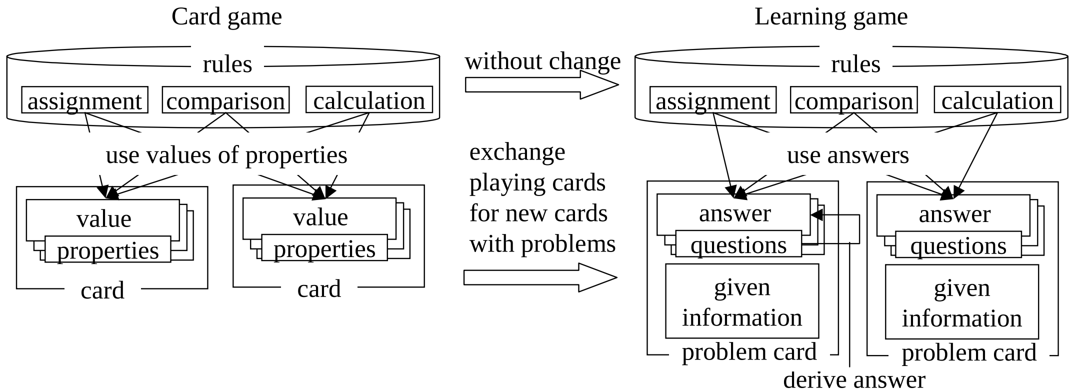

Figure 1. Model of EPIC method

We have proposed a card game model that is a structured representation of a set of concepts within a card game and the relationships between those concepts [6]. The card game model tells that a card of a card game has some properties, for examples, “number”, “mark (suit)” or “color”. The values of these properties are used in playing a card game.

In the card game model, operations of the cards are decided based on only by three evaluations of the values of the cards, that is assignment, comparison or calculation. Therefore, an existing card game is transformed into playable new game by exchanging the cards of the existing card game for other cards whose properties can be performed the three evaluations on. In other words, a new game is also developed by exchanging the cards of existing card game for cards with problem statements. The problem statement consists of given information and questions. The question is used in place of the property of the original card. The answer of the question is used in place of the value of the property. Thus in playing the game made by the exchange, a player has to derive answers from given information since the answers are used in place of values of properties.

Based on the method, we have implemented an application to generate computer-based learning games automatically. However, after further research, some of 120 learning games had poor effect. In next section, we explain the research.

1.2 Experimental uses of Low efficient Learning Games

We conducted an experiment in order to clarify when and how many times a player solved problems in playing a learning game. We added “solve” button in the interface of the computer-based learning game. Then, we told subjects to push the button with each solving a problem in playing the learning games. The learning game recorded the process of the playing, number of times the “solve” button pushed and when the “solve” button pushed.

First, we played each of 120 learning games for 5 minutes. As the result, number of times the “solve” button pushed in 8 learning games is extremely lower than others. Following the result, 4 subjects played each of the 8 learning games and other 8 normal learning games for 15 minutes. The same problems used in the games for the same learning target. We also told the subjects to push “solve” button with each solving a problem.

Table 1 shows the results. The number in the table shows average of the number of times one player pushed “solve” button for 15 minutes. The results suggest that players in playing the low efficient learning games solved fewer problems than in the normal games, even if they used the same problems. We expected that the players ideally solved more problems in the low efficient learning game, because answers were evaluated quite a few times. However, solved problems in the low efficient learning games were fewer than the number of the evaluation of the answers.

Table 1. Average of Number of Problems one Player Solved for 15 minutes

Problem type	Base (normal)	Solved	Base (low)	Solved
Arithmetic formula	Spit	66.50	Old made	3.75
	Pig tail	63.75	War game	1.50
	Memory	38.25	Money game	2.25
Calculating the area of rectangle	Spit	79.00	Old made	5.25
	Pig tail	65.25	War game	2.75
	Memory	39.75	Money game	3.25
Chemical formula	UNO	17.50	No change Poker	1.75
Simultaneous equation	UNO	18.25	No change Poker	1.50

2. Low efficient Learning Games

2.1 Learning in a Game

We investigated the rules in common and difference between normal and low efficient learning games in order to clarify what make players solve problems. We also asked the subjects about the experiment. In this chapter, we explain the result of the investigation.

We found a player derive answers of problems because the answers are useful for a player to decide which to choose in playing a game. In other words, if the result of making a choice based on answers and a player can derive the answers when the player making a choice, the player intends to derive the answers form problems. In normal learning game, a player makes a choice based on answers of problems. There are three types of low efficient learning game: a player has no choice, a player makes a choice but the result of the choice has no concern with answers or a player has no way of seeing problems when the player makes a choice although the result of the choice depend on the answers of the problems.

If a player has no choice, the player cannot change a process of playing a game no matter how the player derives answers. If answers have no concern with result of making a choice, the player has no advantage no matter the player derive the answers because the answers are useless for deciding which to choose. If a player has no way of seeing problems when the player makes a choose, the player cannot solve the problems. In such cases, the player doesn’t intend to solve the problems.

2.2 How to Detect low efficient Learning Games

The way to distinguish normal learning game from low efficient learning game is the way to find a game in which the result of making a choice is based on properties of cards.

Such game is picked out by investigating its rules. Based on a card game model as mentioned in 1.1, there are two rules that make a player make a choice: a player choose a value or a player choose a card. In the first step to distinguish suitable game or not, find the two rules form the rules of target game. Second step, find a rule which use the chosen value or card. In case of the choosing a card, third step, check the rule use the value of the property of the chosen card or not. There are three rules that use the value of the property of the choosing card: assigning the value into variable, comparing the value with other value or calculating something with the value. If the rule doesn’t use the value, it is not a rule in which the result of making a choice is based on properties. In case of the choosing values, another third step, check the rule also uses the chosen value and a value of a property of a card at the same time or not. There are two rules that use chosen value and a value of a property of a card at the same time: comparing them or calculating something with them. If the rule doesn’t use a value of a property of a card, it is not a rule in which making a choice

is based on properties. If the rule uses the value of the property the card in either case, fourth step, check that there is a rule in which a player can see the face of the card before choosing the values/cards. If the card is face-up when the player makes a choice, of course the player can see the face. If the card is face-down, check the card have been opened one at least and the card isn't shuffled (move cards randomly) before the choosing. In that case, the player can see the face of the card before the choosing. There are two rules that open a card: moving a card from private space (cards in which aren't open) into public space with face-up or turn up face-down card. In the end, if the player can see the face, the game which has such rules are suitable for EPIC method. The other games are unsuitable games.
Based on the way to detect, we implemented an application, the name is low efficient detector. The detector is supposed to be used with automatic generator of learning game. If an author try to generate low efficient learning games with the automatic generator, the detector serve notice to the author.

3. How to Improve

It is a way not to deal with unsuitable games, but some of the unsuitable games are popular and simple for learners. Therefore, we propose how to improve low efficient learning games. There are three ways to improve low efficient learning games. First way is making a player assign, compare, calculate the answers instead of a computer. Second way is making a player decide which operation should be done in next. Third way is giving penalty for the mistake on the player. The third way is used in combination first or second way.
First way of improvement is making a player enter the result of the assignment, comparison and calculation. In computer-based learning game, the computer automatically assigns, compares and calculates answers. Therefore, a player doesn't need to deriver the answer if the answer is useless for deciding which to choose. Thus, if the player assign, compare and calculate the answers instead of the computer, the player has to derive the answers. If the player enters wrong one, the computer should tell it is wrong and correct one.
However, some players intend to enter the result of the operation randomly and get the correct one, because the mistake brings down no disadvantage for a player. To prevent such behavior, penalty is given for the mistake of entering on the player. This is third way to improve. It is difficult to add appropriate penalty rule to learning games because how give penalty differs according to games, although it brings about appreciable results.
Second way is making a player decide which operation should be done in next. Sometimes in playing a game, which operation will be done in next is based on the result of the evaluation. Thus, let a player always do every operations, in order to make the player consider which operation should be done in next. In other words, the player has to derive answers in order to consider which operation is legal based on the evaluation of the answers. Of course, it is a good idea to give penalty for illegal operation, too. The penalty may prevent a player from deciding next operation randomly.

4. Evaluations

We conducted two experimental evaluations: one to confirm that detector could detect low efficient learning games, and the other to test the use of improved learning games. For the first evaluation, we entered the 120 learning games as mentioned in 1.1 into the low efficient detector. The detector certainly detected the 8 low efficient learning games as mentioned in 1.1. For the second experimental evaluation, we improved the 8 low efficient learning games as mentioned in 1.2. The learning games for arithmetic and chemical formula were

Table 2. Average of Number of Solved Problems for 15 minutes in improved games

Problem type	How improve	Base game	Not improved	Improved	Penalty
Arithmetic formula	Enter the result of operation	Old made	3.75	17.25	26.25
		War game	1.50	33.00	69.75
		Money game	2.25	35.25	35.25
Calculating the area of rectangle	Decide next operation	Old made	5.25	27.50	32.00
		War game	2.75	40.75	77.50
		Money game	3.25	42.50	42.75
Chemical formula	Enter the result of operation	No change Poker	1.75	15.25	15.50
Simultaneous equation	Decide next operation	No change Poker	1.50	17.50	18.00

improved by making players enter the result of operation. The learning games for calculating the area and simultaneous equation were improved by making players decide next operation. We moreover prepared other 8 learning games by improving the improved 8 learning games by penalty. The 4 subjects played these 16 learning games for 15 minutes. The subjects were the same member of the evaluation in 1.2. We also told the subjects to push “solve” button with each solving a problem in playing. Table 2 shows the results. The number in the table shows average of the number of problems one player solved for 15 minutes. The result suggests that the improvement brought about appreciable results.

5. Conclusion

In this paper, we proposed how to detect and improve the low efficient learning games that are automatically generated by our previous system. We also confirmed the detection and the improvement method of the detected games were useful from the report the results of experimental evaluation. In future work, we should research the possibility of the detection. We think the detection is applicable to compare learning effectiveness of normal learning games, because the detection tells which rule make a player solve problems.

Acknowledgements

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References

[1] U. Takanobu, H. Tsukasa, T. Akira (2006). Property Exchange Method for Automatic Generation of Computer-Based Learning Games. *Proceedings of ICCE2006* (pp. 483-490)
[2] Marc Prensky (2001). Digital game-based learning. McGraw-Hill.
[3] T. W. Malone (1981). Toward a Theory of Intrinsically motivating instruction. *Cognitive Science, Vol. 5* (pp. 130-145)
[4] M.M. Klawe (1998). When Does The Use Of Computer Games And Other Interactive Multimedia Software Help Students Learn Mathematics? *http://www.cs.ubc.ca/nest/egems/reports/NCTM.doc*
[5] H. M. Halff (2005). Adventure Games for Science Education: Generative Methods in Exploratory Environments. *Proc. of AIED05 WORKSHOP5: Educational Games as Intelligent Learning Environments* (pp.12-20).
[6] U. Takanobu, A. Takuya, H. Tsukasa, T. Akira (2009) Automatic Generation of Mini Learning Games based on a Card Game Model. *Proceedings of ICCE2009* (pp. 122-126)

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Changing Science Classroom Discourse toward Doing Science: The Design of a Game-based Learning Curriculum

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Abstract: This paper presents a game-based learning program designed to foster classroom discourse toward doing science with language. Both schools and professional science communities practice science, but the beliefs guiding their practices and discourse patterns are significantly different. In schools, students talk about science in order to learn the ready-made science. In professional science communities, scientists use and develop language as tools for constructing scientific knowledge. In order to transform the discourse practice in the mainstream science classrooms as doing science with language, we design the Legends of Alkhimia 3D role-playing game and curriculum.

Keywords: science discourse, science education, game-based learning, design-based research

1. Introduction

What should students learn in order to be literate in the 21st century? One of the more compelling arguments about the literacy skills of the 21st century is the ability to innovate and produce knowledge like working scientists [14]. Teaching young people to perform like working scientists may be seen as a productive trajectory that prepares them to be literate in science in the 21st century in which reading and writing skills are no more seen as sufficient for a globalized knowledge economy. In this paper, we conceptualize how schools may engage students in performing like working scientists through discourse practice. In particular, we focus on how the design of a game-based learning program—The Legends of Alkhimia game and curriculum—may engage students in *doing science with language*. Doing science with language utilizes language to construct scientific knowledge. It differs considerably from the mainstream science classrooms discourse—using language to talk about ready-made scientific knowledge.

2. Conceptual Framework

2.1 Community Discourse Practice

Discourse, or language-in-use, is a major medium that characterizes a community of practice [8]. Therefore, examining the discourse practiced by a community channels our understanding of its core practice. We examine the discourse patterns in science communities and in the mainstream classrooms in order to understand how we may design a science classroom that engages students in the practice of science with language.

2.2 Discourse Patterns in the Communities of Working Scientists

The discourse practiced by scientists may be characterized as *doing science with language* [7], [11]. In doing science with language, scientists develop specialized language and use language as a tool for supporting knowledge construction activities, such as observation, comparison, evaluation, hypothesis, generalization, design, discussion, etc. The following aspects of doing science with language depict three salient features of this language action tool:

1. Using language as a tool for scientific knowledge construction [7], [11]. Central to this particular language tool is its functions in serving scientific inquiry, which can be further delineated as questioning, hypothesizing, evaluating, and theorizing, etc.
2. Using argumentation as a tool for validating knowledge construction [6], [10]. Scientists use language to develop and examine their proposed theories/claims. In particular, language is used to examine the accountability of evidence, articulate the relationship between the proposed theory and its evidence/data for alternative interpretations.
3. Using language as a tool for evaluating the constructed scientific knowledge. The underpinning epistemology of doing science with language is both constructive and evaluative [5], [10]. When scientists use language to construct knowledge (such as inquiry), they evaluate the knowledge construction process at the same time.

2.3 Discourse Patterns in the Mainstream Science Classroom

Students' practices of science in the classrooms differ noticeably from that of working scientists. The prevalent discourse pattern in the mainstream science classrooms may be characterized as *talking about science* [11], [7]. Talking about science means that students talk about ready-made science contents and often bypass the processes through which the scientific theories are constructed.

In the mainstream classrooms where direct instruction is a norm of pedagogy, students often do not learn science by doing science with language, such as making arguments. When there is a discourse exchange in the classroom, it often takes the form of simple questioning and answering between students and the teacher [11], with the teacher providing one-sided answer that tends to reinforce science as "unmitigated rhetoric of conclusions" [13].

The Question-Answer-Evaluate (QAE) or Initiate-Response-Evaluate (IRE) triadic discourse pattern is a typical discourse pattern in classroom discussions [4], [11], [12]. In QAE/IRE, the classroom dialogue begins with a teacher asking/initiating a question to invite answers/response from students. When a student provides an answer, the teacher evaluates the answer. The process continues until students get the right answers. A defining feature of the QAE/IRE discourse pattern is that, more often than not, the teacher already has authoritative answers to the questions he raised. Such questions often do not initiate an inquiry process that invites dialogic arguments among all learning participants. It invites predefined short answers, which can be found or inferred from textbooks.

Then, what do students learn through a practice characterized by talking about ready-made science? Kelly and Crawford [9] maintain that it eventually leads to false belief about the nature of scientific knowledge. They argue that students generally believe that scientific knowledge is (1) generated by standard methodology, (2) created only by great scientists, and (3) discovered without controversies. It suggests that the discourse community in schools often foster a positivist epistemology—a belief that eventually relegates students as passive receivers of scientific knowledge.

Maintaining that a guiding discourse pattern for working scientists is doing science with language does not exclude the fact that scientists also talk about science contents. What differs scientific discourse from classroom discourse in talking about science is that scientists often talk about ready-made science with the intention to go beyond the information given [3] while it is often not the case in a typical classroom. Scientists talk about science with an aim to interrogate, rebuild, or even deconstruct the prevalent theories. Therefore, talking about ready-made science with an evaluative epistemology is also a way of doing science with language.

3. Designing Classroom Discourse as Doing Science with Language

3.1 *Guiding Design Objectives*

To help students do science with language, we articulate how students may thrive in a classroom ecology that situates learning in conducting scientific inquiry and making argumentation. In crafting this program, our goal is to engage students in the three design objectives that characterize scientific discourse—using language for scientific knowledge construction, using argumentation to validate knowledge construction, and using language to evaluative the constructed scientific knowledge.

3.2 Designing Students' Discourse Practice in Doing Science

Guided by the three design objectives, we draw from the stories of ancient alchemists to design the Legends of Alkhimia 3D role-playing game (referred to as LOA game) and a game-based learning curriculum (referred to as LOA curriculum). The LOA curriculum is an eight-session chemistry-learning program for secondary (middle school) science education in Singapore. The LOA game is the cornerstone where all curricular activities are structured.

In a typical LOA curricular unit, the program begins with students sharing their experience related to scientific inquiry, such as asking questions. Then they play a level of the LOA game as a team of four apprentices of a senior chemist. In game play, students encounter problematic situations, ask questions, propose hypotheses and conduct virtual experiments to solve the problem in game. Following game play, students analyze virtual data collected in game play and propose theories about the nature of in-game virtual substances via small group and whole class dialogic arguments. In the entire curriculum, students are situated in designed contexts where they need to use language to do science—constructing theories, making arguments and evaluating others' theories. The following describes in details how the design of LOA game and curriculum situates students in a learning context that requires doing science with language.

3.3 The Legends of Alkhimia Game

Role-playing in the LOA game as apprentices of a master chemist, students face six levels of game challenges in the virtual place of Alkhimia. Typically, a game challenge is designed to engage players in cycles of three Inquiry Actions. First, a player encounters a situation that can be overcome by conducting appropriate “virtual” experiments. He must identify the sources of the problems and hypothesize how he may tackle the challenges. Second, he conducts virtual experiments in the virtual lab in order to produce virtual substances (designed based on Earth substances) that may solve the problems. Third, he tests the lab generated virtual substances—and therefore his hypotheses—in the game challenges in order to investigate how they work. For example, in Level One of the LOA game, the players were attacked by three moderately reactive metallic monsters, which can be destroyed using cartridges with acid in the battlefield. Defeated by the monsters, players manage to retreat to the virtual lab where several lab functional units and apparatus are available for conducting experiments. The players’ experiments are guided by their hypotheses about how the monsters can be destroyed. After the experiments, players return to the battlefield to face the monsters until they successfully defeat them.

To design a context where players can do science with language, we position the game in an era where all Alkhimia substances have not been investigated and named. It situates players in a world similar to that of the ancient alchemists on Earth. Players must collect and identify suitable data from multiple resources in game, such as the procedure through which a virtual substance is produced and its effectiveness against virtual monsters in the battlefield, to interpret and construct knowledge about the Alkhimia substances.

3.4 The Legends of Alkhimia Curriculum

The three in-game Inquiry Actions comprise three key procedures in an inquiry cycle—asking questions, proposing hypotheses and conducting investigation. The after-game activities make it a full inquiry cycle by asking students to (1) analyze data and (2) synthesize findings. Following game-play, students organize themselves in their game-play groups to propose their theories about the properties of the virtual substances. They share their own in-game inquiry notebook and game log (log of virtual experiment and game play) with the group members in order to select the best notebook to present to the class. Students will also negotiate how the Alkhimia substances are classified and what names to be given to them. When doing this, students must also defend their claims by using the game log as evidence. As students present their hypotheses about the properties of the in-game substances, they make their hypotheses/claims visible to the whole class for evaluation in teacher-facilitated whole-class discussions.

In the QAE/IRE triadic discourse pattern, a teacher plays the role of content authority. In the Legends of Alkhimia curriculum, the teacher facilitates the discourse practice toward constructing knowledge with dialogic argument. She interprets (and invites other students to interpret) students’ performance (e.g. classification and naming of substances) and speech acts. He or she will also mediate discourse as a more or less equal voice. At times, the teacher questions students as a curious co-participant. At times, he or she assumes more control in guiding the direction of the arguments.

As closure to the session, students will vote, as a class, the best names for the substances. The teacher will also recap the knowledge constructed by the class as a way to help students understand the constructed nature of scientific knowledge. After the session, each student will complete tasks online on a wiki. They will write a narrative in the form of a diary entry about their personal experience in the game and their personal reflection upon their experience.

4. Conclusion

Guided by a design-based research approach [1], [2], we characterize the defining features of two science discourses—working scientists and students—to develop a design guideline for designing the LOA game and curriculum. The main purpose of our design is to provide a context where students are immersed in using language for doing science. In proposing and designing the LOA game-based learning program, we also acknowledge the limitations of our design in transforming current educational practices. As the belief guiding the design of the mainstream educational systems differs from ours, we expect pushback from the current system at multiple levels—administration, teacher education, pedagogy, and even the physical configuration of classrooms. Therefore, changing how students practice science discourse is but a beginning that must also initiate changes at different levels.

References

[1] Barab, S.A. & Squire, K.D. (2004). Design-based research: Putting a stake in the ground. *Journal of the Learning Sciences, 13*(1), 1-14.

[2] Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *Journal of The Learning Sciences, 2*(2), 141–178.

[3] Bruner, J. S. (1957). Going beyond the information given. In H. Gruber et al. (Eds.), *Contemporary approaches to cognition* (pp. 41-69). Cambridge, MA: Harvard University Press.

[4] Cazden, C. (2001). *Classroom Discourse The Language of Teaching and Learning*. Portsmouth: Heinemann.

[5] Driver, R., Asoko, H., Leach, J., Mortimer, E., & Scott, P. (1994). Constructing scientific knowledge in the classroom. *Educational Researcher*, *23*(7), 5-12.

[6] Driver, R., Newton, P., & Osborne, J. (2000). Establishing the norms of scientific argumentation in classrooms. *Science Education*, *84*(3), 287-312.

[7] Gee, J. P. (2004). *Situated language and learning: A critique of traditional schooling*. London: Routledge.

[8] Gee, J. P. (2005). *An introduction to discourse analysis: Theory and method*. London: Routledge.

[9] Kelly, G. J., & Crawford, T. (1997). An ethnographic investigation of the discourse processes of school science. *Science Education, 81* (5), 533-559.

[10] Kuhn, D. (2005). *Education for thinking*. Cambridge, MA: Harvard University Press.

[11] Lemke, J. (1990). *Talking science: Language, learning, and values*. Norwood, NJ: Ablex.

[12] Mehan, H. (1979). *Learning lessons: Social organization in the classroom*. Cambridge: Harvard University Press.

[13] Schwab, J. J. (1962). The teaching of science as enquiry. Cambridge, MA: Harvard University Press.

[14] Shaffer, D. W., & Gee, J. P. (2005). *Before every child is left behind: How epistemic games can solve the coming crisis in education* (WCER Working Paper): University of Wisconsin-Madison, Wisconsin Center for Education Research.

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My-Investment: Simulation Games to Help Primary Students Learn Financial Management

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Abstract: In this paper, we describe a simulation-based game environment, My-Investment, which is developed to foster primary students' financial management learning. Before introducing the detailed functions of the My-Investment system, we elaborate two design guidelines to underpin the system development, including fostering participation cycle as well as offering learning by doing opportunities. According to the two principles, six major functions are developed in the My-Investment system.

Keywords: financial education, game-based learning, simulation

1. Introduction

Recently, digital games have been regarded as a potential learning strategy that could engage students to learn specific skills or subject knowledge. In terms of *specific skills*, a number of significant skills are promoted in game-based learning environments, such as critical thinking [1], problem-solving [2], exploration and reflection [2], and independent learning [3]. This is due to the fact that most digital games are a kind of goal-oriented activity that invites students to discover, explore, think, and overcome a set of challenges in a joyful way. During the game playing, these games demand students to apply specific skills to solve their problems. Thus, these significant skills are developed and improved.

In terms of *subject knowledge*, some studies utilize digital games to help students acquire knowledge in the domain of software engineering [4], medical education [5], and sports education [6]. A major reason for this lies that digital games could integrate various advanced technologies, including multimedia effects, distributed computing, and augmented reality, to offer specific educational affordances to help students understand abstract knowledge. That is, students have more opportunities to understand the subject knowledge from multiple perspectives and in different representation ways, which in turn results in better learning outcomes.

Moreover, digital games are not only regarded as a highly interactive environment that could engage students to acquire knowledge in a more joyful way, several significant opinions or philosophy about game-based learning are advocated, such as serious games [7], commercial off-the-shelf games [8] and epistemic games [9]. Nevertheless, some studies have pointed out that the research filed of game-based learning still lacks sufficient practical studies [10], although the natural characteristics of digital games are attempted to identify, some philosophy or theories are tried to develop as well. Insufficient practical studies would result in a major problem: the gap between conceptual theory and practical application. The lack of practical studies, on one hand, cannot provide specific feedbacks to revise the underpinning conceptual theory. On the other hand, it is difficult to develop some guidelines for applying digital games to practical settings; however, this is one of the major goals for game-based learning. Thus, in this study, we develop a simulation-based game to enhance students' financial education.

In recent years, financial education has become more and more important, because of the emergence of the global village. Although many activities in our daily life are related with financial management, elementary students have relative fewer opportunities to acquire financial management knowledge. A possible reason is that younger students are often looked after by their parents, and have little experience in working, money-making, or investment. It is difficult for them to deepen their understanding of financial knowledge. Therefore, we attempt to develop a simulation-based game environment, in which each student plays a responsible “master” to look after their virtual pets. Through eliciting students’ nature instincts of loving pets, students are encouraged to learn financial management well in the simulation game so that their pets could have happy lives. During this process, related financial management knowledge is also offered to help students learn in the simulation game.

2. Design guidelines

With respect to financial games, monopoly [11] is a typical one in this genre. Although monopoly often involves buying and selling of real property, its major purpose is for entertainment, instead of financial education. To design a financial game for educational purpose, we first identify two design guidelines to direct the development of My-Investment system.

2.1 Fostering participation cycle driven by game and learning activities

The first guideline of developing a game-based environment for financial education is to address the relationship between game and learning activities, so that students’ participation could form as a positive learning cycle. To this end, we attempt to borrow a *needs-learning-investment* model from human society, since the model is a pervasive working one in our society. The model consists of three elements—needs, learning, and investment. We use game and learning activities to realize the three elements in the working model.

With respect to “needs”, we choose a pet-nurturing game as a basic structure to create requirements for students. This is duo to the following two reasons. The first reason is that taking care of pets seems to be a natural way to initiate and deepen human-computer interaction. Research had found that people tend to look after subjects who are weaker than themselves [12]. For students, pets might be a suitable candidate to elicit such looking-after behaviors and emotional involvement, which might be helpful to initiate and sustain students’ participation in a learning environment.

The second reason is that pet-nurturing could further involve an economic process, in which students could be guided to do something (including learning tasks) for earning their pets’ happier lives. In other words, learning tasks could easily be embedded into the pet-nurturing game. Under such a structure, undertaking learning tasks is quite similar to a kind of “work”. This is just like the working model in our work-centered society [13]. Based on this metaphor, the second element, “learning” could be realized by learning activities.

With respect to “investment”, we choose a financial simulation game as a primary structure to offer opportunities for students to learn how to invest their money either in a bank or a stock market. This is because a simulation game is good at representing specific scenario or context in an efficient, economical, and safe way. Because students have little experience to invest a great deal of money in the bank or stock market, some financial management knowledge is too abstract to understand. If we could create a simulation game for students, they might learn the management knowledge better, and easily apply to practical contexts.

2.2 Offering learning-by-doing opportunities within the participation cycle

The second guideline is based on the participation cycle to develop a simulation-based game environment for offering learning-by-doing opportunities within students' participation. This is because learning-by-doing is an apparent educational characteristic that a simulation-based environment could bring. Specifically, a simulation-based environment has the following three educational features: *helpful to concept learning, offering practice in decision-making* and *good at dealing with time and scale* [14].

First, a simulation-based environment is helpful for students to understand abstract ideas and concepts, because simulations could bring more concrete representation and manipulations, which could deepen students' understanding. In other words, through learning by doing, students could acquire knowledge in a more interactive way, instead of reading a passage merely to memorize the definition of a formula. Students who learn in a simulation-based environment could have different learning experiences, in which these ideas or concepts could be discovered or identified by students' actions.

Next, a simulation-based environment could simplify complex situations as simple but core models, where students could have sufficient practice to make decisions before they face these situations in real live. Because the situations are simplified, students could understand easier the core models behind these situations. On one hand, such simulations could prepare students practices in "life-like" situations so that they have more opportunities to experience and learn how to react in these situations. On the other hand, simulations could reduce the risk or cost if students' experiencing these situations might be dangerous or resource-demanding.

Finally, a simulation-based environment could speed up the result of actions, so that students could gain an immediate outcome, instead of taking a long period of time or a great deal of resources. In other words, within a simulation-based environment, students have more opportunities to operate by themselves, make decisions, and observe the consequences in a short time. The shortened time is helpful for students to link what they do and what the result are, and have a clear cause-and-effect relationship, which might contribute to a better understanding for the potential impact of the decision they made, particular in the large-scaled or long-term domain subjects.

3. My-Investment system

According to the two guidelines, a My-Investment system is developed for elementary school students. The My-Investment system contain the following six major functions. First, every student keeps a virtual pet, My-Pet, and the game goal is to take good care of the My-Pet. To this end, the student needs to purchase pets' food and goods in the pet store. However, it requires virtual coins, EduCoins, to purchase these items for satisfying the My-Pet. These pet-keeping functions (step 1 and step 2 in Table 1) are all related to the game activities. To some extent, these game activities are an incentive for the following learning part.

Next, two kinds of learning activities are provided as "work". The first one is animal-caring program (step 3), which provides students knowledge about how to take good care of their pets, such as how to treat their pets when the pets are unhappy or ill. Students are taught to decide give some medicines to cure them, or have some exercise with them. The second work is financial management program (step 4), which provides students knowledge about how to invest their money in a bank or a stock market. No matter animal-caring program or financial management program, when student complete the learning tasks, they could earn their Edu-Coins as salary.

Finally, when the students gain the salary, they could save them in the bank for an interest income (step 5). In addition, students could also apply the bank to a credit card, so that they could buy pets' food or goods by the credit card. During the process, they could learn how to use the credit card under the credit line, and how to maintain a good credit position. In addition to the bank, students could invest their money in the stock market (step 6). They could buy some stocks from the stock market. They might earn money from the stock market; however, they need to risk losing their money as well.

Table 1. Six major functions in the My-Investment system

Function	Location	Description
1) **Needs**	Backyard	A student keeps a virtual pet, My-Pet. The game goal is to look after the pet better, including satisfying her basic needs: hungry, thirsty, healthy needs.
2) **Needs**	Store	To satisfy the pet's needs, the student needs to earn Edu-Coins to buy pets' food, goods, and other services. That is, pet-nurturing games create requirement for students to fulfill these requirements.
3) **Learning**	Hospital	Two kind of work (i.e., learning activities) in games are provided for students. One is animal-caring program, which teaches students how to look after animals.
4) **Learning**	Library	Another program is financial management program, which offers students the knowledge about how to distinguish what we need and what we need, and how to invest money.
5) **Investment**	Bank	Students are offered two kinds of approaches to invest their money. The first one is bank, in which they could save the money to earn an interest income (see Figure 1).
6) **Investment**	Stock market	Another approach is to invest the money in the stock market. They could earn some money at the risk of selling the stocks, since they might lose their money as well (see Figure 2).

Figure 1. Snapshot of Bank

Figure 2. Snapshot of stock market

4. Work in progress

After the My-Investment system is developed, a case study is undertaking to examine the design of the My-Investment system, since we hope to use a design-based research to gain some revision cues after students' use in a practical setting. This could help us adjust the direction of the system development. The participants were 26 fifth-grade primary school students (aged approximately eleven) in Taiwan. Every participant used the My-Investment system in a computer laboratory. During the process, students' usage logs were recorded, so that we could analyze their behaviors. Consequently, our next step is to have an examination on the My-Investment system for having a deeper understanding about students' learning behaviors in the system.

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References

[1] Gee, J. P. (2003). What video games have to teach us about learning and literacy. New York: Palgrave/Macmillan.
[2] Kiili, K. (2007). Foundation for Problem-Based Gaming. British Journal of Educational Technology, 38(3), 394-404.
[3] Cagiltay *(2007).* Teaching software engineering by means of computer-game development: Challenges and opportunities. *British Journal of Educational Technology*. 38(3). 405-415.
[4] Connolly, T. M., Stansfield, M. H., Hainey, T. (2007). An Application of Games-based Learning within Software Engineering. *British Journal of Educational Technology*, 38(3), 416–418.
[5] Moreno-Ger, P., Burgos, D., Sierra, J.L., Fernández-Manjón, B. (2008). Educational Game Design for Online Education. *Computers in Human Behavior*, 24, 2530–2540.
[6] Mueller, F., Gibbs, M., Vetere, F., and Agamanolis, S. (2008). Design space of networked exertion games demonstrated by a three-way physical game based on Table Tennis, *ACM Computer Entertainment*, 6(3), 1-31.
[7] Abt, C. (1970). Serious Games. New York: The Viking Press.
[8] Šisler, V., Brom, C. (2008). Designing an Educational Game: Case Study of 'Europe 2045'. In: Pan, Z., Cheok, D.A.D., Müller, W., El Rhalibi, A. (eds.) Transactions on Edutainment I. LNCS, vol. 5080, 1–16. Springer, Heidelberg.
[9] Shaffer, D. W. (2007). How computer games help children learn. New York: Palgrave.
[10] Shelton, B. E., & Wiley, D. A. (2007). (Eds.) The design and use of simulation computer games in education. Rotterdam : Sense Publishers.
[11] Wikipeida. Retrieved May 17, 2010, from http://en.wikipedia.org/wiki/Monopoly_(game)
[12] Melson, G. F. (2001). Why the wild things are: Animals in the lives of children. Cambridge, MA: Harvard University Press.
[13] Ransome, P. (2005) Work, Consumption and Culture: Affluence and Social Change in the Twenty First Century, London: Sage.
[14] Aldrich, C. (2005). Learning by Doing: A comprehensive Guide to Simulations, Computer Games, and Pedagogy in e-Learning and Other Educational Experiences, John Wiley & Sons.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

A Preliminary Study of Promoting Students' Effort-Making by Preparation-before-Competitive Game

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Abstract: Digital games can be regarded as a possible vehicle for changing the students' behaviors. However, not all digital games could produce these possibilities. In order to address this issue, we proposed a preparation-before-competition approach and adopted it to design a game-based learning environment, entitled My-Pet-Trainer, to foster the habit of endeavor. That is, students make more effort to learn; they will win more easily. The system encourages students to improve their learning in the preparation phase where the virtual pets represent students' profiles before the competition phase. My-Pet-Trainer was used in an elementary after-school club and students' home; we evaluated it by the field observation and the interview of individual student. The findings showed that rich phenomenon about the effect of My-Pet-Trainer. During each observation and interview, we re-adjusted continuously My-Pet-Trainer according to students' feedbacks and behaviors.

Keywords: competitive game, effort-making, animal companion, observation, interview

1. Introduction

Over the past decade, educational researchers have proposed digital games as an educational tool with considerable potential benefits in joyful learning context and stimulating students' intrinsic motivation (Rieber, 1996). Significant motivational factors that stimulate a student's motivation to learn have been identified, such as, some key motivational elements: challenge, fantasy, curiosity, and control (CFCC; Malone, & Lepper, 1987); and a motivational model: attention, relevance, confidence, and satisfaction (ARCS; Keller, 1987). In other words, digital games can be regarded as a possible vehicle for changing the students' behaviors and attitudes.

However, not all digital games could produce these possibilities changing the students' behaviors, attitudes, and even belief. Fortunately, more and more digital games have been developed for educational goals; and sophisticated digital games also provide a wide diversity of pedagogical strategies: individualistic, cooperative, and competitive (Ke, 2008). Among these strategies, competition is one of the vital strategies in game-based learning, because competition has been considered as a way to foster students' excitement, attention, and engagement in a competitive situation (Cheng, Wu, Liao, & Chan, 2009; Malone, & Lepper, 1987). These studies also believed a competition strategy could engage students in play and learning. Hence, this paper developed and evaluated a game-based learning environment, entitled My-Pet-Trainer, according to a preparation-before-competition approach for engaging students and facilitating students' effort making and gained confidence.

2. My-Pet-Trainer System

This study designs a pet-training environment where a pet-style virtual character called My-Pet, performs on the competitive stage on behalf of its trainer student by a preparation-before-competition approach. My-Pet-Trainer (MPT) attempts to encourage students to persist in solving challenging problems and to enhance confidence for competition (Liao, Chen, Cheng, & Chan, 2010). This study also integrated My-Pet-Trainer into a game-based learning environment, entitled Quest Island (see Chen, Liao, & Chan, 2010). Students will play a role of pet-trainer who can interact with My-Pet that sustains his/her motivation and engage him/her in learning tasks and competition activities.
The pet-trainer needs to train My-Pet and to complete the learning task in the preparation phase. Students require to compete with virtual competitor's pet and to cumulate challenge questions (See figure 1). They also require to set and to reach a certain goal, and to determine whether they can move to the next phase (See figure 2). Students would master to competitive activity that can show their performance by pressures of the competition from the virtual competitors and limited time; the pet-trainer also has to control the pet to compete against the other pet-trainer in the competition phase. Students require getting qualification in the practice phase, and then they could choice to enter competitive phase or to continue practice phase. When the students entered the competitive phase, they can decide on his competitor's pet (other student). MPT decided that the winning or losing of students according to answer correctly the maximum of question in limited time.

Figure 1. Screenshot of the My-Pet-Trainer

Figure 2. Screenshot of negotiable goal setting

Therefore, the students could take their own My-Pet that could present the students' performances. The ability of the students presents through revealing the skills and the appearance of My-Pet without directly showing out.

3. Evaluation

3.1 Research Design

The study conducted to utilize a ''promoting students' effort-making behavior'' of My-Pet-Trainer system in an elementary after-school club and students' home. The participants were 29 nine-year-old third-grade students (14 boys and 15 girls) from an elementary school in Taiwan. The process of preliminary study divided into two phases. First phase (school only): during a month period of after-school club, students could nurture the virtual pet, practice the math problems about a serial of math computation, and compete with other pet in game-based learning environment. Second phase (school or home): when students familiar use the My-Pet-Trainer; they can practice the math problems and play the game at home or after-school club in each day. In this phase, we conducted two interviews. During an interview, students also can use notebook to play/learn competitive game.

3.2 Data Collection and Analysis

The data collection contains two parts: *field observation* and *interviews*. Regarding of field observation, we conducted three trials in order to examine the usability of competitive game and investigate some influence in the affective aspect. A semi-structured observation protocol was developed to guide the author's attention during observation, although the actual observation was open to any situational changes. The authors also recorded observation comments (OCs). Regarding of interviews, we selected four students according to students' effort-making behavior of last month: two low-effort students and two high-effort students. We made further adjustments by users' feedbacks and advices. In addition, we also discussed how to increase the interaction design to be suitable to difference students' preference. The authors developed a semi-open-ended protocol to facilitate the participants' thinking without influencing what they said. Participants were prompted to report whatever went through their minds. The author recorded the interview comments (ICs).

4. Findings and Discussions

4.1 Class Observations

In trial 1, we found three phenomenon of in-field observations: *high-level goal setting*, *favorite topic selection*, and *using paper and pencil*. Regarding of high-level goal setting, we observed that most students establish the goal of practice which approximates five or six rounds. In addition, we also observed that two of students establish a high standard goal. One student (#15) needs to practice 30 rounds of math problems, and then he anxious said that he could not finish the goal; but he still attempt to overcome math problems gradually. Another student (#22) needs to practice 100 rounds of math problems; she said that she want to achieve myself decided goal. Although the design of goal setting encouraged that students could free establish the goal according to students' confidence, student possible not establish appropriate goal and ever decrease confidence. Hence, we further modified the form of goal setting from free filled-a-number into limiting drop-down list.

Regarding of favorite topic selection, the system currently provided five free-selection math topics. This design of selection based mainly on the power of choice; because we hope to help students make decisions. However, we found that students select and practice math topic according to their own preferences in trial 1. We hoped that students could practice all topics, not practice some topic. Hence, we using verbal to encourage students more practice other topic. Besides, we also found that most students took a piece of paper and began to solve math problem. In other words, students used conveniently tools (e.g., paper and pencil) to assist math problem solving. We further asked one of students why use paper and pencil while he answered that "I can do better by using paper and pencil (#9)". Hence, we thought that how provide some additional technological tools may supplement digital gaming to facilitate learning.

In trial 2, we also reported some findings about *preparative phase*: *negotiable goal setting* and *attention-getting effort rank*. Regarding of negotiable goal setting, students asked that they hope to change the goal setting, because they want to re-establish the goal. In particular, most of students want to establish higher goal while few of student want to establish lower goal. We intended that students make a commitment of learning, but students seek a negotiable commitment of learning. Hence, we adjusted goal setting form fixed into changeable. Regarding of attention-getting effortful rank of hiding students' name, some students asked why their effortful rank lower and what it means; they also asked who is number one curiously. In other words, they care about effortful rank. This means that effort rank of hiding students' name is effective about inspired students' motivation and reflection.

In trial 3, we reported some findings about *competitive phase*. We observed that some students will not compete with others. One student said that "I don't like competition (#23)"; another student said that "I feel the math problems for me are so difficult (#14)". In order to improve the situation, we inspired students to practice the math problem and then we encouraged them compete with other. Besides, we also found that some students unexpected leave the competitive game. On the one hand, they feel possible lose the game. On the other hand, they want to join other competitive game, such as their friend created games. However, students should learn to engage the competitive game completely, because sportsmanship is important. Being a good player (or good students) involves being a good winner as well as being a good loser. Hence, this game automatic record the time of students' unexpected leaves, and then we remind students not only providing system prompted but also using verbal.

4.2 Individual Interviews

In interview 1, we selected two students: #21 (girl, low-able and low efforts behavior) and #25 (girl, middle-able and low efforts behavior). One student of #21, we discovered that she spent a lot of time to solve her quest in Quest Island every day, so she felt so tired which practice the math problem in My-Pet-Trainer. During interview, she totally solves 69 problems of the addition and subtraction of within 1000. However, we found that she need more practice the concept problems of division. Besides, she also said that she probably understand the game feature and the concept of effort-making. Hence, we first suggested that she needs to manage time, and then we instructed her concept of division. Another student of #25 only sets one goal of practice math problem, because she little uses the My-pet-competitive game. She totally solves 43 problems of multiplication during interview while she just solved 31 problems before interview. In other words, she practiced 74 math problems. However, she still not understands the game rule, function, and even the concept of effort-making. We thought why not she does more practice and what she could afford the practice, because her math competence is not bad. Hence, we re-illustrate the game, and then show that why more practice can easily win. She eventually said that "I will more practice at home or school".

In interview 2, we selected two students: #7 (boy, high-able and high efforts behavior) and #2 (boy, high-able and high efforts behavior). One student of #7, he said that he has one or two successes of competitive game. But, he also said that "I believe that an effortful practice had half successful opportunity. Sometimes it works while sometimes it not works". Besides, we also found that he just sometimes use the game while he said that "I occasionally play the game at weekend". Hence, we serious explained why we believe a successful experience is important that can engage long-term practice and "failure is the mother of success". Another student of #2, he thought that the My-Pet-Trainer enough not excited, because he like the game type of high-challenge and high-difficulty. He also said that "I don't play the game. Even game could provide the more rewards or change the math problems". Besides, we observed that he current just to solve her quest in Quest Island every day. The aforementioned matter, we conjectured that he lack for high challenge goal and appropriate opponent, because he believed that he perform better by practice more. Hence, we will develop an adaptative version for high-able students in the future.

The last 5 minutes of interview 2, we organized two competitions of between #7 and #2. Beginning of the competition, #7 expressed immediately that "I will lose" and #2 said that "#7 has been lost two times"; and consequently, one of author privately encouraged #7 to select the weakest topic of #2 and compete with #2. First round, #7 selected the topic of multiplication according to his ability and competed with #2. The result showed that #2 defeated #7. Beginning of second round, #7 practices the topic of multiplication once, and then he competed with #2 again. The result still showed that #2 defeated #7, because #7 felt so nervous that he answered wrong which he could be correct, and he cannot maintain previous level. But he also said that "I don't care about losing the game" and "I will win #2 eventually". Hence, he needs more prepare the math problem in practice phase in order to maintain level in competitive phase.

5. Conclusion

In this study, we explore an issue that how to design a competitive game for promoting students' effort-making behavior. The findings showed that rich phenomenon about the effect of My-Pet-Trainer. During each observation and interview, we re-adjusted continuously according to students' feedbacks and behaviors. Moreover, a number of studies should be further conducted in the future, including a formal experiment to examine the influence of students' confidence, as well as more scaffolding designs to promote students' effort-making and to support students' learning in My-Pet-Trainer.

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References

[1] Chen, Z., Liao, C. C. Y., & Chan, T. (2010). Quest Island: Developing Quest-Driven Learning Model by Blending Learning Tasks with Game Quests in a Virtual World. In *Digital Game and Intelligent Toy Enhanced Learning, IEEE International Workshop on* (pp. 93-100). Los Alamitos, CA, USA: IEEE Computer Society.

[2] Cheng, H. N. H., Wu, W. M. C., Liao, C. C. Y., & Chan, T. W. (2009). Equal opportunity tactic: Redesigning and applying competition games in classrooms. *Computers & Education*, 53(3), 866-876. doi: 10.1016/j.compedu.2009.05.006.

[3] Ke, F. (2008). Alternative goal structures for computer game-based learning. *International Journal of Computer-Supported Collaborative Learning*, *3*(4), 429-445. doi: 10.1007/s11412-008-9048-2.

[4] Keller, J. M. (1987). Strategies for stimulating the motivation to learn. Performance & Instruction, 26 (8), 1-7.

[5] Liao, C. C. Y., Chen, Z. H., Cheng, H. N. H., & Chan, T. W. (2010). Preparation-before-Competition: Designing a Game-based Environment to Facilitate Making Effort before Pet-Competitive Stage. In *Digital Game and Intelligent Toy Enhanced Learning, IEEE International Workshop on* (pp. 171-175). Los Alamitos, CA, USA: IEEE Computer Society.

[6] Malone, T. W. and Lepper, M. R. (1987) *Making Learning fun: a taxonomy of intrinsic motivations for learning, Aptitude, learning, and instruction, 3, Cognitive and Affective Process Analyses*, Erlbaum, Hillsdale, NJ.

[7] Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research and Development*, *44*(2), 43–58.

Interaction Design Based on Augmented Reality Technologies for English Vocabulary Learning

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Abstract: In this paper, we present the Augmented Reality English Vocabulary Learning System (AREVLS) with immersive English Vocabulary learning. AREVLS consists of two components: (1) Magic Book, and (2) Card Matching System. Moreover, we use Heuristic Evaluation and System Usability Scale (SUS) to make a questionnaire for English teachers in elementary schools as well as kindergartens. The research results show that the SUS has positive usability and participants enjoy the interaction with it. From the Heuristic Evaluation, the disadvantages of AREVLS are acquired, and the experts provide some feedback for further improving the system.

Keywords: Augmented Reality, English Vocabulary Learning, Heuristic Evaluation, Human Computer Interaction

Introduction

With the progress of information technology development, the form of digital learning multimedia materials has changed dramatically from traditional books to digital media. Thus, the learning becomes more lively and interesting. In the beginning of learning English, students first learn English letters, pronunciation and vocabulary. As for the traditional teaching in classrooms, the interaction between teachers and students is usually by gestures as well as discussions, lack of interesting learning and interaction. On the shelf are many interactive learning media, changing the traditional learning way.
Paivio brings up Dual-Coding Theory [1, 2]. According to the theory, there are two kinds of systems respectively dealing with different cognitive messages in the human processing procedure. However, as we see text, we won’t see it the way we see images. In terms of this, Paivio provides the idea of the importance of images to our learning. For the sake of images providing another access to coding, information can connect in many ways in learner’s memories via the impulse of both text and image. The more the related information is, the deeper their memories will be. Thus, it is beneficial to our learning, for learners have less chance to forget what they have learned.

Related Work

AR is applied in researches on English learning. Kirner et al. [3] develops an English letter spelling game. Its rule is players have to pick up the right cards to spell the correct word in the AR English letter cards. If their spelling is right, there will be a virtual object of the English letter card on the monitor. In such an attractive situation, the game can encourage players to interact more actively and fortify their ability of solving problems. Hsieh and Lee [4] make the card design less complex with the conception of permutation and combination, offer students a new digital media of different learning stimulation, and present the English learning system with immersion learning effect, which help students learning English vocabulary. To sum up, the system contributes to making the traditional way of learning English vocabulary more vivid and better.

Based on the references stated above, we combine AREVLS with English Vocabulary Magic Book. In Mixed Reality, through the combination of virtual objects and real scenes, students are able to interact with virtual objects, get sense excitement to improve their learning effect, and finally have an interesting learning.

Augmented Reality English Vocabulary Learning System

We devise an English vocabulary learning system by taking advantage of the AR technology. The system development is based on ARToolKit [5, 6]. In order to build a virtual object, we use SketchUp software and 3D Warehouse as the model-design tool.

The AREVLS interactive mechanism is primarily divided into two interactive ways, English Vocabulary Magic Book interactive mechanism and English vocabulary card matching interactive mechanism. English Vocabulary Magic Book interaction mechanism: if learners open the English Vocabulary Magic Book, the webcam will capture the AR marker of English Vocabulary Magic Book. Next, the system will automatically recognize the AR marker, combine the 3D virtual object in the virtual object database, and superimposes it on the English Vocabulary Magic Book. Figure 1 is the operation of English Vocabulary Magic Book. Taking letter C in Unit 1 for example, when the webcam captures the AR marker of English Vocabulary Magic Book, buttons of “phonics” and “vocabulary phonics” appear on the monitor. As learners use mouse to click “phonics”, the system will pronounce the letter and its phonics; as learners click “vocabulary phonics”, the system will pronounce the word. Figure 2 shows what is stated above.

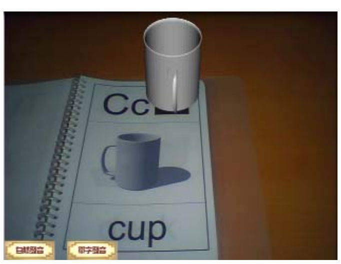


Figure 1: Letter C and D of AR English Vocabulary Magic Book

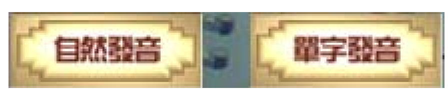
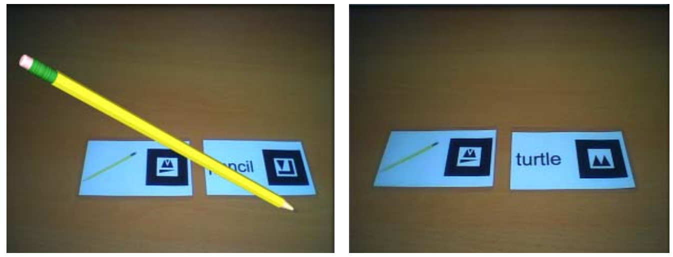


Figure 2: AR English Vocabulary Magic Book interactive button - ”Phonics” and “Vocabulary Phonics”

Matching interactive mechanism of English vocabulary picture card: With an eye to testing if learners really know these words, after their learning, the system provides matching interactive mechanism of English vocabulary picture card, so they can have a set of unit cards to do the matching, as Figure 3 demonstrates. One word is with two cards. One is picture card and the other is vocabulary card. Students take the picture card to match the vocabulary card. Through the judgment of matching interactive mechanism of English vocabulary picture card, when the matching is right, the system will shows the 3D virtual object from the virtual object database through the monitor. In the contrast, when the wrong matching happens, there will be no 3D virtual object on the monitor, for the system automatically judges that the picture card and the vocabulary card don't match each other, as Figure 4 shows.

Figure 3: English Vocabulary Card Matching.



(a) (b)

Figure 4: (a) is a correct matching; (b) is a false matching.

System Evaluation

Although we have preliminarily finished the implementation of AREVLS, we can possibly miss many aspects, for the whole producing process was mainly done by the authors. Thus, we hope utilize expertise evaluation to quickly and accurately discover the problems for using AREVLS; meanwhile, we also use System Usability Scale to do system usability testing. With the results of evaluations, we can find out the problems of interface usability to improve our design or provide information for future development.

1. Heuristic Evaluation

Heuristic Evaluation [7, 8] is developed by Jakob Nielsen according to usability exploring rules (Heuristics), which evaluates whether the elements of making up user interface is based on these principles. In Nielsen's research, it is proved that experts can usually check out around 75% usability problems and skilled experts are able to observe a lot of usability problems on their own. Also, based on Nielsen's advice, there should be four to six experts. In the research, we have five experts. Listed in Table 1 is the backgrounds and specialties of the experts.

Table 1: The backgrounds and specialties of experts

Expert	Specialty	Background
A	Augmented Reality , Human Computer Interaction	Computer Science and Information Engineering
B	Augmented Reality, Interactive Design	Computer Science and Information Engineering
C	Usability Engineering, Augmented Reality	Computer Science and Information Engineering
D	Usability Engineering, Human Computer Interaction	Computer Science and Information Engineering
E	Multimedia Design, Interactive Design	Visual Communication Design

Each expert spends one to two hours examining products at least twice. First, experts grasp the procedure of the whole interactive interface manipulation and gain some knowledge about the product. Then, experts check the usability problems of the entire system. Finally, experts discuss their evaluation results together, prioritize the problems, and offer solutions to them. According to experts' opinions for interface design of AREVLS, the illustration for their opinions is as follows:

(1) In English Vocabulary Card Matching, the system should come with voices. If learners do wrongly on card matching, the screen will display the image on the wrong matching with voices like "Please try again" and to let learners know their matching errors. For instance, by showing a cross mark (×) with the sentence "Please try again" spoken out, the system can let them know their incorrect matching while by using a check mark (✓) with the sentence "Congratulations, you are right" pronounced, it can let them know their correct matching
(2) AREVLS is lack of instruction of assistant document. When users enter the system, they might be not clear about manipulating it. As a result, it will be better to display manipulation instructions on the window before users go into AREVLS. Then, they will be aware of operating.
(3) 3D virtual objects can be displayed with Chinese characters. In addition to showing 3D virtual objects, we also display Chinese character beside 3D virtual objects. Consequently, there will be more visual effects to help learners learn.
(4) AREVLS lacks unit introduction. We should let learners know the outline of the unit they are going to learn and make a short introduction before they learn a unit.
(5) The name of each unit should be displayed on the window. While learners learn a unit, we have to display the name of each unit on the window to let them know which unit they are learning.

2. System Usability Scale

In the research, AREVLS serves as the assistant material of English vocabulary learning. Participants are teachers in elementary schools and kindergartens, English-learning beginners, and householders who are asked to receive the task assignment and start using the system. They then get to the operation in accordance with the task assignment, as Table 2 shows. After finishing the task assignment, we will evaluate the system usability.

Table 2: Task Assignment for interaction mechanism of English Vocabulary Magic Book and English Vocabulary Card

Task Assignment for Interactive Mechanism of English Vocabulary Magic Book	Task Assignment for Interactive Mechanism of English Vocabulary Card Matching
1. Open to letter Bb in Unit1 of English Vocabulary Magic Book.	1. Select English Vocabulary Card - correct matching.
2. Click letter phonics of Bb.	2. Shift the correct- matching English Vocabulary Card.
3. Click letter phonics of Bb again.	3. Move the correct- matching English Vocabulary Card up and down.
4. Click vocabulary pronunciation of Bb.	4. Select English Vocabulary Card - false matching.
5. Click vocabulary pronunciation of Bb again.	5. Shift the false- matching English Vocabulary Card.
6. Turn around English Vocabulary Magic Book horizontally.	6. Move the false - matching English Vocabulary Card up and down.

We utilize System Usability Scale (SUS) as our framework for evaluating the system usability. Participants are English teachers in elementary school and kindergartens and householders. We have interviews with these users on their ideas about AREVLS after they finish operating the system and filling out the SUS questionnaire [9-11]. Listed in Table 3 are the "SUS scores" of AREVLS. As summarized in Table 3, the mean SUS score is 77, the median is 85, the maximum is 93 and the minimum is 43. Since the Mean and the Median are 77 and 85, respectively, these scores indicate that the AREVLS system is usable. Besides, according to each item of SUS, the Mean of item four is apparently lower while its SD is larger than that of any other items (Table 4). Therefore, we find out that users need someone to help them or give some instructions before the use the system.

Table 3: SUS scores descriptive statistics

	N	Mean	Median	Min	Max	SD
Stat	24	77	85	43	93	15

Table 4: SUS questionnaire and scores descriptive statistics of each item

System Usability Scale Items	1	2	3	4	5	6	7	8	9	10
Mean	3.33	3.25	3.33	1.67	3.08	3.5	2.92	3.5	3.08	3.08
SD	0.74	0.99	0.97	1.42	0.8	0.65	0.9	0.77	0.97	0.89

Conclusion and Future Work

AREVLS designed in our research is composed of the English Vocabulary Magic Book and the English Vocabulary Card System. In this paper, we use Heuristic Evaluation and SUS to evaluate AREVLS. We find that the evaluation results show that AREVLS has positive usability and users enjoy the interaction with it. However, there still leaves something to be desired. Therefore, we will make further improvement based on the opinions collected from both experts and users. What's more, we will add interesting materials to the learning system, offer more diverse learning tools, and carry out more experiments of AREVLS on learners to see their English learning achievement.

References

[1] Paivio, A. (1986). Mental representations – a dual coding approach. Oxford University Press, Oxford, England.

[2] Paivio, A. (1971). Imagery and Verbal Processes, New York: Holt, Rinehart and Winston.

[3] Kirner, C. & Zorzal, E.R. (2005). Educational applications of augmented reality collaborative environments. *Proceedings of sixteenth Brazilian Symposium on Informatics in Education*, 114-124.

[4] Hsieh, M.C. & Lee, J.S. (2008). AR marker capacity increasing for kindergarten English learning. *International Multiconference of Engineerings and Computer Scientists*, 663-666.

[5] Kato, H., Billinghurst. M., Blanding. B., & May. R. (1999). ARToolKit. Technical Report (Hiroshima City University).

[6] ARToolKit. http://www.hitl.washington.edu/artoolkit/

[7] Nielsen, J., & Molich, R. (1990). Heuristic evaluation of user interfaces, *Proceedings ACM CHI'90 Conf.* (Seattle, WA, 1-5 April), 249-256.

[8] Nielsen, J. (1994). Heuristic evaluation. In Nielsen, J., and Mack, R.L. (Eds.), Usability Inspection Methods. John Wiley & Sons, New York, NY.

[9] Brooke, J. (1986). System Usability Scale (SUS): A Quick-and-Dirty Method of System Evaluation User Information. Digital Equipment Co Ltd, Reading, UK.

[10] Brooke, J. SUS – A quick and dirty usability scale. http://www.usability.serco.com/trump/documents/Suschapt.doc

[11] Tullis, T.S. & Stetson, J.N. (2004). A Comparison of Questionnaires for Assessing Website Usability. *Usability Professional Association Conference*.

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Designing a Negotiation Mechanism to Engage Students in Learning Mathematics

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Abstract: Motivation is an essential element for successful learning, the process of goal setting can be an important source of motivation. On the other hand, video games can also motivate students' learning motivation. Thus, this study designed a negotiation mechanism in a game-based learning environment to increase students' learning motivation. Game was used to initiate students' learning motivation and provide feedbacks. The negotiation mechanism was used to help students set learning goals to maintain their learning motivation. The results showed that the game environment engage students in the learning tasks and helped low-confidence students improve their self-efficacy.

Keywords: negotiation, goal setting, confidence, motivation, self-efficacy

1. Introduction

Mathematics is an important subject in elementary schools. However, it is also a subject that students tend to avoid facing it. For example, a survey indicated that mathematics is the most unpopular subject among students in grade one to grade nine in Taiwan; more and more students had low motivation to learn mathematics with the increase of their age [4]. A possible way to improve a student's motivation in a learning task is helping them set up a goal. Past studies [1][14] indicated that the process of setting a goal actively can be an important source of motivation. Furthermore, providing a feedback after achieving the goal of a task raises self-efficacy [15] and improves performance on a task [7]. On the other hand, video game is considered to be another element that stimulates students' learning motivation [8]. Thus, this study proposed a negotiation mechanism which aims at helping students set up learning goals when learning mathematics in a digital game-based environment.

2. Literature Review

Motivation is regarded as a necessary condition for successful learning [9][10]. From educational point of view, motivation drives a student to participate in a learning process and directs the student to successful learning. In other words, it attempts to reinforce students' engagement to a learning task [2]. Thus, there is a need to evoke and maintain a student's learning motivation to produce a successful learning experience. Goal setting is one of the ways to induce a student's learning motivation.

2.1 Goal setting Theory

A number of studies indicated that goal setting enhanced self-efficacy [13][17], which is one's belief of capabilities to mobilize the motivation [18]. In addition, a specific goal pushes an individual to concentrate on the ongoing task, guide the individual to make effort to goal related activities, and neglect irrelevant events [16]. When the goal is accomplished, it would provide an invisible feedback to appreciate the individual's ability and effort; therefore the confidence of the individual is strengthened. Furthermore, Locke [6] found that specific hard goals resulted in better performance than easy goals, do-your-best goals and no goals.

Goal setting can be summarized into three different types according to how the goal was decided: (1) self-selected goals, (2) assigned goals, and (3) participative goal setting. A self-selected goal means an individual can select a goal for herself/himself based on the individual's confidence, ability, and prior knowledge. An assigned goal refers to the goal was assigned by people who is in higher position or authority. The participative goal setting usually occurs in a workgroup which allow members to join the process of deciding goals [3]. The comparison of these goal setting approaches is summarized in Table 1.

Table 1. Comparison of three types of goal setting

	Self-selected goals	Assigned goals	Participative goal setting
Goal quantity	Many	Usually one	Several
Intrinsic Motivation	Very high	Depends on the property of tasks	High
Possible advantages	People choice a goal based on their own ability	A challenging task may encourage subordinates to prove their ability	Members in the same team make efforts to maximize the common benefit
Possible disadvantages	People may decide a non challenging goal	People may lack intrinsic motivation	An individual may need to compromise to the common goal

In an individual learning situation, teachers often directly assign goals to students, however, students may not accepted the goal willingly. If students are allowed to choose their own goal, low-confidence students may set a goal that is below their ability. For participative goal setting, it is more suitable to apply for teamwork. Therefore this study designed an alternative method—negotiation mechanism to help students set learning goals.

2.2 Game-based learning

Digital game is another source to evoke student's learning motivation. Previous research showed that game can also enhance students' motivation when they carrying out learning tasks [11][12]. For example, Klawe and her colleagues launched a project, "E-GEMS", in which they designed some computer games for students to learn math and science [5]. The results showed that those computer games increased students' learning motivation.

From the aforementioned studies, the motivational benefit of goal setting is the process that a student makes a commitment to a learning goal. This process encourages the student to keep making efforts to attain the goals. On the other hand, digital games can attract students' attention and initiate their learning motivation. Thus, this study applied a negotiation mechanism in a game-based learning environment to trigger and maintain students' learning motivation and maximize their learning performance.

3. Design

3.1 Negotiation mechanism for goal setting

The negotiation mechanism was derived from the aforementioned goal setting approaches. More specifically, it is more closed to the participative approach. The differences between negotiation mechanism and participative goal setting are listed in Table 2.

Table 2. Comparison between negotiation mechanism and participative goal setting

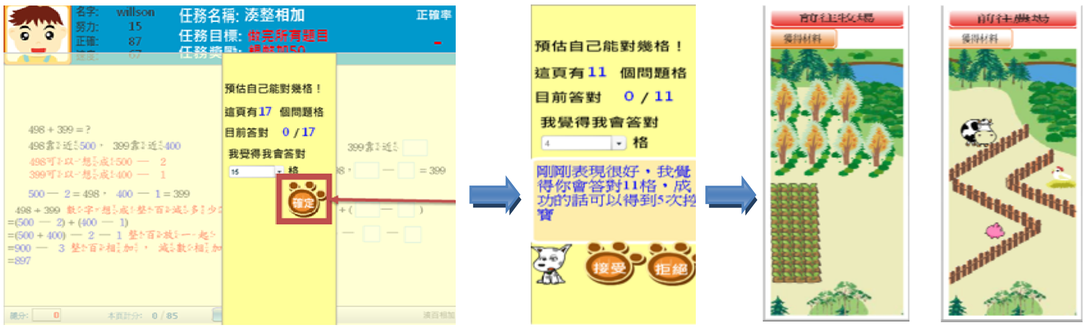
	Negotiation mechanism	Participative goal setting
Participants	Two	At least two, usually a team
Method	One to one (student vs. virtual character)	One to many or many to many
Who leads the discussion	The student	Authority or the team leader
Relationship of participants	The virtual character plays as a suggestion provider	Hierarchical relationship

Two principles were considered in the design of the negotiation mechanism: (1) a specific and hard goal pushes a student to produce better performance; (2) the goal must be achievable for the student. Thus the student can really make a commitment to the goal and make efforts to complete the task [16]. The process of the negotiation goal setting contains four steps:

- Step 1: Choose a goal. The system shows a list of goals with different levels of reward. The student then selects a goal based on the self-evaluation of her/his ability and confidence. Meanwhile, the system predicts the student's performance based on the student's portfolio.
- Step 2: Negotiation. The system starts to negotiate with the student. If the student's goal matches the system's prediction (i.e. a bit higher than the student's ability), the student enters the execution step to solve problems. If the student overestimates or underestimates her/his ability, the system starts to bargain with the student to get a common goal which satisfies both sides. The student can, of course, neglect the system's intervention.
- Step 3: Execution. After the goal is set, the student then starts to work for the goal.
- Step 4: Reward: Students get feedbacks and reward from the system.

3.2 System

The system used in this study contains a learning portal, which serves as a Learning Management System. Two modules, pet nurturing module and learning module are coupled by tasks and reward. In order to raise the pet, students have to complete some assigned missions (learning tasks). The negotiation mechanism directs students to set a goal. After completing the mission, the students enter farms to collect materials as rewards, the quantity and quality of materials is generated depends on what level of goal they achieved. The flow of a goal setting process in this study is illustrated in Figure 1.



Preview the content and select a goal — Negotiation — Get rewards

Figure 1. Process of a round of task

4. Pilot Study

Eight primary school students participated in the pilot study. Their ages were between 9-10 years old. There are nine sub-tasks in the whole learning session; students had to set a goal for each sub-task. The pilot study lasted for 40 minutes. Students' data log was analyzed to investigate: (1) whether this negotiation mechanism enhances students' self-efficacy; (2) whether there are some patterns of goal setting for students with different level of ability and confidence.

5. Result

Students' data showed that they tended to accept system's suggestions when the system suggested them to heighten their goals. On the contrary, students tend to reject system's suggestion when the system asked them to lower their goals. The students' goal setting data were classified into four categories according students' ability and self-confidence.

- High ability-low confidence
  Two students were identified as high ability-low confidence. Students in this category usually set the lowest level of goal in the beginning. After finding that the students were able to challenge higher goals, the system intervened in the goal-setting process in next round. Then the student and the system come to a common goal. After completing the goal successfully, the students started to set the highest goal in following rounds. However, if they did not achieve the goal, their confidence then dropped to the lowest level in next round. The system again negotiated with the students and helped them to raise their goal.
- High ability-high confidence
  This type of students always set the highest goal, Even they did not attain their preset goal.
- Low ability-low confidence
  This type of students tended to set lower goals. They always set goals less than the medium value. However, the negotiation mechanism helped them to set higher goals. And the confidence of the students seemed to be improved gradually in the following rounds.
- Low ability-high confidence
  No student was classified into this category in this study.

6. Discussion

From the result of this study, students were classified into four categories according to their ability and confidence. For high-ability-high-confidence students, it seems that they had high self-efficacy originally. For low confident students in this study, especially for low-ability-low-confidence students, the negotiation mechanism seemed to help them establish their self-confidence gradually and meanwhile improved their self-efficacy. Since this study is in its beginning stage, and there were only eight students participated the pilot study. The data may not enough to conclude general rules. Further studies are needed to investigate the relationship among student's ability, self-confidence, self-efficacy, and motivation. More different level of contents are also needed to identify the goal setting behaviors of high ability students, since the content used in this study was too easy for them.

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References

[1] Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

[2] Bomia, L., Beluzo, L., Demeester, D., Elander, K., Johnson, & M.,Sheldon, B. (1997). *The impact of teaching strategies on intrinsic motivation*. Champaign, IL: ERIC Clearinghouse on Elementary and Early Childhood Education. (ERIC Document Reproduction Service No. ED418925).

[3] Chin, W. R., & Chin, W. R. (2006). *The role of impression management in goal setting*. Unpublished Masters, University of Waterloo.

[4] Department of Statistics, Ministry of Education, Taiwan. (1988). *Report of "The proportion of disliked subjects of students in Grade 1 to Grade 9"*, Taiwan: Ministry of Education.

[5] Klawe, M. (1998). When does the use of computer games and other interactive multimedia software help students learn mathematics? *Proceedings of NCTM Standards 2000 Technology Conference*. Arlington, VA.

[6] Locke, E. A. (1968). Toward a theory of task motivation and incentives. *Organizational Behavior and Human Performance. 3*(2), 157-189.

[7] Neubert, M. J. (1998). The value of feedback and goal setting over goal setting alone potential moderator of this effect: A meta-analysis. *Human Performance, 11*(4), 321-335.

[8] Nussbaum, M. (2007). *Games, Learning, Collaboration and Cognitive Divide*. OECD. Retrieved May, 20, 2010 from http://www.oecd.org/dataoecd/43/39/39414787.pdf

[9] Paras, B., & Bizzocchi, J. (2005). Game, motivation, and effective learning: An integrated model for educational game design. In *Proceedings of Digital Games Research Association Conference (DiGRA2005)*, Canada.

[10] Prensky, M. (2003). Digital game-based learning. *Computers in Entertainment, 1*(1), 1-4.

[11] Randel, J. M., Morris, B. A., Wetzel, C. D., & Whitehill, B. V. (1992). The effectiveness of games for educational purposes: A review of the research. *Simulation and Gaming, 25*, 261-276.

[12] Rosas, R., Nussbaum, M., Cumsille, P., Marianov, V., Correa, M., et al. (2003). Beyond Nintendo: design and assessment of educational video games for first and second grade students. *Computers & Education, 40*(1) 71-94.

[13] Schunk, D. H. (1985). Participation in goal setting: effects on self-efficacy and skills of learning-disable children. *The Journal of Special Education, 19*(3), 307-317.

[14] Schunk, D. H. (1989). Self-efficacy and achievement behaviors. Educational *Psychology Review, 1*, 173-208.

[15] Schunk, D. H. & Swartz, C. W. (1993). Goals and progress feedback: Effects on self-efficacy and writing achievement. *Contemporary Educational Psychology, 18*, 337-354.

[16] Small, R.V. (1997). *Motivation in instructional design. Syracuse, NY: ERIC Clearinghouse on Information and Technology*. (ERIC Document Reproduction Service No. ED409895).

[17] Stock, J., & Cervone, D. (1990). Proximal goal-setting and self-regulatory processes. *Cognitive Therapy and Research, 14*, 483-498.

[18] Wood, R. E., & Bandura, A. (1989). Impact of conceptions of ability on self-regulatory mechanisms and complex decision making. *Journal of Personality and Social Psychology, 56*, 407-415.

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A Preliminary Study on the Use of Second Life for Career Counseling

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Abstract: The present study intends to explore the potential of Second Life as compared to traditional face-to-face and internet counseling practices for university counseling. Different spaces and avatars have been constructed in Second Life to support university students' exploration of their career choices in a virtual environment. The perceptions of 45 university students with regards to their preference and perceived potential of different counseling channels as well as factors affecting their choice were collected. As evidenced in the study though Second Life is least preferred by the respondents when seeking counseling, its potential is well received. Suggestions for future developments are provided.

Keywords: career counseling, internet counseling, Second Life, virtual reality

1. Introduction

To supplement traditional face-to-face counseling, internet counseling has been present since 90s. With the fast advancements in computer and network technologies, forms of internet counseling and helping services become more versatile in recent years. Current common forms for Internet counseling are e-mail, electronic bulletin boards, instant messaging and Internet chat rooms and so on [1, 2]. With its distinct features like convenience, anonymity and instantaneity, Internet counseling is growing popularity [2]. However, non-verbal messages and cues (e.g. clients' movements, facial features, appearances, etc.), which are considered crucial, cannot be transpired or detected in cyber counseling contexts. In light of the potential of immersive technology for enriching sensory experience during interaction, the present study explored the potential of Second Life. Specifically, participants' preference and perceived potential of different counseling channels (namely, traditional face-to-face, internet counseling and counseling in Second Life) was explored. In addition, factors influencing participants' choices in counseling venues were investigated.

2. Career Counseling Spaces Built in Second Life

Several spaces, each with a specific designated purpose, were created in Second Life (28,141,79) to support counseling practices: lobby, questionnaire room, dressing room, resources room and counseling room. The lobby is check-in space and reserved for social interaction among participants (Figure 1). The questionnaire room, housing a battery of vocational interest inventory and personal resume, enables participants to take any online career interest assessments for future analysis and reference (Figure 2). The dressing room allows participants to change their appearances (e.g., clothing, accessories, hair style, etc.) by being transported to other spaces in Second Life. The resources room, by showing a video clip of a typical day of different vocations, is designed to familiarize students with the normal life associated with the job of interest. Five counseling rooms, each with a distinct style (i.e., standard counseling room, western tarot emphasis, oriental fortune-telling style, Buddhist style, Christianity emphasis) are built in consideration of people's tendency to resort to religious or mysteries power when in distress or puzzlement (Figure 3). Finally, to allow the clients to choose who to interact with (i.e., the helper in the case), six counselors with different gender and styles (i.e., female and male with a professional look, traditional Chinese look, and causal look) were created (Fig. 4).



Fig. 1 Lobby Fig. 2 Questionnaire room Fig. 3 Counseling rooms

Fig. 4 Counselors with different gender and styles

3. Method

45 psychology major university students were recruited for participation in the study. A 10-minutes slideshow depicting the current practices of traditional face-to-face and internet counseling was briefly reviewed before the newly constructed counseling environment was introduced. A questionnaire was disseminated for individual completion to collect data on participants' preference and perceived potential toward three different counseling channels and factors influencing their choice when seeking counseling.

4. Results, Discussion & Conclusions

Data from the question on students' most preferred counseling venue showed that almost all (93.33%) preferred most the traditional face-to-face over the other two possibilities for their counseling needs. However, when it comes to perceived potential, traditional face-to-face and Second Life were chosen by most respondents (37.78%) (See Table 1). After converting the score of all participants (most preferred and potential as 3, second preferred and potential as 2 and least preferred and potential as 1), Second Life had the highest averaged score on the potential index (2.04) and lowest averaged score on the preference index.

Table 1 Preference and perceived potential of different counseling venues

	Traditional F2F	Internet counseling	Counseling in SL
Most preferred	42 (93.33%)	2 (4.44%)	1 (2.22%)
Second preferred	1 (2.22%)	23 (51.11%)	18 (40%)
Least preferred	1 (2.22%)	18 (40%)	23 (51.11%)
Averaged mean	2.93	1.63	1.48
Most potential	17 (37.78%)	11 (24.45%)	17 (37.78%)
Second potential	10 (22.22%)	22 (48.89%)	13 (28.89%)
Least potential	18 (40%)	12 (26.67%)	15 (33.33%)
Averaged mean	1.98	1.98	2.04

Students responses to the question—"important factors to consider when choosing counseling channels: (a) anonymity, (b) convenience in terms of time and space, (c) seclusiveness of counseling site, (d) diversity and freedom to choose counseling sites, (e) interactivity (both verbal and non-verbal messages detectability, such as facial expression, physical movement, tone of voice, appearance, etc.), (f) freedom to choose the helper, (g) appearance personalization (such as gender, hair style, wardrobe) and (h) others (choose all that apply)," indicated that anonymity, convenience, seclusiveness of counseling site and interactivity were viewed as important by more than half of all respondents.

Table 2 Factors influencing counseling sites choice

	N	%	Rank
Anonymity	31	68.89	3
Convenience	31	68.89	3
Seclusiveness of counseling site	38	84.44	2
Diversity of counseling sites	11	24.44	6
Interactivity	39	86.67	1
Freedom to choose the helper	20	44.44	5
Appearance personalization	3	6.67	7
Others	0	0	

Several important results were obtained. First, though Second Life is least preferred by the respondents, its potential is well received, as evidenced in the study. Second, despite the fact that comparatively fewer respondents regarded variety and freedom of choice with regards to helpers and counseling sites as importance factors (as compared to anonymity, convenience, seclusiveness and interactivity), still nearly one fourth (24.44%) and more than 40% (44.44%) of the respondents viewed them as important factors for counseling. In light of the present study and the affordances of Second Life, its potential for university counseling should be explored more.

References

[1] Lei, Y. M. (1998). Issues on real-time individual counseling in cyberspace. *Student Guidance*, 56, 100 -109.

[2] Wang, C. H., Lin, C. W., Liu, S. H., Yang, C. F., & Ling, X. Y. (2008). A survey research study on the development of Cyber Counseling services in Taiwan. *Bulletin of Educational Psychology, 39*(3), 395-412.

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Using Handheld Gaming Device to Increase Multiple Intelligences with Digital Puzzle Game

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Abstract: Today, video game has become an indispensable entertainment to children, and the theory of Multiple Intelligences is popular in Education, too. But so far, there are no researchers focused their studies on relation between video game and Multiple Intelligences in education. In this study, the researcher explored that students' change after utilizing video game into the curriculum of Multiple Intelligences. According to the theory of authentic assessment, there were four fifth grade students participated in this study, the researcher tried to investigate the effect of Multiple Intelligences when students played video game. The researcher used hand-held device: Nintendo Dual Screen and puzzle game software: Big Brain Academy for this experiment, and adopted observation and interview for data collection to understand students' change of Multiple Intelligences. The researcher discovered that he could assess students' spatial intelligence and logical-mathematical intelligence during the game. At the same time, students also enhanced their spatial intelligence, logical mathematical intelligence, interpersonal intelligence and bodily-kinesthetic intelligence.

Keywords: Multiple Intelligences, handheld game, Game-Based Learning

Introduction

Prensky states that the 21st century is the generation of Digital Game-Based Learning [1]. Prensky names the new generation born after year 1975 and growing up with technologies as Generation G, who has contributed to the prevalence of digital simulation games. An increase in the average intelligence quotient (IQ) test scores over generations [2][3]. Furthermore, past educators emphasized that games are beneficial to students' learning and should be integrated into the teaching objectives. In combination of game-like teaching, learning in the classroom can be less dull. And Professor Gardner at Harvard University states in his Theory of Multiple Intelligence that human can have various types of intelligence. He argues that the concept of traditional intelligence test is narrowly defined, so a macroscopic view is proposed, encompassing the interpersonal ability and special abilities in the range of intelligence. The essence of mobile learning is to add mobile elements into digital learning. Learners can reach the goal of learning anytime, anywhere and all around through mobile devices. With the above-mentioned views in mind, this research, based on the conception of Authentic Tests from multiple intelligences, used qualitative research methods of observing and interviewing, to find out the changes and learning effects in students' multiple intelligences through portable puzzle games. The following are the key questions for this study:

- Do students appear to have improved multiple intelligences in problem solving when playing handheld puzzle games?
- Can the development level of students' multiple intelligences in problem solving be assessed when students are playing handheld puzzle games?

1. Literature Review

Gardner defines intelligence as "an ability to solve problems in real life, an ability to produce new problems, and a person's ability to create a product or offer a service that is valued in the culture he or she is in." That is, he thinks that human intelligence must include problem solving skills, allowing individuals to solve the problems or difficulties they encounter and creating fruitful results at appropriate timing [5]. And the potential to seek or create problems also has to be included to be part of human intelligence, as the basics for humans to gain new knowledge. In other words, the intelligence defined by Gardner is an ability to solve problems or fashion a product, and it has to be valued by one or more cultural settings.

2. The study

Osborne indicated that multiple intelligences measurement tool is not easy to establish. Multiple intelligences place a great emphasis on the so-called authentic tests. The best way to assess students' multiple intelligences is to put students in the real situations and take the students' performance during problem solving and final results as references for evaluation [8]. This study used NDS as research tool and chose puzzle games as its main content, using the following criteria for game analysis.

I. Children-appropriate software rating.
II. No difficult operation skills required.
III. Low demand on language ability.
IV. No apparent educational aim.

Based on the criteria above, this study decided to use "Big Brain Academy".

2.1 Sample

Because the language the software used is all English, 5th and 6th graders were targeted to be the subjects of this study. As 6th graders would graduate in June, we conducted this study with the 5th graders, so that when analyzing data, re-observation can be done in the field.

2.2 Design

The observation time of this research was the lunch break during school days in an elementary school (approximately 40 minutes). During the lunch break, 4 students were gathered to play group games. After school or on holidays, students took NDS game consoles home with them for practice, in order to improve students' scores in playing games through intensive practices and to increase the game's influence on students. During class hours, NDS were returned to the researchers to record game scores, and interviews were conducted if needed.

3. Results

The researchers then took on the formal testing. The testing dates were between May 18th and June 4th, 2009, totaling 19 days. The following is the analyses of students' performance based on observation and interviews, taking into consideration the spatial, logical-mathematical, linguistic, bodily-kinesthetic and interpersonal intelligences among the multiple intelligences.

4. Conclusion

With the belief of multiple intelligences, all the activities students participate in should carry the objective of cultivating multiple intelligences. And the courses and results of activities they participate in can all be assessed for multiple intelligences. Based on this belief, this study invited students to play video games, hoping that they could grow happily in play and pleasure while being stimulated for multiple intelligences, improving students' performances in schoolwork.

For the assessment of multiple intelligences, it is uppermost to put the students in a real situation, in which the skills developed can be assessed for multiple intelligences. In this study, we put the students in the setting of video games, and assessed the students' tendency in multiple intelligences and explored the development of students' multiple intelligences through the process of students playing games. Due to the limitation of the used software, not all the various intelligences could be detected in this study, and the observed items were limited to the spatial, logical-mathematical, linguistic, interpersonal and bodily-kinesthetic intelligences only. These intelligences were observed to have positive growth, while the levels of development were not identical.

Playing video games stimulates the cultivation of multiple intelligences, affecting the students' performances in schoolwork, as shown in the regular class. This study found that after the subjects had played video games, they showed significant progress in the math tests, especially the students originally with lower achievements. As for students originally with better grades, since they had had good performances, it was a great challenge to draw more improvements. Therefore, though their progress was marked, the degree of progress was limited.

References

[1] Boot, W. R., Kramer, A. F., Simons, D. J., Fabiani, M. & Gratton, G. (2008). *The effects of video game playing on attention, memory, and executive control*. Acta Psychologica.
[2] Flynn, J. R. (1987). *Massive IQ gains 14 nations: What IQ tests really measure*. Psychological Bulletin.
[3] Flynn, J. R. & Widaman, K. F. (2008). *The flynn effect and the shadow of the past: Mental retardation and the indefensible and indispensable role of IQ*. International Review of Research in Mental Retardation.
[4] Funk, J. B., & Buchman, D. D. (1996). Playing violent video and computer games and adolescent self-concept. *Journal of Communication, 46*(2), 19-32.
[5] Gardner, H. (1993). *Frames of mind : the theory of multiple intelligences*. NY: Basic Books.
[6] Gardner, H. (1999). *Intelligence reframed: multiple intelligences for the 21th century*. NY: Basic Books.
[7] Gardner, H. (2004). Audiences for the theory of multiple intelligences. *Teacher College Record, 106*(1)., 212-219.
[8] Padgett, D. K. (1998). *Qualitative Methods in Social Work Research: Challenges and Rewards*. Thousand Oaks, CA: Sage.
[9] Prensky, M. (2001). *The digital game-based learning revolution*: McGraw-Hill.

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A Practice and Evaluation of Game-based Learning Environment for Linear Equation

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Abstract: The purpose of this study is to design and develop a game-based learning environment (GBLE) that incorporates an educational control method to generates and enhance interaction among learners intentionally. In this paper, we explain a GBLE "Who becomes the king in the country of mathematics?", in which we incorporated "learner support agent" to support each learner and "game control agent" to control the game.

Keywords: Game-based learning environment (GBLE), Interaction among students, motivation, Pedagogical agents, Junior high school

Introduction

Many studies and systems to use "pleasure" and "fun" to be inherent in the game for improvement of the learner's motivation have been developed in the field of the learning environment [1, 3, 5]. However, when plural learners gather in one computer and learn by game-based learning environment (GBLE), there are still few studies, in which a computer designs the learning process by controlling the interaction (competition, collaboration and learning by teaching etc.) between learners and the observation (observational learning etc.) of other learners [2]. Therefore, the purpose of this study is to propose a method (interaction control between learners) to generate interaction between learners intentionally to create an opportunity of the learning depending on the situation of the knowledge understanding model of the individual learner. To achieve this purpose, we set up three sub-goals. Firstly, we try to propose the design of a GBLE that incorporates some viewpoints for the fun of the game. Secondly, we try to propose an educational control mechanism that creates a learning opportunity for learners in GBLE. Furthermore, we implement this learning environment with an agent system.

In this paper, we describe a GBLE "Who becomes the king in the country of mathematics?”. And then, we explain the framework of educational control in this GBLE.

1. Outline of "Who becomes the king in the country of mathematics?” game

Users of games have classified this "fun" of a game differently. Koster has stated four propositions with regard to the fun of games [4]. Based on these propositions, we classified fun in an education game into the following four types (**Fun when a player achieves a goal**, **Fun when a player has an unpredictable experience**, **Elation when a player faces a challenging problem**, **Satisfaction when a player receives an honor**). It is effective for the maintenance and the improvement of a learner's motivation to develop the support that

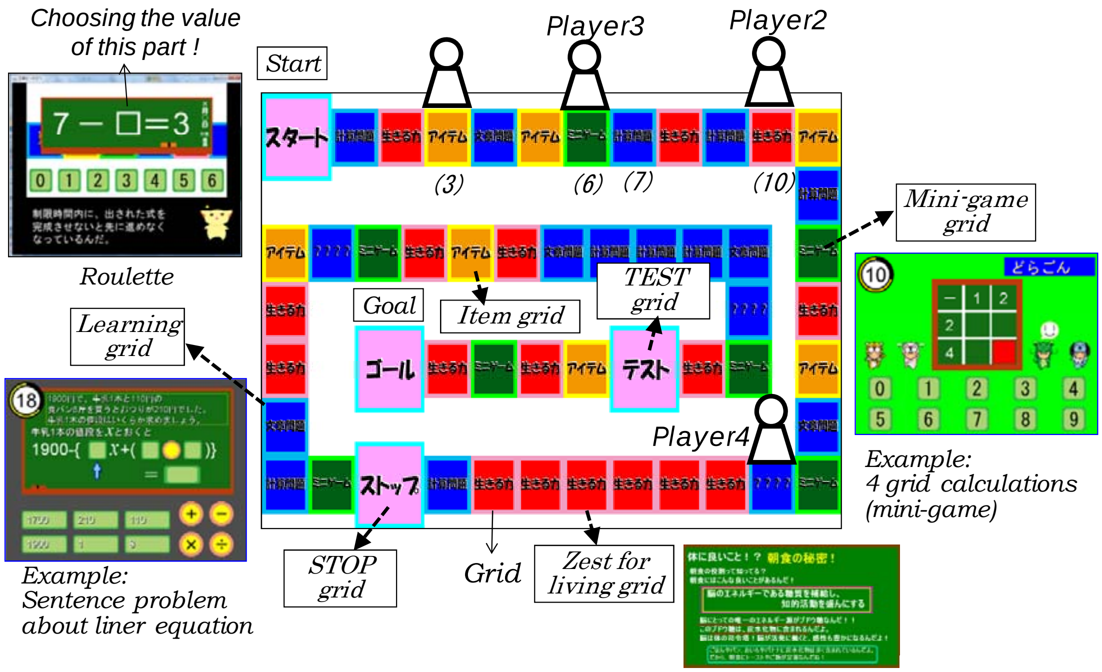

Figure 1. Image of game-based learning environment for linear equation

fun brings to the game in GBLE. Therefore, we set three design indicators in consideration of the four types;

I. Setting a time limit and the number of problems.

II. Preventing a player from getting tired by having to prepare too much for a questions form for a problem.

III. Setting a bonus point and various posts according to order.

We made a learning design in the GBLE based on the three indicators explained above. This game is a board game with roulette in which there are four players (see Figure 1). The winner can become the next king of the mathematics kingdom.

From the roulette, the player receives a number to determine his forward movement. He then replies with an unknown value in solving a calculating formula in the roulette. If the player solves the problem correctly, he can advance only the number of the answer. Next, the player carries out an event, such as the game or learning, on the grid on which he stopped. The player can increase the mark of a parameter (the learning power and the power of zest for living) of the organism which the player operates by clearing the event.

The player who has the highest general marks ([learning power] x [power of zest for living] + [bonus point]) becomes the winner when all players have reached the goal grid. At the end of the game, the first place player becomes the king of the mathematics kingdom. The second, third, and fourth place players are given a post depending on their general marks and the marks of two parameters for each player.

As different kinds of grids in this GBLE, there are a "Learning grid," a "Zest for living grid," an "Item grid," a "Mini-game grid," and a "Special gird" (see Figure 1). The "Learning grid" has to do with solving a problem about the linear equation for the subject domain. We prepared five learning items about the linear equation in this environment. A calculation problem or sentence problem is set to each grid. When a player stops on a learning grid, a learning form depending on his learning situation is set to the grid. The "Zest for living grid" concerns solving a problem about intellectual, physical and moral competency. When a player stops on a "Zest for living grid," a story about a problem that is chosen depending on the experience situation of the player's learning forms occurs, and the problem is shown (for example, a problem about a moral or dietary education). The player must solve the problem by a method which computer points out. The "Item grid" is given by an item card which allows the player to advance only according to a number written on the card. The player can use the item card after his next turn. The "Mini-game grid" is about learning ability or the zest competency for living. The player carries the game such as "4 grid calculations" or "let's go out with me" either alone or while he competes or collaborates with other players. On the "Special grid" the player must stop forcibly. There are a "STOP grid" and a "TEST grid" as special grids in the developed game environment. On the STOP grid, the player plays rock-paper-scissors with the computer. If he loses, then he must play rock-paper-scissors again on his next turn. In addition, when the player wins, a bonus point is given at random. On the TEST grid, the player must answer all the questions for each learning item correctly. If he makes a mistake, then he must return to a certain grid.

2. Method for educational control in the GBLE

The learning control in this GBLE is performed by two kinds of agents (a "learner support agent" and a "game control agent"). The learning support agent diagnoses the state of understanding of the learner for which the agent takes care and has the role of determining an effective learning task based on his diagnosis. This agent recognizes the state of understanding of the learner for each learning item.

The learner support agent demands the learning item from the game control agent after determining the learning item of the learner. The game control agent receives information about the player’s state of understanding and requests the next learning item from each learning support agent; he determines the learning item for the learner for his next turn and carries out the turn. When the learner needs learning control, the agent decides on a calculating formula and the answer by controlling the roulette. The agent has three learning forms; personal learning in which the learner himself solves a learning problem, collaborative learning in which the learner competes or collaborates with other learners, and observation learning in which the learner learns from other learners’ problem solutions. The agent chooses a learning form based on the state of the learner’s understanding for his next turn and for other learners.

3. Conclusion

In this paper, we described the design ideas of the GBLE that incorporated four viewpoints of the fun in the game and the outline of our game. Moreover, we explain the framework of this GBLE. In future, we would like to develop collaborative support protocols among pedagogical agents to support collaborative group learning as our final aim of this study.

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References

[1] Bourgonion, J., Valcke, M., Soetaert, R & Schellens, T. (2009). Exploring the Acceptance of Video Games in the Classroom by Secondary School Students, *Procceindgs of ICCE2009*(pp.651-658).

[2] Burton, R. & Brown, J.S. (1979). An Investigation of Computer Coaching for Informal Learning Activities, *Int. Jour. of Man-Machine studies*, 11, 5-24.

[3] Fong-Lok, L. & Jimmy, H.M. (2006). WorkShop: Pedagogical Design and Educational Games, *Proceedings of ICCE2006* .

[4] Koster, R. (2005). A Theory of Fun for Game Design, Scottsdale, Arizona: Paraglyph Press.

[5] Ogan, A., Aleven, V., Kim, J. & Jones, C. (2010). Instructional Negotiation with Virtual Humans: The Effect of Social Goals on Gameplay and Learning, *Procceindgs of ITS2010* (pp.174-183).

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Students' Competitive Preferences on Multiple Mice Classroom Interactive Environment

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Abstract: In this study, a competitive multiple mice classroom learning environment is designed to afford the students' classroom information technology accessibility and to provide a social interaction platform for the teachers and students. One hundred and one 8th grade students from three classes participated in the pilot study with the English vocabulary memorizing subject. All the students interacted with their peers on the large shared display moving their mouse simultaneously. Two competitive modes, individual task competition and group rush competition, were implemented. The results indicate the system usability is acceptable and the classroom atmosphere changed dramatically through competition.

Keywords: Multiple mice game, classroom face-to-face learning activity

Introduction

Information technology is widely used in classroom [1]. Integrating social activities into learning environment is an important issue in designing technology enhanced learning system [2]. Traditionally, the classroom is equipped with computer, keyboard, and mouse. However, kids have their unique requirements in using digital learning devices in classroom [3]. Some novel tools are needed to meet the need. So human-computer interaction researchers have been trying and much supporting for the development of multiple mice design of which a computer can equipped with many mice [4]. In this study, a multi-mouse supported classroom is established in which a computer is equipped with more than ten mice and the students can interact with their peers on the large shared display simultaneously. We urge that letting students use the multiple mice interaction system with peers can break the isolated learning scenario, attract students' attention, encourage group work, and improve students' interaction [5]. Moreover, to facilitate students in performing the multiple mice social interaction environment, two competitive activities, individual task competition and group rush competition, were implemented. A pilot study was applied and reported.

1. MMC: Multiple Mice Classroom System

MMC is a system that allows the teachers to use a computer with several mice (more than ten mice). Each student can have at least one mouse which can provide the student with the minimal information technology accessibility. Two competition modes have been implemented to facilitate the students' interactions. Two major functions, individual task competition and group rush competition, of the MMC are elaborated below:

- Individual Task Competition Mode
  In the individual competition mode, each student assigned to a personal zone does the exercise proposed by the computer individually (shown as Figure 1-a).

- Group Rush Competition Mode
  All the students answer the same question proposed by the computer (shown as Figure 1-b). There are several options in this mode such as the competing for the one which is the most competitive, the eight competing for two, the one-second competition which is the less competitive.

(a) (b)

Figure 1: Individual Task Competition and Group Rush Competition Modes

2. Preliminary Evaluation

One hundred and one 8th grade students participated in the pilot study. Sixty-five are female, and thirty-six are male. One of them was refuse to participate in this activity, and the other two were absent from the class. Two modes, individual task competition and group rush competition, were proceeded to examine students' competitive preferences.

2.1 Questionnaire Study

A five-point Likert item questionnaire was applied. Eleven of the copies were extreme data and excluded. Six failed to record. Eighty-four copies are analyzed as below (shown as Table 1). Each item of the questionnaire was transformed into numbers. Strongly agree was coded as 5 and strongly disagree was coded as 1.
According to the statistics, 3.36 students expressed that they like the English course, but 3.22 students said that they would like to spend time on memorizing vocabularies (shown as Item 1 & 2). The willingness of learning is not high. With MMC, the motivation of learning vocabularies was promoted to 3.68 and 3.79 students had fun in having MMC learning activity (Item 3 & 4). Dramatically, 69.0% of the students showed their willingness to learn better if they have more time (Item 5). Furthermore, more than half of the students like the feeling of competition (Item 6) though there are some different preferences. From Item 8 to 10, we learn that 47.6%students felt more relax in the mode of one-second competition. However, 41.6% students were also interested in competing for the one. Only one-third of students wanted to play the mode of eight competing for two again.

Table 1: Statistics of the Students' Preference on MMC

Item	Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagree (%)	Ave.	SD
1. I like learning English.	17.9	26.2	36.9	9.5	8.3	3.36	1.14
2. I am willing to spend time memorizing vocabularies.	13.1	28.6	33.3	13.1	11.9	3.18	1.18
3. I like to learn vocabularies with my classmates by MMC.	27.4	28.6	33.3	6	4.8	3.68	1.09
4. It is interesting that many people use multiple mice together.	27.4	36.9	27.4	3.6	4.8	3.79	1.04

5. I hope more people can use MMC to have activities together.	33.3	22.6	34.5	4.8	4.8	3.8	1.12
6. If I have enough time, I think I can do much better.	22.6	46.4	19	4.8	6	3.76	1.05
7. I like the feeling of competition.	29.8	22.6	31	9.5	4.8	3.65	1.16
8. I feel more relax in the mode of one-second competition.	19	28.6	39.3	10.7	2.4	3.51	1
9. Eight competing for two makes me want to play again.	15.5	17.9	47.6	13.1	6	3.24	1.06
10. Competing for the one is the most interesting and exciting.	21.4	20.2	40.5	8.3	9.5	3.36	1.2

2.2 Learning Achievement Study

To study the learning achievement of the students, a pretest and posttest of the thirty English vocabularies including thirty adjectives were applied. The numbers represents how many correct answers the students made. Only Class B's achievement is significant, but three class members all learned from the activity according to the average of the posttest. Without teaching, the students can learn with peers in MMC environment, too.

Table 2: Students' Vocabularies Learning Achievement in Pretest and Posttest Scores

	Pretest		**Posttest**		
	M	SD	M	SD	Sig.
Class A	16.0	7.89	17.7	9.64	.14
Class B	19.2	7.96	21.3	8.80	.00
Class C	18.7	7.20	19.0	7.30	.67

3. Discussion and Conclusion

This study reports a multiple mice classroom (MMC) system in which a computer can connect with more than ten mice. All the students can interact with their peers on the large shared display with their own mice simultaneously. We will argue that can break the isolated individual learning and attract the students' attention, encourage the group works, and improve the classroom atmosphere. A pilot study has been applied to study the usability and sociability of the system. The result indicates that the students like to learn with peers with MMC in spite of different competitive preferences. Maybe what the students like is not what they really want. Concerning about the learning achievement, the significance may be promoted with better instructional design and technology support. More detailed study is needed in the future.

References

[1] Roschelle, J., Penuel, B., & Abrahamson, L. (2004). The networked classroom, *Educational Leadership*, *61*, 50-54.

[2] Chang, L. J., Yang, J. C., Yu F. Y., & Chan, T. W. (2003). Development and evaluation of multiple competitive activities in a synchronous quiz game system, *Journal of Innovations in Education and Training International*, *40*(1), 2003, 16-26.

[3] Plowman, L., & Stephen, C. (2003). A 'benign addition'? Research on ICT and pre-school children. *Journal of Computer Assisted Learning , 19*, pp. 149-164.

[4] Moraveji, N., Kim, T., Pawar, U. (2007). A mouse on each desk: An inexpensive classroom interaction technique for remote teaching, Microsoft Research Technical Report, Redmond, WA.

[5] Chang, B., and Lin, Y. S. (2009). Enhancement of mobile learning using wireless sensor network, *IEEE Learning Technology Newsletter*, *11*(1, 2), 22-25.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education

Creative Writing: A Study Investigating Factors Influencing Creativity in Writing and their Outcomes

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Abstract: Storytelling is a time-honoured tradition that is essential in connecting mankind together and communicating essential lessons via the story medium. In this study, we identify two elements – identity and interactivity – that inspire good storytelling and attempt to integrate them within a creative writing assignment study conducted with a group of 10-year old students. This article details how using these two elements can potentially increase the quality of creativity and language proficiency in creative writing assignments as well as increase the fun in writing a story.

Keywords: storytelling, creative writing, creativity, identity, interactivity, interactive storytelling

1. Introduction

Stories have a great impact on society. Roche [1] commented that narratives define humans, characterizing human actions as the basis of narrative history. Individuals relate to stories through their personal experiences and are able to connect with each other through shared experiences – reaffirming and sharing their identities. A key feature in engaging attention and entertaining viewers, Bolter and Joyce [2] pointed out that interactive fiction only requires two elements, i.e., episodes (which establish the story background and environment) and decision points (which link episodes together with a procedure on which link to follow). Consequently, we will focus on these two elements in the development of creative writing.

2. Study Methods

Our objective is to increase the quality of the written assignment itself by making it more creative. We hope to achieve this by investigating if:

- the element of identity could motivate students to immerse themselves in the character and story development.
- the element of interactivity would be able to motivate students to improve their creative writing by making storytelling fun.

Our study was conducted among over fifty Year 4 students from a school in Malaysia. First, the students were asked to colour and fill out the outline of a superhero. They were instructed to name their superheroes, add facial features, clothing details and colors, and write up a brief profile on their new superhero. This activity was designed to represent the element of identity by immersing them in creating their own superheroes.

The next activity was a story reading session from a ‘choose-your-own-adventure’ storybook. The book allowed readers to ‘decide’ the next course of action and followed up on the decision with the corresponding page. The story contained multiple endings, based on the readers' 'decisions'. The interactivity element encouraged readers to choose their endings and further immerse themselves within the story.

Finally, students were instructed to use the general plot of the story along with their newly-created superheroes as the basis of their writing test. However they were given the freedom to decide the story's pacing and outcome to encourage creativity in their writing assignments. Students were encouraged to feature their characters unique traits and powers in their stories, in hopes to encourage creative and fresh story development ideas. The assignments were then graded by their teacher.

4. Results

The students' English teacher graded them on creativity, story development, clarity of ideas, and language skills. We used a paired sample *t*-test to analyse and compare the scores of the students before the treatment and after the treatment. We found no significant differences between the students' scores before and after the treatment (see Table 1). However, the mean scores displayed an increase in students' test scores after the treatment - a positive sign of the treatment's effectiveness.

Table 1 (Post-test - Pre-test assignment scores)

	Pre-test Results	Post-test Results
Mean	65.56	69.22
Standard Deviation	11.99	9.47d
t – test	1.8576	
p – value	0.0728 > 0.05	

Students were divided into two groups, Better Academic Achievement Group (BAAG) and Poorer Academic Achievement Group (PAAG), according to their pre-test academic achievement results. When comparing the pre-test scores of both groups, the results are extremely significant (see Table 2). Upon comparing the post-test scores of both groups, the results are comparatively less though still significant. While BAAG displayed little change in test scores after treatment, PAAG displayed a very significant difference in post-test scores.

Table 2 - Post-test Scores - Pre-test Scores between Academic Achievement Groups

	Pre-test Mean (SD)	Post-test Mean (SD)	*t* - test
Better Academic Achievement Group (*N* = 12)	76.92 (5.838)	73.5 (8.028)	1.352
Poor Academic Achievement Group (*N* = 20)	58.75 (9.187)	66.60 (9.417)	-3.414
t – test	6.1274	2.0444	

5. Discussions

5.1 Investigating if the Identity element encourages immersive story development

While not all the students were explicit in developing their stories around their created superheroes, we believe that encouraging the students to create a superhero profile was able to motivate them to develop better stories. By establishing their characters appearances and capabilities, the students adapted their characters to fit and flow into a given story situation. By investing themselves emotionally into a new identity, they were naturally more compelled to care about their characters' involvement in the story environment and the outcomes of the given situation [3]. As a result of introducing the element of identity into their writing, the students naturally progressed into deeper interactivity with the story.

5.2 Investigating if the interactivity element could improve creative writing by encouraging students to enjoy the storytelling process

Overall, students were excited while they were designing their superhero avatars and reading through the story booklet. When they were told that their decisions affected the story's outcome, it was a novel experience for them. From the data analysis in Table 2 above, we discovered that students of poorer academic achievements were able to score significantly better after going through the interactive treatment. These findings agree with Palaniappan's [4] research, which postulated that creativity might help compensate the lack of intelligence to enhance academic achievement levels. By allowing them the freedom to recreate the story in their own words and on their own terms, students were not confined by academic or society standards and were able to writer better and more creatively.

6. Conclusions and Future Research

The activity of writing stories produced significant results in inspiring and motivating the students to write creatively. While the literacy skills of the students did not improve noticeably, the implications of using storytelling elements in creative writing is worth looking into.

The teacher aiding us also suggested that students should be encouraged to outline their ideas. She suggested that student creativity and language skills would be greatly improved if they were encouraged to organize their ideas before writing their stories.

We intend to create a game prototype that will use the elements of identity and interactivity to encourage creative writing among students. We will design separate modules to teach the importance of settings descriptions, character development, and story outline. Based on the modules, students will then write new stories.

7. References

[1] Roche, L. S. (2003). The Power of Stories (I): A Discussion of Why Stories are Powerful. *International Journal of Information Technology and Management, Vol. 2, No. 4* , 377-388.

[2] Bolter, J., & Joyce, M. (1987). Hypertext and Creative Writing. *Proceedings of the ACM Conference on Hypertext*, pp. 41-50.

[3] Gee, J. (2007). *Good Video Games and Good Learning: Collected Essasys on Video Games, Learning, and Literacy.* New York: Peter Lang Publishing Inc.

[4] Palaniappan, A. (2007). Academic Achievement of Groups formed based on Creativity and Intelligence. *Proceedings of the 13th International Conference on Thinking Norrkoping,* (pp. 145-151). Sweden.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Integrating Technology in the Classroom: Favourable Conditions for Teachers' Upward Developmental Trajectories

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Abstract: In this paper, we study developmental trajectories of three teachers as they integrate GroupScribbles (GS) technology in their classroom lessons over the period of about one academic semester. Coherency diagrams are used to capture the complex interplay of a teacher's knowledge (K), goals (G) and beliefs (B) in leveraging technology effectively in the classroom. The degree of coherency between the KGB region and the affordances of the technology provides an indication of the teacher's developmental progression through the initiation, implementation and maturation phases of using technology in the classroom. Our analysis of these three teachers' trajectories suggests that initial high coherency in a teacher's KGB region and having students who have already been enculturated with the technology-enabled pedagogies accelerate upward developmental trajectories in integrating technology in the classroom.

Keywords: Teacher change, technology integration, technology in the classroom.

1. Introduction

Teachers play a central role in integrating technology in the 21st century classrooms. Many research studies have shown that teachers' beliefs play an important role in leveraging technologies effectively [1,2]. Schoenfeld [3] further extend this paradigm by showing that the beliefs (B), knowledge (K) and goals (G) of the teacher influence every pedagogical decision. In our previous paper [4] we argued that the coherency between teacher's knowledge, goals and beliefs and the affordances of the technology is the main key in leveraging the technology successfully. Using the Coherency diagrams [4] to examine the developmental trajectories of two primary (elementary) school teachers, we postulated that high coherency at the initiation stage and support for teachers are important factors for successful technology integration. In this paper, we investigate the different KGBs for one primary (elementary) and two secondary school teachers as they integrate a technology called GroupScribbles (GS) in their lessons that seek to employ pedagogies based on the concepts of Rapid Collaborative Knowledge Building (RCKB) [5]. By comparing their developmental trajectories vis-à-vis the Coherency diagrams, we obtain more insights into developing teacher's competencies in using technology in the classroom.

2. The Coherency diagram

The complex interplay between teachers' knowledge (K), goals (G) and beliefs (B) can be represented by the "KGB diagram" (Figure 1). The intersection of the all three elements is marked out by the KGB region in the KGB diagram, shown in Figure 1. This region denotes teacher's selection of knowledge that is based on goals which are prioritized by his or her beliefs. In leveraging technology, the teacher must possess knowledge of the affordances of the technology to achieve goals that are set in the classroom. More importantly, teacher's beliefs provide the affective motivation for teacher to utilize the technology. To capture the relation between the affordances of the technology and teacher's KGB region, the Coherency diagram's intersection region (Figure 1) describes the extent to which the technology is leveraged in teaching and hence, serves as an indicator of the teacher's developmental state in technology competency.

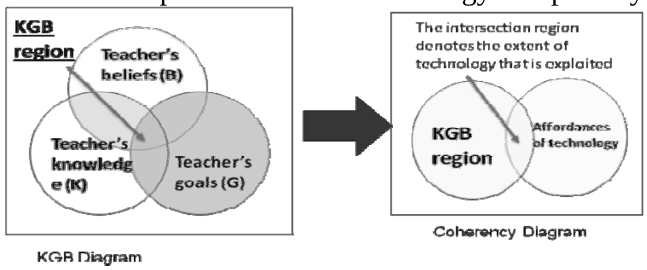


Figure 1: KGB diagram, KGB region and Coherency diagram

In the continuum of intersection regions, we divide into four distinct developmental states (states 1 to 4) to plot the trajectory path of teacher's technology competency across the initiation, implementation and maturation stages of technology implementation. These are reported more in details [4].

(continuum of coherency diagram)

(increasing intersection between KGB region and affordances of technology)

State 1 — State 2 — State 3 — State 4

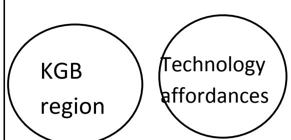
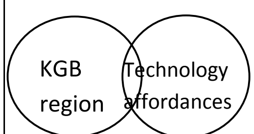
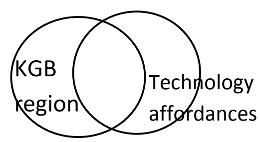
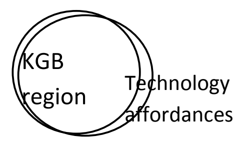
State 1: No coherency	**State 2: Little coherency**	**State 3: Much coherency**	**State 4: Total coherency**
			
There is no intersection. Hence, no coherency at all. Therefore, technology is not leveraged at all.	There is little intersection. Hence, little coherency. Technology is leveraged to a limited extent	There is much intersection. Hence, much coherency. Therefore, technology is leveraged at a large extent	There is total intersection. Hence, total coherency. Therefore, all affordances of the technology are leveraged. This forms the ideal state.

Figure 2: Four states along the continuum in the Coherency diagram

3. GroupScribbles (GS) as a technology that supports RCKB

GroupScribbles (GS) is an interactive technology which enhances the characteristics of sticky paper notes and Student Response System (SRS, sometimes called "clickers"), by providing their key features while avoiding some of their constraints [5]. Developed by Standsford Research Institute (SRI) International, GS enables collaborative generation, collection and aggregation of ideas through a shared space. GS2.0 user interface presents each user with a two-paned window (Figure 3) on a web browser. The lower pane is the user's personal work area, or "private board", with a virtual pad of fresh "scribble pads" on which the user can draw or type. A scribble can be shared by being dragged and dropped on the public board in the upper pane which is synchronized across all devices. The essential feature of the GS client is the combination of the private board where students can work individually and group boards or public boards where students can post the work and position it relative to others', view others' work, and take items back to the private board for further elaboration [6]. With appropriate class activities, the affordances of GS enable collaboration learning to take place in the classroom.

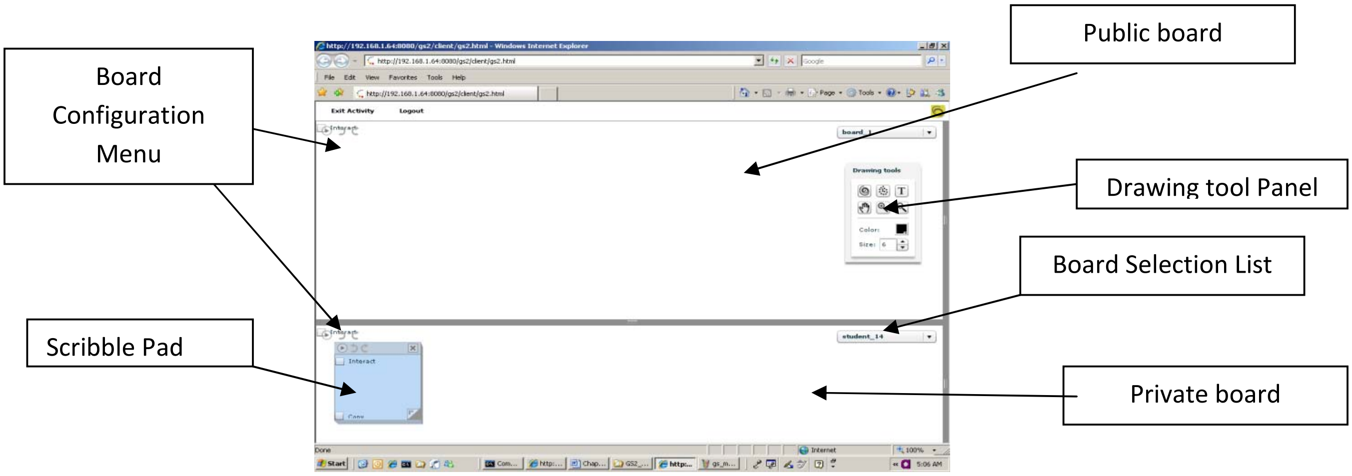


Figure 3: GS 2.0 User Interface

4. Research Context

In our study, we worked with one primary school and two secondary school teachers for about one semester (three to six month). Denise is an experienced primary six (elementary grade 6) science teacher in the latter stages of her successful career in teaching. Previously, she was a Vice-Principal with another primary school before deciding to become a senior teacher in the primary school we are working with. She has about 21 years of extensive teaching in primary schools and is a respected mentor teacher in the school. In contrasts with other teachers in her school, Denise (before our study) is a technology novice, using the computers mainly for grades recording, email communications and word processing. Before our study, Denise commented that she rarely uses technology that supports collaborative learning. Despite this, she was willing to participate in this project. Parry is a young secondary two science teacher of about three years of teaching experience while Jolin is a novice secondary one mathematics teacher of about one year of teaching experience. Being computer science graduates teaching in the same school, Parry and Jolin were designated to collaborate with us in this project by their school. Parry is a sociable and open-minded individual while Jolin is a quiet and passive teacher who desires to complete the syllabus within stipulated curriculum time. Before this study, both teachers have used other ICT tools in their teaching.

In Singapore, the school year starts in January and ends in November. We started working with Denise and Jolin in January 2009 and with Parry in June 2009, in their respective schools. Denise teaches a class of high-ability, GS competent and highly enculturated students who have used GS about one and half year in their lessons. Similarly, Parry teaches a class of high-ability students who have about six months experience with GS. In contrasts, Jolin teaches a class of average ability students who has no experience with GS before our study. Every week for 8 weeks, two lesson periods (totalling an hour and 10 mins) for the respective subjects adopted GS lessons. In these 2 classes of 40 students, each student has an individual Tablet-PC (TPC) with a GS client software installed. We have co-designed, implemented and observed about eight lessons in total.

5. Data Collection

In our collection of data, 2 or more researchers observed each class and took down detailed field observation notes. One video camera was set behind the classroom to record the classroom session, while two other video cameras were focused on two target groups of students. Screen capturing software Morae 2.0 was installed on the TPCs to record the interaction of the students using GS. Semi-structured interviews were used to gain access to the subjective understanding of the teacher. This includes an hour long interview conducted at the end of the semester and weekly post lesson conference sessions. In post lesson conference sessions, both researchers and teacher discussed about the lesson that has been implemented. In the end of semester interview session, the teacher was interviewed by two researchers with a list of prepared interview questions in a private location. The interview session was audio and video recorded.

6. Analysis

This section discusses the use of coherency diagrams in explaining Denise's, Parry's and Jolin's various pivotal decisions to integrate technology into the curriculum. This is done by establishing their beliefs, goals and knowledge in the first instance and employing them as lenses to explain and understand the various GS-related activities in the classroom.

6.1 Parry's developmental trajectory

In the initiation phase, Parry begins his developmental path on a good stead at a high coherency of state 3. There is much alignment between his KGB and his perceptions on the affordances of GS technology evidenced by his perceptions that GS will solve most of the problems he encountered in collaborative group lesson activities he implemented in biology and physics lessons prior to this study. With regards to Parry's beliefs, Parry values every student's contributions and ideas in the class. In his own words, "every student's answers count. I would really like to see their answers in some ways. Students should explore and find things out on their own. In fact, they should take the initiative to learn from one another." Parry also believes that group work is only effective if every student can articulate and "explain their thoughts". In this way, their ideas could be evaluated (by peers or teacher) and thus, learning can take place. However, he laments that "opportunities for expressions are often limited" by time and modes.

Closely linked to his beliefs is his "overarching" goal in integrating GS in his classroom. In the interviews with Parry, he expresses that his main goal is to "maximize learning for students whatever possible." In line with this goal, he commented that "software used in classroom should always help students learn better". In fact, Parry has encouraged students' learning beyond the curriculum content and not on completing the syllabus. Because of his student-centred beliefs, Parry has devised good collaborative lessons that were relevant to the students because Parry perceived that the affordances of GS were congruent with his KGB and thus able to help to solve the problems he encountered in collaborative learning In addition, also believes that a teacher should not appear incompetent before his students. This could be another motivating factor for Parry to pick up the competencies in GS fast and plan his lessons carefully so as not to reveal his inadequacies before a class of GS-enculturated class. Parry started off with a good stead of high coherency state 3.

In the implementation phase, Parry proceeds to implements what he perceived to be coherent in the initiation phase in the classroom. In many of Parry's science lessons, authentic problems in familiar everyday settings are used to formulate open-ended group questions for students to discuss. For example, questions like "explain the similarities and differences of work done and moments using everyday examples", "do you think there is work done in climbing up the stairs?" in lesson 2. By doing this, Parry hopes to trigger the interest level of the students and elicit responses from all students. This stems from his belief that every student should contribute ideas in the class, mentioned in the last section. This belief causes him to leverage on the multimodal affordance of GS which allows students to type, draw or write their answers. This has created more opportunities for students to express their answers in rich diversity, shown in Figure 4 below. Some students prefer to type while some prefer to draw and colour. Some students prefer to verbalise their answers during the lessons. There were active concurrent posting and building on ideas on the shared space on GS within a short period of about 20-30 minutes which would not be possible without GS.

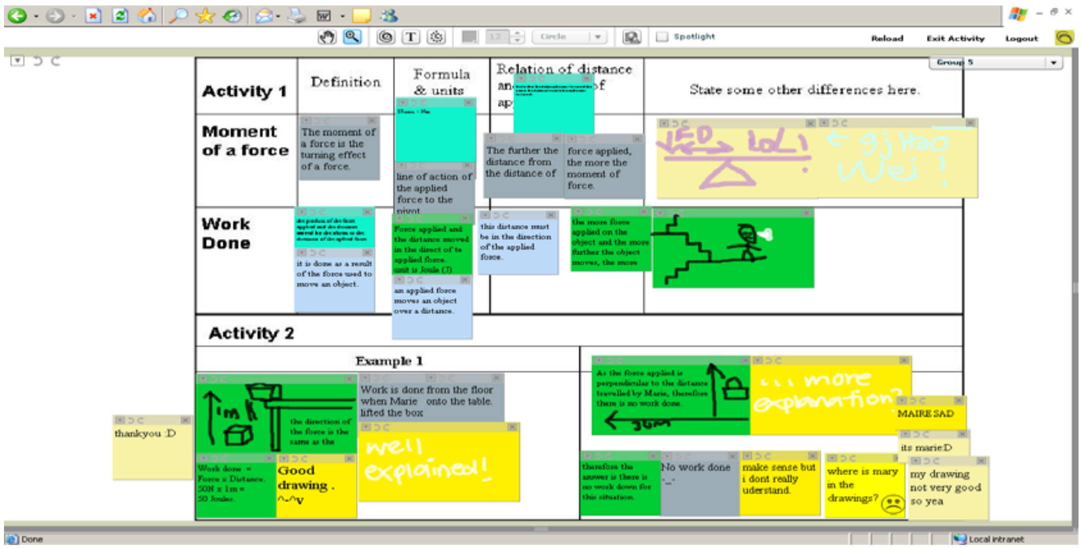


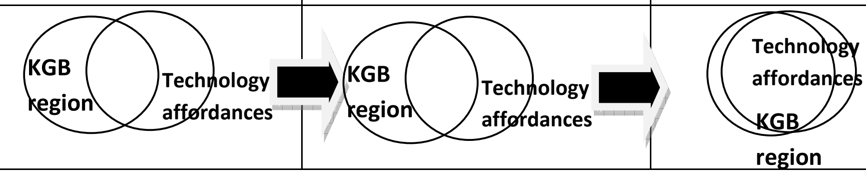
Figure 4: Multimodal expressions in Parry's science lessons

Parry's student-centred belief also enables him to create a collaborative learning environment. In his lessons, students are allowed to express their answers (which may be not in the syllabus) without fear of criticism. In turn, this produces many new and innovative ideas. This is not only seen in verbal articulation but also in written ideas on GS boards. Below is a transcript that happens in the science lesson on force and moments:

> Parry: Any other examples of moments?
> Student 1: Singapore Flyer!
> Parry: Good! Although that is not in our syllabus, it is an interesting example. How does that illustrate moments? (Students in the class begin to see that content outside the syllabus could be discussed in the class, began to raise their hands)
> Student 2: the Ferris wheel turns because of a clockwise moment and an anticlockwise moment with the pivot at the centre.
> Student 3: The engine provides the power to turn at the pivot and there is a change in direction for every passenger every half a revolution. (The discussion continues..)

Beside this, Parry takes time to carefully co-design and rehearse every lesson plans so that he can "appear competent in front of his students". All these points to successful exploiting features of GS in maximizing collaborative learning e.g. viewing other group boards, peer-reviewing each other ideas, posting ideas real time etc because Parry values students' contributions, peer-learning and new ideas. The successful enactment of his congruent perceptions put him in a high coherency state 3.

Table 1: Parry's and Denise's accelerated upward developmental trajectory

	Initiation phase (State 3)	Implementation phase (State 3)	Maturation phase (State 4)
Coherency diagrams			

In the maturation phase, Parry was able to plan innovative lessons that integrate GS without the help of researchers e.g. lesson 6 on heat transfer. Using familiar everyday examples, students were motivated to collaborate with one another via posting and reviewing ideas expressed through different modes in GS, to learn about the various heat transfer mechanisms. In addition, he enjoys GS technology so much that he is exploring the "usage of GS in the laboratory practical lessons" on his own and is tasked by the science department to plan prototype lesson plans for his colleagues to use. Hence, as we trace the coherency diagrams shown in Table 1, Parry exhibits an accelerated upward growth from state 3 to state 4 within a short span of 4 months in implementing technology successfully in the classroom.

6.2 Denise's developmental trajectory

Denise exhibited a similar trajectory as Parry. In the initiation stage, Denise possesses good knowledge of collaborative learning strategies due to her long teaching career. During the pre-intervention interview, she commented that collaborative group work allows students to "think as an individual and as a group." She was able to anticipate some group work problems e.g. "I foresee the possibility of sleeping member in groups so I assign roles". Denise believes in "every student has a different potential that waits to be realised by the teacher". To do that, Denise says that "gaining the students' trust" and building a conducive collaborative environment is important. She "sees every child's strong points and there is a wealth of knowledge where peers can learn from one another". Thus, her goal in the classroom is to maximise every students' potential to the fullest. Beside these, Denise has a high regard for the teaching profession where she believes in "delivering the best lesson possible in order to realise the students' potential". This is manifested in rehearsing her GS lessons several time before the actual implementation so that she can be as, if not more, technically competent as her well GS-enculturated class. She sought to portray herself as a competent teacher, a belief and goal quite similar to Parry. Therefore, Denise's KGB is well congruent with the affordances of GS e.g. shared space platform for posting and building ideas and multimodal expressions. She perceives GS as a tool that actualized her KGB in the classroom and her GS experienced class has provided an added impetus for her to embrace GS positively. That would put her in a good start at a high coherency of state 3.

In the implementation phase, Denise successfully utilizes the shared space in GS fully in a variety of collaborative learning settings e.g. Jigsaw, role-playing, group experiments etc. Similar to Parry, Denise exploits fully the features of GS technology that support collaborative learning e.g. allowing students to peer comment and question each other ideas in real time. At the same time, she also allows her students to express their answers in their desired form-write, type or draw. Coupled with a GS competent class, Denise enactment of her congruent perceptions was successful. This put her in state 3. In the maturation phase, Denise was able to plan GS lessons in another subject i.e. English without any help from the researchers. Survey results have shown that about 92.5% of the students in her class commented that they enjoyed her GS lessons. This indicates Denise attainment of GS competencies in short span of three months. As we traced the coherency diagrams of Denise, there is a similar accelerated upward growth from state 3 to state 4 in implementing technology successfully in the classroom shown in Table 1.

6.3 Jolin's developmental trajectory

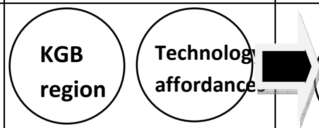
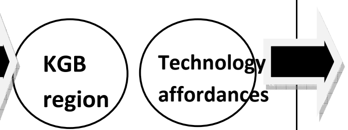
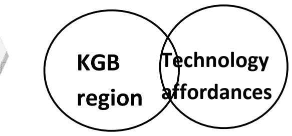
At the initiation stage, Jolin holds several primary beliefs that are incongruent with the affordances of GS technology. First, she expects herself to finish the syllabus on time adhering to a strict schedule called scheme of work (SOW). Secondly, she believes that her students are "not willing to articulate their answers because they are afraid of being identified" and generally believes that "collaborative learning takes up too much time" to wait for students' answers. Coupled with her limited knowledge of collaborative learning strategies, this has caused her to use predominantly didactic teaching strategies approach in teaching Mathematics e.g. enacting IRE (Initiation-Response-Evaluation) episodes frequently in her lessons. Below shows a transcript of a Maths lesson on algebra:

> Jolin: What is the value of b in this equation: "5b+2b=14"? (Initiation)
> Student 1: 2. (Response)
> Jolin: (proceeds to write the answer b=2 on the board without any verbal response) (Evaluation)
> Jolin: What does b mean? (Initiation)
> Student 2: Number of boys. (Response) [Jolin nods her head and continues the lesson.]

Thirdly, she believes in a strict classroom regime where students are expected to be orderly and follows instructions to the minute details in order for effective learning to take place. Therefore, her goals include creating an orderly classroom and complete syllabus on time. The affordances of GS primarily leverage on collaborative discussions and articulation of ideas by students and this requires more time out of the curriculum. Moreover, Jolin faces much difficulty in planning collaborative learning activities for GS-related lessons due to her limited knowledge. All these factors points to the incoherency between Jolin's KGB region and affordances of GS aptly indicated by state 1.

In the implementation phase (part 1), as Jolin enacts the incoherencies perceived in the initiation phase, she is not able to leverage GS technology effectively in her classroom. Firstly, her fear of not completing the lesson on time is realized partly due to her poor time management skills. As students articulates their ideas more in GS group collaboration lessons, Jolin finds it a challenge to maintain an orderly classroom. Jolin wastes a lot of time in trying to enforce discipline in the GS lessons. She expresses her frustration: "I always cannot complete lesson objectives in a GS lessons!". She attributes the poor implementation to misbehaving students in her class and lack of time. Basically, she seems to have stagnated at state 1 at this phase. Realizing her stagnation, we as researchers decided to increase her confidence and motivation by encouraging her to leverage on multimodal affordance of GS technology. Jolin attempts to use this affordance in one of her Mathematics lesson on Number patterns where she experienced some successes. She was surprised herself: "I never knew (GS) works for my students!" One would expect Jolin to grow close to state 3 but apparently not so. In one of recent interview session with her, she commented that "GS is topic dependent and may not be suitable for her class". There are some minor changes in teaching strategies but she remains largely sceptical. Hence, state 2 would describe her current stage. Her trajectory is plotted in Table 2.

Table 2: Jolin's developmental trajectory

	Initiation phase (State 1)	Implementation phase-part 1 (State 1)	Implementation phase-part 2 (State 2)
Coherency diagrams			

7. Discussion and Conclusion

From Tables 1 and 2, we can make some notable assertions. Firstly, this study reaffirms what we observed in our previous study [4]. Teacher's initial state plays an important role in attaining positive growth. Denise and Parry started with state 3 and ended with state 4 at the maturation stage within short span of three to four months. In contrasts, Jolin exhibited little growth from state 1 to state 2 without entering into maturation phase within a longer span of six months. This is because modifying existing beliefs is easier than replacing existing new ones. Time and support from researchers are of secondary importance as compared to teachers' initial KGB coherency. Secondly, a class of highly motivated and competent students provide an added motivation to teachers for positive development at an accelerated rate. Despite starting with good coherency, Lynn, in our previous study [4] took one and a half year as compared to three months for Denise to attain state 4.

In this study, we showed that the coherency diagrams provided insights into teachers' developmental growth in integrating GS technology. Our results reaffirm the importance of ensuring high coherency right at the initiation stage. A class of highly GS-competent and motivated students accelerates the upward development trajectories in integrating GS technology in the classroom.

Acknowledgements

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References

[1] Ertmer, P.A. (5005) Teacher pedagogical beliefs: The final frontier in our quest for technology integration? *Educational Technology Research and Development*, 56(4), 55-69.

[2] Aguirre, J.M. & Speer , N.M. (5000) Examining the relationship between beliefs and goals in teacher practice. *Journal of Mathematical Behavior*, 48(6), 657-656.

[3] Schoenfeld, A.H. (5000) Models of the teaching process. *The Journal of Mathematical Behavior*,48(6), 546-564.

[4]Chen, F.H., Looi, C.K., & Chen, W. (2009). Integrating technology in the classroom: A visual conceptualization of teachers's knowledge, goals and beliefs. *Journal of Computer-Assisted Learning*, *25*(5), 470-488.

[5] DiGiano, C., Tatar, D., & Kireyev, K. (2006). Learning from the Post-It: Building collective intelligence through lightweight, flexible technology. *In Conference on Computer Supported Cooperative Work Companion*, Banff. From http://groupscribbles.sri.com/download/papers/DiGianoCSCW2006.pdf

[6] Chen, F.H. & Chen, W. (2009). School-based research in GroupScribbles: Sustaining and Creating Impact in Schools. In *3rd Redesigning Pedagogy International Conference* . Singapore: NIE.

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The Cognitive Effects of Different Feedback Modalities in Virtual Reality Learning

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Abstract: Feedback is an important feature of a virtual reality (VR) learning system as appropriate feedback increases learners' motivation as well as interaction. This study aims to investigate the cognitive effects of using VR-based learning systems with different feedback modalities. It employs a pretest-posttest quasi-experimental design to measure the cognitive effects of VR learning systems that use on-screen text, narration, as well as both on-screen text and narration, respectively and an additional non-VR environment, which uses paper-based reference material, to serve as a control of the study. The study reveals that the differences in feedback modality, focusing on narration and on-screen text, do not significantly affect cognitive gain in a VR learning system. In addition, the significant positive effects of the VR-based learning system when compared with the non-VR method, provides another evidence of the potentials of VR technology for instructional use. This paper discusses the findings based on existing learning theories and principles, and concludes with a design implication of VR learning systems that incorporate feedback.

Keywords: virtual reality, learning, feedback

Introduction

Feedback is a crucial component of any learning process [1], [6], [8], & [17]. It informs learners about the consequences of their actions and motivates them to further interact with a system [25]. Interaction with a system can only be considered as a contributor to the learning process if the learner gets feedback on what his or her action will result in. According to Mulder, Elgar, and Brady in [16], effective learning occurs when learners obtain timely and detailed feedback on their performance from their instructors as well as peers.

1. Modality Effects

Past research in multimedia learning demonstrated a modality effect in which students who studied from pictures and spoken words outperformed students who studied the same pictures with text [14]. According to Mousavi, Low and Sweller in [15], students learn better when the verbal information is presented auditorily as speech rather than visually as on-screen text for both concurrent and sequential presentations. Mayer, Heiser and Lonn in [11] investigate the redundancy effect consistent with a dual-channel theory of multimedia learning in which adding on-screen text can overload the visual information-processing channel, causing learners to split their visual attention between two sources. One of the important findings is that audio feedback is perceived to be one of the most important features that engender a sense of presence [5]. Marila and Ronkainen in [9] also reveals that auditory feedback enables faster response times than visual feedback.
Mayer and Moreno in [12] carried out a research in which they requested students to view an animation depicting a complex multimedia system, either along with concurrent narration or along with concurrent on-screen text. Their study shows that students who learned with concurrent narration and animation outperformed those who learned with concurrent

on-screen text and animation. The cognitive capacity increases when information is in mixed (auditory and visual mode) rather than in a single mode [15]. The opportunities for active cognitive processing are reduced when working memory becomes overloaded [14]. Mayer and Moreno in [12] suggests that animations should be accompanied by narration rather than by on-screen text when designing multimedia presentations where working memory is less likely to become overloaded.

Many studies found that students learn better when material is auditorily-presented than visually-presented. Auditory feedback is shown to bring about more positive effects compared with other types of feedback. However, it is important to note that these studies are mostly based on multimedia systems. Indeed, there is still a lack of similar research for virtual reality (VR) learning system. Feedback is an important feature of a VR learning system. According to Jung in [7], a VR learning system with appropriate feedback increases the learners' motivation and interaction. Hence, this study takes the effort to investigate the cognitive effects of using feedback in the form of narration, on-screen text, or both narration and on-screen text in a VR learning system.

2. Aim

The study aims to investigate the cognitive effects of using VR-based learning systems that use on-screen text (VR-T), narration (VR-N), as well as both on-screen text and narration (VR-N&T), respectively and an additional non-VR environment (Non-VR), which uses paper-based reference material, to serve as a control of the study.

2.1 Research Design

A learning mode refers to each of the VR-based learning systems, including the non-VR environment. The study employs a pretest-posttest quasi-experimental design to measure the cognitive effects of each learning mode. Figure 1 depicts this research design.

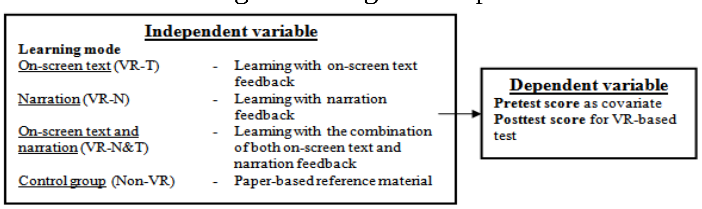

Figure 1: Research design

2.2 Research Question and Hypothesis

This study attempts to answer the following research question:

Is there a difference in the posttest score of the VR-based test between the four learning modes (VR-T, VR-N, VR-N&T, and Non-VR)?

The statement of the null hypothesis that corresponds to the above-stated research question is as follows.

There is no significant difference in the posttest score of the VR-based test between learners exposed to the VR-T mode, learners exposed to the VR-N mode, learners exposed to the VR-N&T mode, and learners of the control group.

The outcomes depict the cognitive effects of VR-based learning systems with different feedback modalities. The understanding of such effects will help to add to the suggestions of how to effectively utilise the VR capabilities to support the desired learning outcomes.

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3. Methods

3.1 VR Learning System

The VR learning system that served as the treatment for the experimental groups was meant to provide novice car drivers, the targeted learners, with the knowledge on basic car maintenance procedures. These procedures include pumping car tyre, changing punctured tyre, adding coolant, adding engine oil, as well as changing engine oil and oil filter. Figure 2 shows a screenshot of the learning system, depicting how its design is guided by the instructional design model for VR-based learning environment as proposed in [2]. As this paper focuses on the findings of the investigation on the effects of different feedback modalities, it does not provide a detail explanation on how the system was designed based on this model.

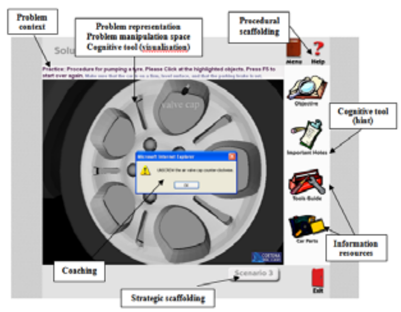

Figure 2: A screenshot of the learning system, depicting how its design is guided by the instructional design model

For learning to occur, a system should allow feedback about the learners' performance on the tasks [15]. If feedback can be built in automatically to the practice routine in some way then it is unnecessary to have an instructor to permanently present as the required feedback can be contained within the system. Hence, by incorporating feedback into the VR-based learning system of this study, it replaces some of the roles that are conventionally played by the instructors of the driving school.

3.2 Population and Sample

The current law in Malaysia allows any person who is 17 years old and above to undergo the 6-hour Class Briefing/Basic Start session in a driving institute or academy. Although the age of these candidates may vary greatly, majority of them are from the younger group, those who are just above the eligible age [2]. Therefore, this majority forms the targeted population of this study.

The accessible population for this study encompassed first-year students of any colleges or universities that are well equipped with multimedia computer laboratories in Kuching, Sarawak. College or universities students are chosen, as most of them are computer and information technology literate. Besides, they are chosen instead of general public, in order to obtain better-controlled samples.

In this study, students of two private educational institutions in Kuching, a college and a university, formed the accessible population. This also implies the findings of this study can only be strictly applied to this group of population. A total of 200 university and college students participated in this experiment. There were five intact classes with 120 first year students from one of the institutions and four intact classes with 80 first year students from another institution participated in this experiment. However, only a total of 153 students were taken into consideration in the analyses as some of them were absent during either the pretest or posttest session. The mean age of the learners was 19.15 years old. Table 1 shows the distribution of learners across learning modes.

Table 1: Learners distribution across learning modes

Learning mode	Number of learners
VR-T	39
VR-N	38
VR-N&T	42
Non-VR	34

3.3 Instruments – VR-based Test (Pretest and Posttest)

The VR-based test (pretest and posttest) is the instrument for this study. Both the VR-based pretest and VR-based posttest are computer-based tests. Each test comprises fifteen multiple-choice questions. The fifteen multiple-choice questions assess the learners' ability to identify the possible missing or incorrect car maintenance procedure performed in the simulations. Each of the fifteen multiple-choice questions is displayed through the web interface showing the maintenance process of a three-dimensional virtual car with possible missing or incorrect step. Both pretest and posttest are similar in content but the order of the questions is different to avoid the set response effect. The total score of each test will be 15. For each question, participants received a score of either 1 (correct answer) or 0 (incorrect answer), and a total score ranging from 0 to 15. This score is multiplied by 100 to convert it to percentage. The Cronbach's alpha reliability coefficient of the pretest was 0.742, which depicted the test items were satisfactorily reliable.

3.4 Procedures

Prior to this study, permissions were obtained from the two institutions for conducting the pilot study as well as the experimental study. In order to prevent any experimental bias, lecturers from the two institutions were asked to conduct the pilot and experimental sessions. The researcher was only present to provide navigation training to the lecturers before the pilot and experimental session were conducted. The lecturers were given precise procedure on how to carry out the sessions smoothly. Students who were not selected as the sample to participate in the experiment were asked to provide assistance during the pretest and posttest sessions.

4. Results

In this study, the pretest score served as the covariate and this pretest was administered before the participants of the four groups underwent their respective learning session to prevent the pretest score being influenced by any of the treatments. Preliminary checks were conducted to ensure the appropriateness of the use of pretest score as the covariate.

4.1 Testing of Hypothesis

One-way analysis of covariance (ANCOVA) was used to measure and analyse the collected data. After adjusting the pretest scores, there was a significant difference between the four learning modes on the posttest scores, $F(3, 148) = 54.457$, $p = 0.000$. The effect size, calculated using η^2, was 0.525, which would be considered as a large effect size. There was also a strong relationship between the pretest scores and the posttest scores, as indicated by the η^2 of 0.377.

The means, standard deviations, adjusted means, and standard error of the dependent variable (posttest score) by the learning mode were measured in Table 2. The standard deviations were used to measure the variability of the posttest scores. The VR-N&T mode with smallest standard deviation value (SD = 7.67079), shows that there is less heterogeneity with these groups when compared with the VR-N mode (SD = 9.93678), the VR-T mode (SD = 10.63806) and Non-VR mode with the largest standard deviation value (SD = 12.47448). The VR-N&T mode had the largest adjusted mean (adjusted M = 90.685), followed by the VR-N mode and VR-T mode (adjusted M = 87.227 and adjusted M = 86.450 respectively). The Non-VR mode had the smallest adjusted mean (adjusted M = 68.184).

Table 2: Means, standard deviations, adjusted means, and standard errors of posttest score by learning mode

Learning mode	**Posttest score (%)**			
	M	***SD***	***Adjusted M***	***SE***
VR-N&T, N = 42	90.4755	7.67079	90.685 [a]	1.247
VR-T, N = 39	87.1787	10.63806	86.450 [a]	1.296
VR-N, N = 38	88.7711	9.93678	87.227 [a]	1.321
Non-VR, N = 34	65.8824	12.47448	68.184 [a]	1.407

Note: [a] Evaluated at covariate appeared in the model: pretest = 64.0956

4.2 Pair Wise Comparisons for One-Way ANCOVA

The follow-up post-hoc pair wise comparisons were conducted when the result of the one-way ANCOVA was found statistically significant. In this study, the Holm's sequential Bonferroni procedure was used to control for Type I error across the six pair wise comparisons.

Three comparisons were found significant: the comparison between the VR-T mode and the Non-VR mode (*p* of 0.000 is less than 0.0083), the comparison between the VR-N mode and the Non-VR mode (*p* of 0.000 is less than 0.0100), and the comparison between the VR-N&T mode and the Non-VR mode (*p* of 0.000 is less than 0.0125). Whereas, another three comparisons were found not significant: the comparison between the VR-T mode and the VR-N&T mode (*p* of 0.0200 is not less than 0.0167), the comparison between the VR-N mode and the VR-N&T mode (*p* of 0.059 is not less than 0.025), and the comparison between the VR-T mode and the VR-N mode (*p* of 0.674 is not less than 0.05).

The analysis revealed that there were significant differences in the adjusted means between: the VR-T mode and the Non-VR mode, between the VR-N mode and the Non-VR mode, and between the VR-N&T mode and the Non-VR mode. However, the analysis revealed that there were no significant differences in the adjusted means between: the VR-T mode and the VR-N&T mode, the VR-N mode and the VR-N&T mode, and the VR-T mode and the VR-N mode.

5. Discussion

The insignificant difference between the posttest results of the learners exposed to VR-T, VR-N, and VR-N&T modes can be explained according to the Cone of Learning by Dale (1969) as well as the limited-capacity assumption and dual-coding assumption of Mayer's (2001) cognitive theory of multimedia learning.

5.1 Cone of Learning

Dale's Cone of Learning in [4] is based on the relationships of various educational experiences to reality (real life). At the upper part of the cone which considers experiences that are far from reality, learners tend to remember only 10% of what they read. Learners, who learn via hearing words, tend to remember 20% of what they hear while those who learn by looking at pictures tend to remember 30% of what they see. As for learners who learn by hearing and seeing images at the same time, they tend to remember more, 50% of what they hear and see. Conversely, the lower part of the cone considers educational experiences that close to real and everyday life. Such mimic to real-world experiences stimulate the use of all senses, which include seeing, smelling, hearing, touching and moving. According to Dale in [4], better learning will occur when more sensory channels are involved in interacting with an educational resource. Hence, the lower part of the cone stresses the importance of learning by doing and suggests that the learners tend to remember 90% of what they both say and do.

All the three learning modes require the learners to experience and perform the maintenance procedures. According to the Cone of Learning, such active learning by doing tend to help the learners to remember up to 90% of the learning content while they interact with the virtual system. The Cone of Learning also explains the use of different feedback modalities tend to produce different amount of recalling ability. Learners exposed to the VR-T, VR-N and VR-N&T mode tend to remember 10%, 20% and 50% respectively of the feedback. This may explain the slightly higher posttest scores achieved by the learners of VR-N&T mode than the learners exposed to either VR-T or VR-N mode. Nevertheless, such differences which are due to different types of feedback used are insignificant because feedback only forms a portion of the overall learning process, while a major part of the learning process focuses on the manipulation of the different parts of the virtual car. This helps to explain the insignificant difference between the three learning modes.

5.2 Cognitive theory of multimedia learning

The three fundamental assumptions underlying the cognitive theory of multimedia are dual channels, limited capacity, and active processing [10]. This theory assumes that the human information processing system includes two channels; a) visual or pictorial, and b) auditory or verbal processing. Each channel has limited capacity for processing, and that active learning entails carrying out a coordinated set of cognitive processes during learning.

The limited capacity assumption of this theory stresses that human can pay attention to only a few pieces of information in each channel at a time, hence, it is important not to overload the working memory during the learning process [22]. According to Cooper in [3], when the intrinsic cognitive load is high (difficult domain concepts or knowledge) and the extraneous cognitive load is high, then total cognitive load will exceed mental resources and learning may fail to occur. In order to reduce the total cognitive load to within the bounds of mental resources, the level of extraneous cognitive load must be modified by changing the instructional materials presented to learners [3]. The dual-channel assumption of this theory posits that humans possess separate information channels for visually presented material and auditorily presented material.

Mayer and Moreno [12] in their research on multimedia have shown that students who learned with concurrent narration and animation outperformed those who learned with concurrent on-screen text and animation. In their research context, students who experienced concurrent narration and animation used the auditory channel to process the information from narration and the visual channel for animation. On the other hand, students who experienced concurrent on-screen text and animation used only the visual channel to process information from both the on-screen text as well as the animation. This has somehow overloaded to visual channel, which consequently resulted in poorer performance.

In this study, the use of narration within the dynamic virtual environment, as in VR-N, involves a learner's auditory channel to process the narration and visual channel to process information from the real-time three-dimensional graphical representation of the virtual environment. The use of on-screen text in VR-T evokes the visual channel of a learner. This visual channel is not overloaded with the information from the virtual environment because the dynamicity of the virtual environment in VR-T is halted when the on-screen text is displayed. In other words, the learner focuses only on the on-screen text when such feedback appears. In the case of VR-N&T, the virtual environment is once again halted when a feedback appears. A learner will only uses the auditory channel to process the narration and visual channel to process the on-screen text. Hence, in all these learning modes, neither visual nor the auditory channel is overloaded. This helps to explain the insignificant difference in the cognitive gain of the three learning modes.

Based on the dual-channel assumption, the use of both channels is supposed to produce better learning as it creates two routes to retrieve information from memory [19]. However, Mayer in [10] asserts that when learners are able to allocate sufficient cognitive resources to a task, it is possible for information originally presented to one channel to be represented in the other channel. In VR-T mode, when information was presented to the learners' eyes (on-screen text), they started to process the information in the visual channel. In VR-N mode, when information was presented to the learners' ears (narration), learners started to process the information in the auditory channel. Due to the simplicity of the feedback message as explained earlier, it is possible that adequate cognitive resources are allocated for the cognitive processing of it. For example, when the on-screen feedback text of VR-T mode, such as "Open the car hood", is initially presented to the eyes, learners may mentally convert the open-the-car-hood images into sound, which is processed through the auditory channel. Similarly in the VR-N mode, when the narration describing the event such as "The engine oil is too dirty" is initially presented to the ears, learners may also form a corresponding mental image that is processed in the visual channel. Therefore, the VR-T and VR-N modes did not seem to produce significant differences when compared with the VR-N&T mode although originally the text or audio message gets into a single information processing channel. The cross-channel representations of the same stimulus play a vital part in Paivio's dual-coding theory [18].

6. Conclusion

The study reveals that the differences in feedback modality, focusing on narration and on-screen text, do not significantly affect cognitive gain in a VR learning system. Hence, the instructional designer of a VR learning system may choose to use any of these feedback modalities without jeopardizing its effectiveness, at least in a learning context that is similar to the one used in this study. In addition, the significant positive effects of the VR-based learning system when compared with the non-VR method, provides another evidence of the potentials of VR technology for instructional use. This VR-based learning system provides new learning opportunities by introducing learning activities that make visible concepts and relationships that are not easily grasped or visualized by learners when relying only on the conventional method.

The study only involves college and university students. As for the future, the work can be extended to include other groups of learners to improve the generalisability of the findings. More research studies are recommended to verify if the similar results will be attained if the VR-based learning system focuses on abstract concepts rather than concrete tasks. The

VR-based learning system in this study only focuses on the simulation of a real-world system, the real-world car maintenance procedures, which correspond to a concrete task. Future initiatives may also include investigations into other VR characteristics such as the control over view position and direction, representation fidelity, ability to manipulate virtual objects, user interface as well as navigation in the virtual world. This may help in generating more useful principles for designing effective VR-based learning systems.

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References

[1] Brown, A. (1997) Designing for learning: What are the essential features of an effective online course? *Australian Journal of Educational Technology*,*13*(2), 115-126.
[2] Chen, C.J., Toh, S.C. & Wan, M.F. (2004). The theoretical model for designing desktop virtual reality-based learning environments. *Journal of Interactive Learning Research,* 15(2), 147-167.
[3] Cooper, G. (1998). Research into cognitive load theory and instructional design at UNSW. Retrieved from http://education.arts.unsw.edu.au/staff/sweller/clt/
[4] Dale, E. (1969). Audio-visual methods in teaching (3rd ed.). New York: Holt, Rinehart & Winston.
[5] Jelfs, A., & Whitelock, D. (2000). The notion of presence in virtual learning environments: What makes the environment 'real'? *British Journal of Educational Technology, 31*(2), 145 – 152.
[6] Jonassen, D.H. & Hannum, W.H. (1987). Research-based principles for designing computer software. *Educational Technology*, *27*(12), 7-14.
[7] Jung, H. J. (2002). Virtual reality for ESL students. *The Internet TESL Journal, 8*(10). Retrieved from http://iteslj.org/Articles/Jung-VR.html
[8] Laurillard, D. (1993). *Rethinking university teaching: A framework for effective use of educational technology*. London: Routledge.
[9] Marila, J., & Ronkainen, S. (2003). Time-out in mobile text input. The effects of learning and feedback. In L. Chitaro (Ed.), *The 5th International Symposium Mobile HCI 2003 Proceedings*. Berlin /
[10] Heidelberg / New York: Springer-Verlag.
[11] Mayer, R. E. (2001). *Multimedia Learning*. Cambridge: Cambridge University Press.
[12] Mayer, R. E., Heiser, J., and Lonn, S. (2001). Cognitive constraints on multimedia learning: When
[13] presenting more material results in less understanding. *Journal of Educational Psychology*, *93*(1), 187-198.
[14] Mayer, R. E., & Moreno, R. (1998). A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. *Journal of Educational Psychology*, *90*, 312-320.
[15] Mayes, J.T. (2002). The technology of learning in a social world. In R. Harrison, F.Reeve, A. Hanson, J.Clarke (Eds.), *Supporting lifelong learning: Perspectives on learning Vo1. 1*, Routledge: London
[16] Moreno, R. & Mayer, R. E. (1999). Cognitive principles of multimedia learning: The role of modality and contiguity. *Journal of Educational Psychology*, *91*, 358-368.
[17] Mousavi, S. Y., Low, R., & Sweller, J. (1995) Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology*, *87*, 319-334.
[18] Mulder, R.A., Elgar, M.A., & Brady, D. (2005). "APRES": Electronically managed student feedback via peer review. *Proceedings of the Blended Learning in Science Teaching and Learning Symposium*. (pp. 2-6).
[19] Norman, G.A., & H.G. Schmidt. (1992). The psychological basis of problem-based learning: A review of the evidence. *Academic Medicine*. *67*, 557–565.
[20] Paivio, A. (1986). *Mental representations*. New York: Oxford University Press.
[21] Rieber, L. P. (2005). Multimedia learning in games, simulations, and micro worlds. In: R.E. Mayer (Ed.), *Cambridge handbook of multimedia learning*. (pp. 549-568). New York: Cambridge University Press.
[22] Sweller, J. (1999). *Instructional design in technical areas*. Camberwell, Australia: ACER.
[23] Vasilyeva, E., Pechenizkiy, M., Puuronen, S. (2006). The challenge of feedback personalization to learning styles in a web-based learning system. *Proceedings 6th IEEE International Conference on Advanced Learning Technologies.* (pp. 1143-1144). IEEE Computer Society.

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Designing a Desktop Virtual Reality-based Learning Environment with Emotional Consideration

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Abstract: Many studies related to the use of virtual reality in education are focused on the cognitive aspects with little consideration given to the emotional domain. Thus, the present study aims to uncover the salient linkages between learners' emotions and design elements of a desktop virtual reality-based learning environment by employing Kansei Engineering concepts. A courseware related to the teaching of road safety skills to young learners was designed and developed to be used as a case for the study. Ten specimens of the courseware, which highlights different design elements, were presented to 90 students from three randomly selected secondary schools. They were required to rate their feelings towards the specimens using the provided checklist that consists of thirty words related to emotions. The gathered data were then analysed using Principal Component Analysis and Partial Least Squares analysis. The results revealed that the most influential design elements in inducing positive emotions are environment richness and coaching. Ultimately, the uncovered linkages could be used to inform future design of emotionally sound desktop VR-learning environments.

Keywords: desktop virtual reality, emotions, Kansei Engineering, instructional design

Introduction

Virtual reality (VR) is one of the many technologies that have become increasingly popular to be used as an educational tool due to the development of low-cost computer graphics technology. With its capability, VR permits users to be immersed in a computer generated virtual world by giving techniques for user orientations in this world [1]. Non-immersive VR or commonly known as desktop VR makes full use of desktop computer to present images in common monitor and allows user interaction with the computer-generated images via generic input devices such as computer mouse and keyboard [2]. The advancement in computer technology has made desktop VR a more popular choice because of the lesser cost that it incurs.

In instructional settings, VR capabilities are often studied in relation to variables related to learners' cognitive capacity using various methodologies [3, 4]. Most evaluations conducted on VR-based learning environments are on common usability issues such as navigation, degree of presence, cognitive load, and interface design [5, 6]. These studies have provided minimal input on aspects of user experience in particular the need to investigate the emotional impacts of VR on the learners. However, with the propagation of instructional models which are derived from the constructivist approach, instructional designers begin to realise that cognitive, social and emotional development cannot be viewed in isolations as each is closely linked with the other [7, 8]. It is generally agreed by educationists that learning is more likely to occur when learners are in a positive state of emotion. Pekrun [9] stipulates that emotions have an immediate effect on learning and achievement as mediated by attention, self-regulation and motivation. They direct a person toward or away from learning matters in learning situations, which eventually leads to self-regulated learning. In addition, previous studies [11, 12] reveal that emotions in computer-supported learning can also affect learners' performance and attainment.

In this paper, the apparent need to investigate the emotional factors of desktop VR-based learning environments is addressed by incorporating Kansei Engineering methods. Specifically, using a VR-based learning environment as a case, this paper demonstrates how Kansei Engineering can be used as part of the evaluation process of such learning environments with the support of empirical findings.

1. ackground

1.1 Emotion and Instructional Design

Emotion is not generally recognised by the disciplines that address the broad issues of understanding complex systems and complex behaviour, especially in the presence of learning as in the case of instructional design [12]. Though there were efforts by researchers such as Martin and Briggs [13] to combine both cognitive and affective domain in creating a more holistic framework for instructions, they were seen as problematic and unpopular due to the lack of proper method to address this gap.

In instructional design, research on emotion in learning context has been conducted actively from two different approaches. One approach has been focused on fostering affective dimensions of human learning and development by designing instruction on affective domain which included emotional development [14]. Emotional development includes understanding own and other's feelings and affective evaluations, learning to manage those feelings, and wanting to do so [15]. The other approach of emotion related studies concentrated on how to moderate emotions that could arise during the learning course. Unlike the first approach, these kinds of study do not consider emotional development, but try to integrate learner's emotion states in learning context aiming at how to handle learner's unstable emotional aspects to be more appropriately maintained during the entire learning course. In this scope of studies, emotions are assumed to be being scattered on some position from positive emotions to negative emotions [12, 16].

Nonetheless, the lack of appropriate method in uncovering the relationships between emotion and various components in instructions often hinders the development of such studies. Therefore, the present study proposes the incorporation of Kansei Engineering methodology as an alternative approach to bridge the gap between emotion and instructional design particularly in the design of desktop VR-based learning environment. Kansei Engineering serves as a potential method to be included in the instructional design process as it can systematically quantify the relationship between emotion and design attributes of VR-based learning environment.

1.2 Kansei Engineering

Kansei Engineering is a product development methodology, which translate customers' impressions, emotions, feelings and demands of existing products or concepts to design solutions and concrete design parameters [17, 18]. This methodology is capable of quantifying the relationships between user's feelings and design parameter with an intention to create a product that is largely desirable by the users or customers. In a typical Kansei measurement procedure, users are required to rate a product on the Semantic Differential scale, which contains list of words in a pre-determined scale range. These words (known as Kansei words) are compiled from various sources such as target users, experts, pertinent literature and the like. The rating of the product is done specifically on each pre-determined design attributes. Generally, product or design attributes are selected from the existing products available in the market. In some cases, however, the product attributes can be created or designed from scratch by the product designers especially when there are limited designs available within a selected domain. Upon obtaining the evaluation data from Kansei measurement, the correlation between the Kansei words and design attributes (e.g. colour, layout, and size) is then analysed quantitatively using statistical methods.

2. Research Questions

The aim of this study is to examine the relationship between learner's emotion and the design elements of a VR-based learning environment. Specifically, the research questions are:

i. What are the salient design elements of a VR-based learning environment that could influence learner's emotions?
ii. How can the identified relationships be used to inform future design of VR-based learning environments?

3. Methodology

For the purpose of the study, a desktop VR-based learning environment related to the teaching of road safety skills to young learners (aged 13 to 15) known as Virtual Simulated Traffics for Road Safety Education (ViSTREET) was selected as a case for investigation. Each specific skill (or problem) is addressed by a distinct module that consists of VR-based scenarios generated using Virtual Reality Modelling Language (VRML) version 2.0. ViSTREET was designed based on the instructional design theoretical framework by Chen, Toh and Wan [19], which emphasises the constructivist view of VR-based learning environments. The VR learning scenarios were developed fulfilling all the components of the framework. A chosen scenario was then manipulated in order to generate ten different specimens for Kansei evaluation [20]. This is done by removing one major component of the guiding framework from the completed scenario to form one different design specimen as illustrated in Figure 1.

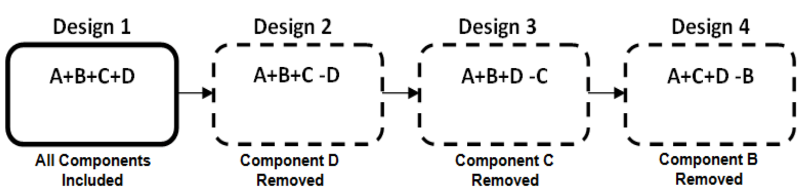

Figure 1: The process of generating design specimens for Kansei evaluation

3.1 Material

Following the step mentioned earlier, ten design specimens were generated. The ten design specimens required participants to perform the same task but the virtual environments differ in terms of salient design elements (according to the elements in the instructional design model). For example, in specimen A01, no element of coaching was provided, in which specific guidance on how to complete a task were removed. Specimen A10 included all components as it was needed to compare the influence of each element when it was removed. Table 1 summarises the generated design specimens and Figure 2 shows a sample screenshot.

Table 1: Specimen codes and descriptions

Code	Specimen Descriptions	Example
A01	Coaching was not given	No feedback messages
A02	Navigational aids were removed	Location map of scenario is excluded
A03	Modelling was not included	No helpful virtual agent
A04	Environment richness was reduced	Reduce the quality of 3D objects
A05	Information resources were removed	No guiding fact sheets/help tips
A06	Narration was removed	No audio narration
A07	No problem representation	Task was given directly as instruction
A08	Objectives were removed	No presentation of objectives
A09	Ignore principles of multimedia design	Font size and font colour
A10	All components included	No manipulation was done.

Figure 2: Screenshot from one of the specimens

3.2 Instrument

The instrument of the present study consisted of a checklist of 30 Kansei words. These Kansei words were chosen from the pertinent research papers and journals related to learning process [12, 16, 21] added with general Kansei words which were considered important to describe learning environment. Some of these words include “frustrated”, “appealing”, “curious”, “calm”, “lost”, “annoyed”, “safe”, etc. The synthesised Kansei words were then organised in 5-point Semantic Differential scale to form the checklist for data collection.

3.3 Sample

The sample for the main study was comprised of 90 participants from three daily schools in the Kuching division, Malaysia (30 from each school). The schools were chosen using simple random sampling method from a list of 15 identified schools in the division with sufficient computers. As for the participants, they were from lower-secondary classes as the VR-based learning environment is designed for this group of learners. They were first filtered based on their computing background such as familiarity with common input devices and software. From the filtered students, they were then randomly selected to meet the required number of participants for each school.

3.4 Data Collection Procedures

Prior to each Kansei evaluation session, the participants were explained on the purpose of the evaluation and what they were required to do. Explanation on the set of Kansei words was also carried out to avoid confusion of meaning. The Kansei evaluation session in each school were carried out in the computer lab with the use of 30 computers of similar specifications such as screen size, audio volume and quality and screen colour. To avoid a sudden surge of excitement, the participants were first presented with a sample VR-based scene (exploration of a house and its surrounding area). This sample scene also served as a navigational training for them to familiarise with the controls needed for the exploration of the actual VR-based learning environment.
During the evaluation session, the ten specimens were presented one by one to participants on each of their computer screen. The participants were allowed to navigate and explore the given virtual scenario and were required to complete the task required. They were given a maximum of 10 minutes to explore each specimen. Then, 3 minutes were given to the participants to rate their feelings towards the specimens using the provided checklist without discussions with their peers. The whole session took approximately two hours to be completed.

4. Results and Discussion

The results of the study are essentially based on two main analyses: i) Principal Component Analysis and Partial Least Squares [17]. Principal Component Analysis is used to reveal the Kansei semantic space as well as the major factors of the specimens that influence the emotion (represented by Kansei words). On the other hand, Partial Least Squares is used to uncover the relationship between the emotion and specific design elements of each specimen.

4.1 Kansei Semantic Space

The semantic space is analysed by Principal Component Analysis [17] using the averaged evaluation value for each specimen. This step is pertinent in finding out the salient factors that could uncover the implicit relationship between the Kansei words and design element. The Principal Component Analysis results produced three major axes. Table 2 lists the three groups of Kansei words (with highest positive factor loadings) for each principal component.

Table 2: Three groups of Kansei words for each principal component

PC1	PC2	PC3
Confident	Interesting	Comfort
Curious	Lively	Calm
Satisfied	Fun	Fresh
Safe	Enjoyable	Thrilled
Motivated	Appealing	Lost

The first principal component (PC1) provided a contribution ratio of 64.5% while the second principal component (PC2) provided 22.1%. The third principal component (PC3), on the other hand, gave a contribution ratio of 8.7%. Clearly, majority of the data structure can be captured in the first two components as they represent a total of 86.6% of the total variability. This would mean that the structure of the Kansei words is highly influenced by the first two components. The remaining principal components account for a very small proportion of the variability and are considered as unimportant or not significant.

4.2 Indentifying the Salient Linkages

Using Partial Least Squares analysis, the coefficient values between emotion and design elements of each specimen were obtained. Design elements with the high coefficient value are considered to be influential on each of the ten emotions (as identified in PC1 and PC2). Table 3 shows the partial view of the tabulated data.

Table 3: Sample tabulated results from the Partial Least Squares analysis

Design elements	**Kansei**		
	Satisfied	**Safe**	**Motivated**
Coaching	0.11281	0.11408	0.11921
Navigational aids	0.10393	0.10634	0.04115
Modelling	0.02714	0.09982	0.03347
Environment Richness	0.03429	0.04291	0.12851
Information Resources	0.03241	0.09113	0.05492
Narration	0.03610	0.01828	0.04091
Problem Representation	0.05021	0.03147	0.03112
Objectives	0.01933	0.01921	0.02847
Multimedia Design Principles	0.05284	0.04113	0.04921

The highest coefficient values of design elements for each Kansei or emotion are then calculated. The obtained results are illustrated in Figure 3.

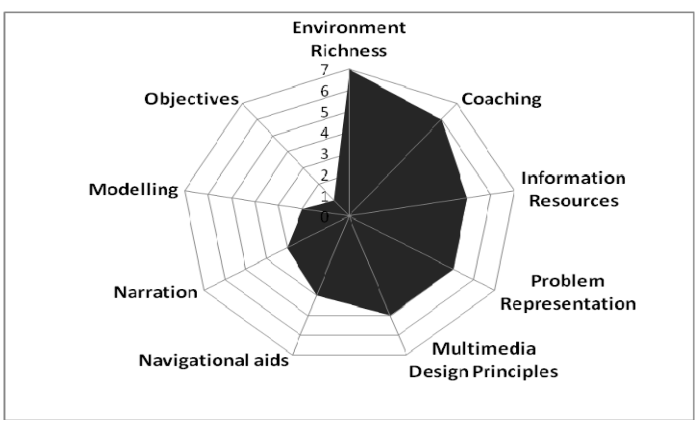

Figure 3: Number of emotions influenced by the design elements

As shown in Figure 3, environment richness of the VR-based learning environment turns out to be a very influential design element. The design element showed strong influence on seven out of the ten emotions. It shows the strongest influence on the emotions of appealing, curious and lively. This is consistent with the findings in previous studies [22, 23] that showed how the attractiveness of the computer-based instructional materials increases learners' positive emotions, which in turn improve their learning performance. The second most influential design element is coaching, which have strong relationships with six emotions especially on confident and motivated. This finding corresponds to the study by Kennewell, Tanner, Jones and Beauchamp [24] who found out that providing relevant guidance and feedback increases learners' confidence in completing a task.
Information resources, multimedia design principles and problem representation are all equally influential on five emotions. These design elements are mainly related to the interface aesthetics, which deal with the presentation of learning content via desktop VR. The design element of navigational aids shows strong influence on four emotions while narration and modelling influenced two and three emotions respectively. The least influential design element is objectives, affecting only one emotion. Interestingly, the presentation of objectives strongly influences the feeling of curiosity. Thus, it can be implied that the environment richness (the inclusion of more life-like 3D virtual objects) could arouse learners' interest and increase their curiosity in wanting to know more about the virtual environment that they are exploring. Craig et al. [25] postulates that a virtual environment which contain objects, content and characters of high realism can activate a person's interest in using the application.

5. Conclusion

Designing a VR-based learning environment to complement other teaching and learning approaches can be a complicated task, which requires careful planning and designing. The identified relationships between emotion and design elements in the present study can be used as a guideline to inform the design of emotionally-sound VR-based learning environment. Due to exploratory nature of the study, it was conducted using solely a VR-based learning environment related to teaching pedestrian safety skills. Thus, the result may not produce globally applicable features. Future research could address such limitation by including more learning environments for a more conclusive comparison. The addition of individual differences as variables in future research is also recommended as it would help to enhance the KE framework further by understanding how each individual reacts to a specific design element emotionally.

References

[1] Burdea, C. G., & Coiffet, P. (2003). *Virtual reality technology* (2nd ed.). New Jersey: Wiley & Sons.
[2] Fisher, P., & Unwin, D. (2002). *Virtual reality in geography.* London: Taylor & Francis.
[3] Cobb, S., Neale, H., Crosier, J., & Wilson, J. R. (2002). Development and evaluation of virtual environments for education. In K. M. Stanney (Ed.) *Handbook of Virtual Environments: Design, Implementation, and Applications* (pp. 911-936). New Jersey: Lawrence Erlbaum Associates Publishers.
[4] Roussou, M. (2004). Learning by doing and learning through play: an exploration of interactivity in virtual environments for children. *ACM Computers in Entertainment*, *2*(1), 1-23.
[5] Kalawsky, R. S., Bee, S. T., & Nee, S. P. (1999). Human factors evaluation techniques to aid understanding of virtual interfaces. *BT Technology Journal, 17*(1), 128-141.
[6] Stanney, K. M., Mourant, R. R., & Kennedy, R. S. (1998). Human factors issues in virtual environments: A review of the literature. *Presence, 7*(4), 327–351.

[7] Mahoney, J. (2004). What is constructivism and why is it growing? *Contemporary Psychology, 49,* 360-363.
[8] O'Regan, L. (2003). Emotion and e-learning. *Journal of Asynchronous Learning Networks*, *7*(3), 78-92.
[9] Pekrun, R. (1992). The impact of emotions on learning and achievement: towards a theory of cognitive/emotional mediators. *Applied Psychology: An International Review*, *41*, 359-376.
[10] Järvenoja, H., & Järvelä, S. (2005). How students describe the sources of their emotional and motivational experiences during the learning process: A qualitative approach. *Learning and Instruction, 15*(5), 465-480.
[11] Nummenmaa, M., & Nummenmaa, L. (2008). University students' emotions, interest and activity in a web-based learning environment. *British Journal of Educational Psychology*, *78*, 163-178.
[12] Kort, B., Reilly, R., & Picard, R. W. (2001). An affective model of interplay between emotions and learning: Reengineering educational pedagogy--building a learning companion. In *Proceedings of ICALT*, New York.
[13] Martin, B., & Briggs, L. (1986). *The affective and cognitive domains: Integration for instruction and research.* Englewood Cliffs: Educational Technology Publications.
[14] Martin, B. L., & Reigeluth, C. M. (1999). Affective education and the affective domain. In C. M. Regeluth (Ed.), *Instructional-design theories and models* (Vol. 2, pp. 485-509). Mahwah: Lawrence Erlbaum Associate.
[15] Bloom, B. S., Mesia, B. B., & Krathwohl, D. R. (1964). *Taxonomy of educational objectives.* New York: David McKay.
[16] Astleitner, H. (2000). Designing emotionally sound instruction: The FEASP-approach. *Instructional Science*, *28*, 169-198.
[17] Nagamachi, M. (1995). Kansei Engineering: A new ergonomic consumer-oriented technology for product development. *International Journal of Industrial Ergonomics*, *15*, 3-11.
[18] Schütte, S. (2005). *Engineering emotional values in product design - Kansei Engineering in development.* Sweden: Linköping Universitet.
[19] Chen, C. J., Toh, S. C., & Wan, M. F. (2004). The theoretical framework for designing desktop virtual reality based learning environments. *Journal of Interactive Learning Research*, *15*(2), 147-167.
[20] Chuah, K. M., Chen, C. J., & Teh, C. S. (2008). Incorporating Kansei Engineering in instructional design: Designing virtual reality based learning environments from a novel perspective. *Themes in Science and Technology Education*, *1*(1), 37-48.
[21] Cornelius, R. R. (1996). *The Science of emotion: research and tradition in the psychology of emotions*. Upper Saddle River: Prentice Hall.
[22] Park, S., & Lim, J. (2007). *Promoting positive emotion in multimedia learning using visual illustrations*. Journal of Educational Multimedia and Hypermedia. 16(2), 141-162.
[23] Ngo, D., Teo, L., & Byrne, (2003). Modelling interface aesthetics. *Information Sciences*, *152*, 25-46.
[24] Kennewell, S., Tanner, H., Jones, S., & Beauchamp, G., (2008). Analysing the use of interactive technology to implement interactive teaching. *Journal of Assisted Learning*, *24*(1), 61-73.
[25] Craig, A., Sherman, W. R., & Jeffrey, D. W. (2009). *Developing virtual reality applications: Foundations of effective design.* New York: Morgan Kaufmann.

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Appreciative Learning Approach: A New Pedagogical Option

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Abstract: This is a theoretical paper in which authors attempt to present appreciative learning approach as a new pedagogical option for educational setting. The paper starts with the description of Appreciative Inquiry (AI) as both theory and practice. Next, it discusses the eight principles of AI in relations to the current trend of learning. Then, the 4Ds (Discovery, Dream, Design, Destiny) model of AI that facilitates the practice of appreciative learning approach is illustrated. Authors propose some amendments to the initial model in order to promote more flexibility adapting to the aggressive technology progression. Subsequently, some thought provoking questions and recommendations for future researches are formulated at the end of the paper.

Keywords: Appreciative Inquiry, appreciative learning approach, pedagogical strategy

Introduction

Appreciative learning approach proposed by the authors as a new pedagogical option for educational setting is based on Appreciative Inquiry (AI). Conklin [1] believed classroom is a form of organization amenable to development and change. However, most schools in Asian countries are traditionally regarded as social institutions [2]. Tan and Law [2] described teachers dutifully transmitting standardized knowledge with conventional methods most of the time. The current norm seriously hold back students from exploring new ideas [3] and being creative [4]. In addition, it is also being deemed as dull and uninteresting by students [5] and it critically deprived students of their rights [6]. Therefore, appreciative learning approach is proposed as a pedagogical option for teachers.

1. Appreciative Inquiry (AI) – Theory and Practice

Appreciative and inquiry are defined as [7]:

> **Ap-pre'ci-ate, v.,** 1. to value; recognize the best in people or the world around us; affirm past and present strengths, successes, and potentials; to perceive those things that give life (health, vitality, excellence) to living systems. 2. to increase in value, e.g., the economy has appreciated in value. Synonyms: value, prize, esteem, and honor.
>
> **In-quire' (kwir), v.,** 1. to explore and discover. 2. to ask questions; to be open to seeing new potentials and possibilities. Synonyms: discover, search, systematically explore, and study.

Appreciative Inquiry (AI) is both theory and practice [8] [9] [10]. As a theory, AI offers a perspective, a set of principles, model, and beliefs about how human systems function. In terms of practices, AI is a transformative agent that recognizes the best in people and helps them moving towards their potential. It is a co-evolutionary search for the best in people and the relevant world around them [7]. According to Cooperrider et al. [7], the practice of AI involves systematic discovery of what gives life to a living system when it is most alive, most effective, and most constructively capable in human term.

AI practices focus on merging the past and present capacities such as achievements, assets, unexplored potentials, strengths, elevated thoughts, opportunities, high point moments, and visions into possible futures [10]. Fitzgerald, Murrell and Miller [11] described problem solving approach as lowered an individual's energy and creativity. On the other hand, by focusing on what is desired, constructive, and possible, it will shift a person's perception and effectiveness towards positive direction. This is because human systems grow in the direction where persistently search on the best of the past will create more desirable future [10]. The powerful images of oneself and the world around will help the person to inspire action and innovation. Cooperrider and Whitney [10] claimed positive images as an important technique to counter initial negative images, beliefs, and expectations. Practitioners guide subjects into discovering positive aspects of themselves and their surroundings, in order for the subjects to lead their life with better visions and actions. Therefore, AI practices start from the desired objectives to achieve and not from the existing problems to be solved.

2. The Eight Principles of Appreciative Inquiry and the Current Trend of Learning

The 21st century of learning uses technology heavily [12]. Yet, digital technology alone cannot be depended on to produce classroom dynamic [13] [12]. Students need to be guided by interesting task integrated with contemporary artefact in a constructive environment. Cramer [12] perceived teaching children of the current century to be more challenging since they were 'born with technology in their hands'. Thus, successful integration of technology into education need changes in teaching and learning strategies [14]. Appreciative Inquiry could be an ideal theoretical and practice guide for today's teachers.

Appreciative Inquiry is originated from management change process within large organisations but less commonly used at classroom level [15] [16] [17]. However, teachers are managers too. In addition, teachers need to manage students in the most humanizing ways. Neville [18] considered classroom as one of the living systems. In order for teachers to practice Appreciative Inquiry both as theory and practice, they need to be well versed with the eight principles of AI. Social constructionism provides the fundamental foundation for the first three principles of AI theory [10]:

i. Constructionist principle

Constructionist principle which based on generative theory focuses on anticipatory articulation of tomorrow's possibilities [10]. Students should not be treated as having brains like blank papers to be filled [19]. In fact, students have their own prior experience and understanding on all context of learning. Learning with technology is not about copy, cut, and paste information [12]. The current trend of authentic learning engages students in real-world and virtual communities of practice [20]. Students are expected to construct information into something novel. Learning itself is a constructive process where students construct personal interpretation of experience. Connections between knowledge and experiences are reform and refined from time to time. Therefore, based on the constructionist principle of AI, teachers are suggested to provide more opportunities for the construction of knowledge, skills, experience, and potentials in order for students to construct tomorrow's possibilities.

ii. Simultaneity principle

Simultaneity principle recognizes discovery and change as simultaneous process [7]. In order for students to change, they should be exposed to different available alternatives. Students will start reflecting and reconstructing their future based on what they found or discovered. The current trend of teaching and learning process is a shared responsibility between teachers and students [21]. AI practices acknowledge this accountability. Thus, in AI practices, teachers are encourage generate questions that will have impact on students' lives. When students start thinking and reflecting positively, simultaneously it co-creates their future possibilities.

iii. Poetic Principle

Pasts, presents, or futures are endless sources of learning, inspiration, or interpretation [10]. Neville [18] illustrated human system as an open book, where experiences being co-authored and co-created. Schools should have community with shared experiences, values, and aspirations. It will help creates connections between students and teachers through better understanding of one another. Students learn best when they experience strong relationship with their teachers and peers within the safe and supportive learning environment [22]. Van Tiem and Rosenzweig [23] also emphasize on the importance of positive language. The world can be created through the words we use and the knowledge we share with others.

The next two principles are based on imagery [11]. The well-known '*placebo effect*' explains situation where positive imagery leading to positive action. Imagery provides the foundation for the following principles:

iv. Anticipatory Principle

Cooperrider et al. [7] claimed that the most important resource for generating constructive change and improvement are through collective imagination and discourse about the future. This is because the images of the future will guide the current behaviour. Anticipatory principle assumes human systems as forever projecting ahead of themselves a horizon of expectation that brings the future powerfully into the present as a mobilizing agent [7]. Neville [18] hold teachers responsible in creating experiences whereby students learn to explore multiple perspectives and imagine beyond the existing. Learning by doing is considered the most effective way as visions are transform into actions and students are provided the opportunities to explore the implications of their actions, decisions, and perceptions [20]. Without a platform for students to take actions, visions will turn to hallucinations.

v. Positive Principle

Building and sustaining momentum for change requires large amounts of positive influence and social bonding [7]. Attitudes such as hope, excitement, inspiration, caring, friendship, sense of urgent purpose, and sheer joy in creating something meaningful are parts of the momentum. The more positive the questions and statements posed, the more long lasting and successful the change efforts. It does not help to begin from the standpoint of the world as a problem to be solved [10]. It will create more problems. Instead, students should be made to believe their capabilities. Life-long learning and innovation abilities emerge when curiosity and affirmation exist [18]. Hence, the theoretical and practice approach of AI provide teachers a guide in cultivating life-long learning among students. Learning does not stop when students graduated from any formal learning institution.

The next three principles are the evidences of the continuing evolution of AI theory [24]:

vi. The Wholeness Principle

Wholeness means involving the entire subjects in a large group to stimulate collective capacity [24]. Wholeness is expected to bring out the best in people. Wholeness does not only mean the involvement of entire subjects in a group but also the completeness outcomes. Learning should not focus entirely on the new knowing of skills and information. Being fun is an important element too. Fun in the sense of enjoyment and pleasure, will help putting students in a relax and receptive frame of mind for learning [25].

vii. The Enactment Principle

Preskill and Catsambas [24] highlighted that in order to really make a change, it should be the change one really wants to see. Positive change occurs when there is a model of the ideal future and living examples of the future. The future is now [24]. It can be created with words, images, and relationships. Students at adolescent age need to feel in control and in power [26]. Teachers should find a platform and pedagogical option in order for students to feel they are in control of their own learning.

viii. The Free Choice Principle

A person is perceived to perform better and more committed when there is freedom to choose [24]. Free choice stimulates creativity and positive change. Learning environment should not restrict student's cognitive process. Instead, students should freely construct knowledge and make choices that could accomplish their dreams. Education relates to what human beings need to learn in their own rights [6]. However, most Asian schools did not facilitate free choice principle in learning process [2]. Students have to follow strictly the conventional ways of teaching and learning. As a result, students often countered it with disciplines problems. On the other hand, if students were given more autonomy power in the process of learning, they will go beyond traditional ways [22]. Thus, the outcomes of learning will be a surprise for both teachers and students.

3. Appreciative Learning Approach and The 4D*s* Model of Appreciative Inquiry.

Appreciative learning approach proposed in this paper is based on Appreciative Inquiry (AI) theory. In order to put a theory into practice, it needs to be supported by a model. The 4D*s* (Discovery, Dream, Design, Destiny) model of Appreciative Inquiry (Figure 1) helps translate images into possibilities, intentions into reality, and beliefs into practice [7]. Cooperrider et al. [7] illustrated the 4D*s* model as revolving in the sequence of discovery, dream, design, and destiny respectively.

Figure 1 shows the core of the cycle is an affirmative topic choice. It is the most important part of the AI theory and practices [10]. The practices of AI do not focus on unmotivated subject matter. The 4D*s* model of appreciative learning approach links the energy of positive core to changes that never thought possible [7]. Therefore, teachers practicing appreciative learning approach need to look at students' most unappealing habits and behaviours as a positive starting point. These are opportunities and not detrimentally aspects that could not be countered.

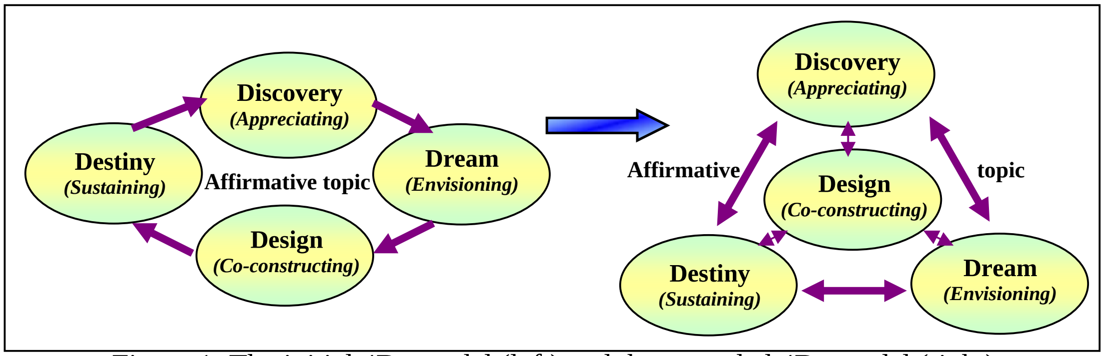

Figure 1: The initial 4D*s* model (left) and the amended 4D*s* model (right)

Discovery stage involves the process of valuing things that worth doing so from the perspectives of the beholders [7]. Dialogue and conversation can be used to facilitate the discoveries of positive moments and peak experiences [15]. The central aim during this phase is to search and appreciate what gives life and energy to a person [27]. Accordingly, teachers have to discover and appreciate students' experience in life, aware of what students love to do and accomplish in their life. Subsequently, teachers should provide opportunities for students to discover alternatives and potential in the areas students appreciate and value in their lives.

Secondly, the students are lead to envision and imagine the possibilities through dream stage. This is when the mind naturally begins to search in-depth and envisioning new potentials [7]. According to Cooperrider et al. [7], envisioning are transpired through passionate thinking, positive images of desires, and preferred future. Dream stage connects a person to images of all possibilities in relation to the discovered potential and capabilities. Teachers can lead their students in questioning themselves of what they want their world to be like with the experiences, skills and knowledge acquired.

The articulation of dreams into constructs occurs during design stage. In the design stage, the emphasis changes from dreaming to co-constructing [27]. Practitioners create opportunities for their subjects to act and achieve their dream at design stage [10]. The subjects will co-constructing their existing world with the dream they generated in previous stage. Design stage also meant to trigger students' curiosity to explore beyond the materials provided. Thus, environment and materials have to be designed to facilitate students in expanding their self-development and capacities, as well as realizing their dreams.

The last stage is destiny. Destiny stage strengthens the affirmative capabilities of the subjects [10]. It focuses on the sustaining of the development and innovation experienced in previous stages [27]. Destiny stage enables the subjects to envisage how they are going to empower their discovered and affirmed experiences, skills and knowledge. It assists the subjects in building long term hope and momentum in their life. Destiny looks beyond current needs and desires.

Today's students anticipating the use of technology during learning process [12]. Since we are in the 21st century, some of the skills and knowledge that are introduced at university level could now make its way to be learned much earlier with the ability of computer technologies in schools [28]. However, most of the time, teachers did not push students to work at higher cognitive levels [29]. It may be due to the weight focus on examination commitments. In addition, teachers find themselves still playing catch up with technology [30]. Teachers often lack the skills and knowledge to integrate technology effectively into their classrooms [21]. On the other hand, today's students know more and will always know more than their teachers about technology and how to manipulate it [21]. Learning by doing, active learning, authentic learning, and experiential learning is the foreground of today's education [31]. Thus, appreciative learning approach could be an appropriate pedagogical strategy for teachers of current generation.

Based on the current trend of technology progress and students' learning style, authors wish to propose some amendments to the initial 4D*s* model of appreciative learning approach (Figure 1). Although the model has been amended, the objectives of all the stages remain the same. Tracking along the rigid sequence of discover, dream, design and destiny stages did not provide flexibility to the process of learning. Learning with digital technology is not always the case where students start with discovering of new knowledge and skills. Students can actually start by having a dream or destiny before proceed to discovery stage. By having dream or destiny, students may take the initiatives by discovering more knowledge and skills that can help accomplishes their dream or destiny. By discovering more knowledge and skills, students are expected to generate or even change their dream, design, and destiny simultaneously. The concrete outcomes are produced through design stage. While constructing their products, students may have changed their dreams, as well as their future envisions in destiny stage. Therefore, active, authentic and experiential learning complemented with digital technology tool needs a more flexible 4D*s* model of appreciative learning approach.

As a conclusion, appreciative learning approach does not view students as lack of ideas. Students might be lack of skills and opportunities to think about their own ideas, turning ideas into construct and decide their own destiny based on what they believe in. Therefore, with the application of appreciative learning approach, students' opinions will be the fundamental base for teachers to take actions accordingly and prepare more opportunities for students to act and making own decisions.

4. Issues and Future Research for the Practice of Appreciative Learning Approach

Authors had tapped on the application of appreciative learning approach in computer games development class for enhancing students' creative perception [32] and creative process [33]. Other researchers probed the practice at tertiary level in management classes [1] [15] [34], in promoting social inclusion of students with disabilities into the school system [35], and business organizations [11]. The question remains as to how appreciative learning approach can be best fit into conventional classroom in teaching standard curriculum. What are the benefits teachers and students might gain when appreciative learning approach is applied into conventional classroom?

The fast evolving technology development has indeed a major challenge for many teachers [36]. While teachers are trying to be comfortable with the contemporary technology, at the same time, teachers need to utilize suitable pedagogical strategy. Authors proposed appreciative learning approach as a new pedagogical option for teachers whom complemented students' learning process with technology tools which students love using. Learning is no more a mere process of knowing. It is a process of utilizing knowledge and skills to produce outcomes that students can be proud of and claim its ownership. Authors foresee teachers might have contradicting belief with students. Thus, how far teachers are willing to change their own attitudes toward learning and teaching process? Will teachers be more receptive and acknowledge students' desires and dreams? Are teachers willing to put extra effort in preparing the settings which consist of discovery, dream, design, and destiny stages that could facilitate students' learning process?

At the end of the day, students and teachers will still facing the assessment of standard curriculum. No one in authority is interested to know what students have learned beyond the standard curriculum. What has been our sadness as educators are the inability in making learning as whole life process. The current norm fails to provide students a platform to think of their future destiny in relation to their current desires. Learning becomes a force action. Teachers are so used in criticizing and belittling students' habits and behaviours by referring to the society norm, without thinking how to manipulate the unwanted elements to improve students' self-development. For example, if students like smoking, maybe they can be given task in finding ways to curb smoking through their own experimental research. As a conclusion, if teachers are receptive to Appreciative Inquiry as both theory and practice, it will change not only the teachers' attitudes, but their pedagogical strategy in class as well. Accordingly, learning will be meaningful and worthwhile experience for students. Therefore, Appreciative Inquiry is a recommended guide for teachers to create classroom dynamic.

5. Summary

In brief, appreciative learning approach does not put teachers as the dominant figure in learning process. What students feel, think, and desire are the most important aspects in learning. It is definitely a mistake to continue teaching students in the time-worn ways as their expectations are beyond what the curriculum offers. However, authors do not assume every student as having the same learning style. Therefore, there is no one best pedagogical strategy in education. Appreciative learning approach could be just another new pedagogical option for teachers of current generation.

Bibliography

[1] Conklin, T. A. (2009). Creating classrooms of preference. Journal of Management Education, 33(6), 772-792.
[2] Tan, A.-G., & Law, L.-C. (2004). *Creativity for teachers*. Singapore: Marshall Cavendish International.
[3] Vint, L. (2005). Fresh Thinking Drives Creativity Innovation. *Quick*(94), 20-22.
[4] Northcott, B., Miliszewska, I., & Dakich, E. (2007). ICT For (I)nspiring (C)reative (T)hinking. *Paper presented at ICT: Providing Choices for Learners and Learning, Singapore*, 761-769.
[5] Eow, Y. L., & Roselan, B. B. (2008). An exploratory study on the reasons and preferences of six Malaysian students on the video games played. *Journal of Environmental and Science Education, 3*(1), 19-25.
[6] Wilson, J. (2003). The concept of education revisited. *Journal of Philosophy of Education, 37*(1), 101-108.
[7] Cooperrider, D. L., Whitney, D., & Stavros, J. M. (2008). *Appreciative inquiry handbook: For leaders of change (2nd edition)*. Brunswick, OH; San Francisco: Brown.
[8] Whitney, D., & Trosten-Bloom, A. (2003). *The power of Appreciative Inquiry*. San Francisco, CA: Berrett-Koehler.
[9] Watkins, J. M., & Mohr, B. J. (2001). *Appreciative Inquiry: Change at the speed of imagination*. San Francisco, CA: Jossey-Bass/Pfeiffer.
[10] Cooperrider, D. L., & Whitney, D. (2005). *A positive revolution in change: Appreciative inquiry*. San Francisco, CA: Berrett-Koehler Publishers.
[11] Fitzgerald, S. P., Murrell, K. L., & Miller, M. G. (2003). Appreciative inquiry: Accentuating the positive. *Business Strategy Review, 14*(1), 5-7.
[12] Cramer, S. R. (2007). Update your classroom with learning objects and twenty-first-century skills. *Learning Objects and Twenty-First-Century Skills, 80*(3), 126-132.
[13] Sassen, S. (2004). Space and power. In N. Gane (Ed.), *The future of social theory* (pp. 125-152). London: Continuum.

[14] Wadmany, R., & Levin, T. (2004). The use of Information technologies in the classrooms: Patterns of change and development in educational beliefs and in educational practices among teachers and their students. Paper presented at the Proceedings of Society for Information Technology & Teacher Education International Conference 2004, Chesapeake, VA: AACE.

[15] Yballe, L., & O'Connor, D. (2000). Appreciative pedagogy: Constructing positive models for learning. Journal of Management Education, 24(4), 474-483.

[16] Doveston, M., & Keenaghan, M. (2006). Growing talent for inclusion: Using an appreciative inquiry approach into investigating classroom dynamics. *Journal of Research in Special Education Needs, 6*(3), 153-165.

[17] Morsillo, J., & Fisher, A. (2007). Appreciative inquiry with youth to create meaningful community projects. *The Australian Community Psychologist, 19*(1), 47-62.

[18] Neville, M. G. (2008). Using appreciative inquiry and dialogical learning to explore dominant paradigms. *Journal of Management Education, 32*(1), 100-119.

[19] Bencze, J. L. (2007). Constructivist learning theory. Retrieved August 18, 2007, from http://leo.oise.utoronto.co/~lbencze?Constructivism.html

[20] Lombardi, M. M. (2007). Authentic learning for the 21st century: An overview [Electronic Version]. *Educause - Learning Initiative*. Retrieved May 10, 2010 from http://net.educause.edu/ir/library/pdf/ELI3009.pdf.

[21] Prensky, M. (2007). How to teach with technology: Keeping both teachers and students comfortable in an era of exponential change. In BECTA (Ed.), *Emerging technology for learning (Volume 2)* (pp. 39-46). Conventry, JJ, UK: British Educational Communications and Technology Agency (BECTA)

[22] Filleul, M., & Rowland, B. (2006). Using appreciative inquiry in the Vancouver school district: A positive approach to enhance learning [Electronic Version]. *BC Educational Leadership Research*. Retrieved January 20, 2009 from http://www.vsb.bc.ca/NR/rdonlyres/2472C846-D90E-4BA6-8FA9-DC6ED5FD4A74/0/UsingAIintheVSDbyMaryFilleulandBarbaraRowland.pdf.

[23] Van Tiem, D., & Rosenzweig, J. (2006). Appreciative inquiry [Electronic Version]. *Info Line: Tips, Tools, and Intelligence For Trainers.* , 6 (1). Retrieved January 15, 2009 from http://books.google.com/books?id=VJqvEcEJyKEC&printsec=frontcover&dq=Van+Tiem,+D.,+%26+Rosenzweig,+J.+(2006).+Appreciative+Inquiry.&sig=poHQyVN4HNxIxq2JpjOxGiBTDLo#PPP1,M1

[24] Preskill, H., & Catsambas, T. T. (2006). *Reframing evaluation through appreciative inquiry*. California, US: Sage Publication, Inc.

[25] Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.

[26] Blackwell, B. S., Sellers, C. S., & Schlaupitz, S. M. (2002). A power-control theory of vulnerability to crime and adolescent role exits - revisited [Electronic Version]. *The Canadian Review of Sociology and Anthropology*. Retrieved July 13, 2008 from http://goliath.ecnext.com/coms2/gi_0199-1775938/A-power-control-theory-of.html.

[27] van der Haar, D., & Hosking, D. (2004). Evaluating appreciative inquiry: A relational constructionist perspective. *Human Relations, 57*(8), 1017–1036.

[28] Resnick, M. (2002). Rethinking learning in digital age. Retrieved July 8, 2007, from http://www.cid.arvard.edu/cr/pd/gitrr2002_ch03.pdf.

[29] Niederhauser, D. S., & Lindstrom, D. L. (2006). Addressing the nets for students through constructivist technolgoy use in K-12 classrooms. *Journal of Educational Computing Research, 34*(1), 91-128.

[30] Sprague, D. (2004). Technology and teacher education: are we talking to ourselves? *Contemporary Issues in Technology and Teacher Education, 2004,* 353-361.

[31] Pivec, M. (2007). Play and learn: Potential of game-based learning. *British Journal of Educational Technology, 38*(3), 387-393.

[32] Eow, Y. L., Wan Zah, B. W. A., Rosnaini, B. M., & Roselan, B. B. (2010). Computer games development and appreciative learning approach in enhancing students' creative perception. *Computers & Education, 54*(1), 146-161.

[33] Eow, Y. L., Wan Zah, b. W. A., Rosnaini, b. M., & Roselan, b. B. (20xx). Computer games development and appreciative learning approach for creative process enhancement. *Computers & Education xx*(x), xx-xx.

[34] Watt, L. (2007). Appraising professional practice in a tertiary environment using appreciative inquiry. *Proceedings of 30th HERDSA Annual Conference: Enhancing Higher Education, Theory and Scholarship [CD-ROM], July 8-11, Adelaide, Australia*.

[35] Calabrese, R., Patterson, J., Liu, F., Goodvin, S., Hummel, C., & Nance, E. (2008). An appreciative inquiry into the circle of friends program: The benefits of social inclusion of students with disabilities. *International Journal of Whole Schooling, 4*(2), 20-49.

[36] Juniu, S. (2006). Use of technology for constructivist learning in a performance assessment class. *Measurement in Physical Education and Exercise Science, 10*(1), 67-79.

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E-learning system design with humor and empathy interaction by virtual human to improve students' learning

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Abstract: Students' affections have a significant impact on motivation and learning performance. Many researches revealed that humor has a great effect on students' learning motivation and emotion. And some researchers thought empathy can increase students' interests and self-efficiency and ease off negative emotions. Therefore, we try to add several emoticons into e-learning system to capture learners' emotions and design a humorous and empathic virtual human to respond to learners' emotions at proper moments. In this paper, we had done a preliminary experiment which showed the virtual human with humor and empathy can enhance learners' motivation, learning performance, and ease learners' emotions.

Keywords: E-learning, humor, empathy, virtual human

Introduction

Many students have an experience, which they always feel sleepy, bored, and some negative emotion, in their learning life. When students have these negative emotions, they usually do not learn well. Students' emotions can impact how motivated student is to continue with the learning process and the way student perceives the learning process significantly. However, in e-learning system, it is difficult and important to capture learners' emotions and give them feedback at appropriate moments. Moreover, tutor may not interact with learners well in e-learning because there is no gaze and emotional communication between their interactions. Therefore, we try to improve these problems in e-learning by the design of a humorous and empathic virtual human.

Studies have indicated that a learning system with affective interaction may increase student' motivation, makes the system more engaging, and persuade learners during the interaction [23][26]. Students' emotions are varied and complex, so they are difficult to be recognized and be responded appropriately by computer systems. Researchers have tried to detect user's affective states and give appropriate feedbacks. Jaques used the BDI approach to infer student's emotions and use an affective pedagogical agent to give an appropriate affective feedback according to these emotions [13]. To make the computer recognize emotions, many researchers used sensors to read their emotional parameters [7][24]. Picard developed an affect-sensitive system that can detect student's emotion via sensors such as cameras, posture patterns, screen-capturing software, etc, and an embodied pedagogical agent would give empathetic or motivational statement to students [7].

Empathic reaction can increase students' interests and self-efficiency [17]. The definitions of empathy that based on Roger's explanations is the process of putting oneself in the place of another person, seeing matters from the other's perspective, perceiving the other's feelings and thoughts and conveying this awareness to that person [5]. An empathic interface may improve human–computer interaction and reduce users' frustration [18]. Existed study also indicates that an empathic learning system can encourage and persuade students [26]. Hence, we use empathy as one of the emotional responses.

Humor also can help students learn well. There are many researches revealed that humor could exert a positive influence on students' learning. Teachers often use humorous performance to motivate students, attract their attention, and increase their remembrance in traditional learning environments [1][15]. Humor can also release students' negative emotion, such as anxiety, stress, or nervous, and promote the relationships between students and teachers in learning processes [16]. Classroom information is kept longer when presented in a humor manner [19]. Humor which is relevant to the learning materials can enhance the retention of the concepts being taught [15]. In addition to applying humor to the traditional learning environment, it has also been applied to the e-learning environment. Houng thought humorous virtual human applying to e-learning can enhance students' learning motivation and ease their emotion [11]. A great deal of e-learning systems was built, but no humorous performances were designed in most e-learning systems. Consequently, we design a humorous database for supporting emotional feedback and interaction.

In recent years, virtual human was applied extensively in e-learning environments to improve human-computer interaction. Actually, the most successful application of virtual human is to serve as a supporting role in e-learning environments, especially instructor, trainer, and companion, to assist students to learn [1][2][14]. Some researchers showed the virtual human with abundant face expressions and body movements can enhance students' learning motivation and will [3][20]. The virtual human with plentiful emotion can enhance students' motivation intensively [14]. Among these studies, we use virtual human to give feedback in this study. The performance of virtual human could be adjusted freely to what we want. The virtual human could be a useful style of computer interface to interact with students. Students could feel more interested and attractive in humorous learning processes by using virtual human.

As above-mentioned, many researches revealed the design of emotion capturing, empathy, humor, and virtual human may be effective on learning separately. Empathic interface may improve human–computer interaction and reduce learners' negative emotion. But, only using empathy to interact with learners sometimes is not enough when learners' feel confused or frustrated because it may not help them to solve their problems in leaning. Therefore, we proposed humor performance to let learners understand and impress on learning. In this paper, we design an affective interface and learning process with a humorous database by virtual human to interact with learners to improve existing e-learning system. The aims of our learning system are as follows:

1. To help students deal with negative emotions and keep their attention
2. To enhance students' learning motivation, interest, and performance

1. System Description

Figure 1. System Interface

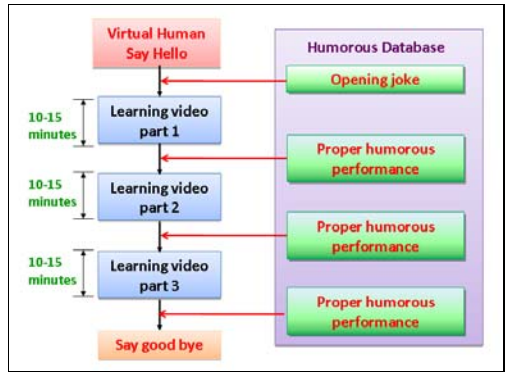

Figure 2. Learning Process

The purpose of our study is to (1) design several emotional buttons for capturing and empathizing learners' emotion, (2) search proper humorous performance from the humorous database, which was built by us, and add these into the existing learning materials at proper moments. For the purpose, we designed an empathic and humorous learning system to promote students to enhance their learning motivation and performance (Figure 1). Figure 1 show our system interface which was composed of video playing part and emoticon part that learners can express their learning emotion freely.

1.1 Learning Process

In this study, we divided the learning process into several segments (each segment is 10-15 minutes) and take 1-2 minutes break between each learning segment which was suggested by Weaver et al. [27]. For keeping students' learning interest, attention and impression on the previous learning, we queried the proper humorous performance which is related with the previous learning segment from humorous database into this learning process (Figure 2). Figure 2 shows the learning process in this study; in the beginning, virtual human introduce herself and say an opening joke for motivating students to learn and release their stress, tension, anxiety, and other negative emotions [2]. And then move to the learning video part to learn lecture. During the learning video part, students can follow their emotion to click the emoticons we designed to interact with virtual human and release students' emotions. In the following sections, we will describe emotion capture, responses, and humorous database in detail.

1.2 Emotion Capture

We want to know the critical emotions that have influence on learning, first. Many studies have proposed models of learning-related emotions [21]. Learners are less effective at learning when distracted, boredom, and stressed [6]. Students usually cannot learn well and take in information efficiency when they have negative emotions. Based on the studies above, we choose the negative emotions boredom, dissatisfied, confusion, and frustration. Besides these negative emotions, we also choose two positive emotions joy and interested that may occur in our system.
In this study, we let learners to express their emotions only by mouse-clicking. The reasons are as following: First, complicated software and hardware systems also might not be easy to promote to the public. These systems will take a lot of money, too. The second reason is that people would disguise negative emotions because of social pressures, so these emotions

would be difficult to be detected. So when the users can freely reflect or report their emotions, they will prefer to express their emotions. To make learners more willing to express their emotions, we let they can use emoticons to express their emotions. We choose some sets of emoticons that are commonly used on internet.

1.3 Emotional Responses

Students' motivational beliefs depend largely on how tutors provide feedback, so how to give feedback to learners is an important problem. In this paper, we use empathy and humor as the emotional response. According to social psychologists, empathy is defined as " putting oneself in the place of another person, seeing matters from the other's perspective, perceiving the other's feelings and thoughts and conveying this awareness to that person" [12]. We design our virtual human with empathy by considering the three important elements of empathy as follows: Firstly, putting ourselves in the place of the target and seeing matters from his/her perspective. Secondly, understanding and perceiving correctly the target's thoughts and affective states. Thirdly, conveying empathic considerations to the target [12]. For another emotional response we used, some researchers thought humor has the ability to decrease students' anxiety, improve students' learning, and boost their self-esteem [2]. Humor can enhance emotional and social involvement, and through humorous conversations are enlivened, become more interesting and enjoyable [8]. And it is also a way of getting students to pay more attention, and enhancing the recall of classroom information [22]. Therefore, we try to design the virtual human with humor for responding learners' emotions.

When the learner expresses his/her emotions in our system, the virtual human will encourage and persuade them with empathy and humor into persistent learning according to learner's emotional states. For example, if learners feel bored, virtual human will says" I am sorry that you seem to feel bored, let me tell you a joke to make you happy". For another example, if learners feel confused, virtual human will soothe the learner and tell a proper humorous story which was queried from humor database to assist his/her learning. With regard to humor database, we will describe it next section.

In the case of the design of virtual human, we referred to several studies as follow. For the facial expressions of virtual human, we designed it refer to the design of facial expressions proposed by Ekman [9]. For gestures and body movements, we designed this aspect by referring to some researches of psychologists, behaviorists, and arts performers [10]. Figure3 and Figure 4 show the virtual human, Maggie, care and encourage learners by plentiful facial expression, gesture, and body movement for transferring learners' negative emotion to positive emotion (Figure 3, Figure 4).

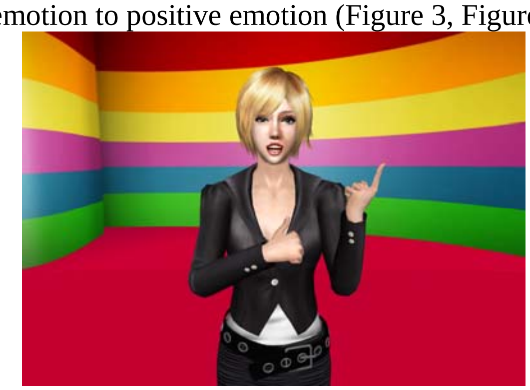

Figure 3. The virtual human cares for learners.

Figure 4. The virtual human encourages learners.

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1.4 Humor Database

For supporting humorous learning system, we build a humor database. We search and collect the humorous materials which are composed of humorous figural, verbal, physical and auditory, and so on [25]. According to some famous researches, this database is composed of humorous performances with avoiding ridiculing students, not related with learning materials, inimical humor, taboo humor, using humor to weaken serious things which is such as drinking, drug taking, drunk driving, and so on [25].
According to above-mentioned researches about humorous virtual human and humor how to be designed, we found the database we designed is not all humorous performances related with learning materials. Therefore, we created some humorous performances which were learning-related by the principles suggested by Chiou et al. [4]. They found most often used humor-creating skills were homonym, word-combination, lexical ambiguity, syntactic ambiguity, erroneous inference, reinterpretation, and metaphorical inference. After their evaluation, they found homonym, word-combination, lexical ambiguity, and syntactic ambiguity have much better effects on creating humor. Hence, we queried humorous jokes from the database and created proper humorous performances which were much related with learning materials by above-mentioned four skills and several humorous strategies in teaching proposed by Berk, such as opening joke, humorous questions, humorous examples, and so on [2]. Figure 5 shows a part of the humorous performance which was related with learning materials and expressed by virtual human and funny pictures in order to make learning interesting. Figure 6 reveals that the virtual human was telling a humorous riddle as a humorous example. The purpose of these humorous performances is to relax learners and increase their impression on their learning.

Figure 5. The humorous performance with funny pictures.

Figure 6. The virtual human is telling a humorous riddle.

2. Experiment

The purpose of this experiment was to understand whether providing an empathic and humorous virtual human environment in which students interact with animated virtual human results in more motivated, interesting, and effective learning than providing the same information as an on-screen traditional learning video environment. To verify the effect of empathic and humorous virtual human, the experiment included two treatments. One treatment was experimental group which was to evaluate the situation of students using the system with empathic and humorous virtual human. The other treatment was control group which was to test the situation of students using the system with non-empathic and non-humor virtual human for comparing with experimental group.

2.1 Participant and Procedure

Participants in the evaluation were 16 college students (12 males and 4 females) in National Central University. 8 participants served in the experimental group and 8 participants served in the control group. Each participant was randomly assigned to a treatment group (experimental group or control group). For each participant, the paper-and-pencil materials consisted of a pre-test, a post-test, and a questionnaire. The computerized materials consisted of a multimedia computer program on teaching Chinese history. It would take about 30 minutes to interact with the system. To measure the participant's level of history before and after learning, paper-and-pencil pre- and post-tests were administered.

In the beginning of this experiment, all participants were asked to complete a pre-test. When the participants had completed the pre-test, the experimenter presented oral instructions that how to interact with the system. After the participant logged in the learning system, the virtual human, Maggie, would introduce herself and tell an opening joke. When participant began to learn, he/she could express his/her emotion by clicking emoticons. After he/she expressed his/her emotion, Maggie would give response according to his/her emotion. After interacting with the learning system, the participant was asked to complete the post-test. And then the participant in experimental group had to complete the questionnaire with a five point Likert scale (5 = strongly agree; 1 = strongly disagree). Finally, we interviewed each participant who was in experimental group to know the participants' viewpoints about our design.

2.2 Results

The score of the pre-test and post-test were conducted for the learning performance. We compared and analyzed the score of post-test subtracting pre-test of each group by T-test analyzing. According to the result of our analyzing, we found the experimental group was significantly better than control group in learning performance ($P=0.025$, $t=-2.503$, $P<0.05$). Therefore, we can know our design has a significant effect on students' learning performance.

Table 1 shows some of the results of the questionnaire. According to the results, the participants thought that the virtual human can facilitate to increase their attention and interests. In motivation, they told us that the humorous performance expressed by virtual human can let them relax and be willing to continue learning.

Table 1: The means of questions

Questions	Mean
1. The proper humorous performance expressed by virtual human in the learning process can increase my learning attention.	4.5
2. The proper humorous performance expressed by virtual human in the learning process can make learning material interesting.	4.2
3. Putting the proper humor performance into the learning system can motivate me to use the learning system	3.9
4. The proper humorous performance expressed virtual human in the learning system can help me learn better.	4.3
5. The virtual human's humorous performance do not interfere me during the learning process.	4
6. For the empathic expression of virtual human, I can feel her cares for me.	3.6
7. I can get rid of the negative emotions after interacting with the humorous and empathic virtual human	3.8
8. Interacting with the humorous and empathic virtual human can increase my positive emotions.	4

In this study, we let the users freely express their emotions. According to the systematic logs, the emotion that participants expressed the most was confused and interested. They told us that they usually clicked confusion button when they need the humorous performances to help them remember. According to our observation and interview, the probability that they expressed their emotions when they were really in these emotional states was about 60%. Sometimes they did not express their emotions when they had these emotions. According to the interview, some participants said that they did not express their emotions because they thought they can deal with emotions by themselves then. Most participants like virtual human's humorous performance more than the empathic responses because they thought those performances can help them understand the learning materials and get great effect on tests. Overall, most of the participants are willing to use this system again.

3. Discussion

In this paper, we design a system that students could freely express their emotions and the virtual human would use humor and empathy to deal with student's emotions. The first problem that we encountered was how to know student's emotional states. Many studies used automatic affect recognition and automatic respond to users. Although this is a good solution, sometimes students like to have rights to control in the learning process. According the interview, some participants said that they prefer to decide the time that virtual human to appear. The reasons are as following: The unexpected response may interrupt their learning then. Sometimes the students can deal with emotions by themselves. The other problem that we encountered was that students did not express their emotions. One of the reasons is that the experimental period was too short to experience some emotional states for some participants. Besides, we also found the emotions that they are more willing to express are bored, confused and interested.

In this study, we designed the humorous performances that were learning-relevant to help students remember. There are two kinds of the performances. One would appear at the end of every learning video, and the other appeared when the students expressed their emotions. In our interview, some participants said that they like the humorous performances that appeared at the end of every learning video more than the other one because the performance and learning video didn't link up very well. Sometimes the student would fell strange after the emotional responses. We will keep on improving our design according to the results and interviews.

4. Conclusion and Future Work

This research proposed an approach of interaction with a virtual human with humor and empathy in e-learning system by clicking emoticons. In this study, the humorous performance can motivate learners to learn, make them feel more interested in learning, relax their learning emotion, and enhance their learning performance. Besides, empathic responses can relax their emotions and take a short break even though it is not better than humor performance in learning performance. Overall, the e-learning system with a humorous and empathic virtual human can keep learners' attention and enhance their learning motivation, interest, and learning performance.

In further work, virtual human should be much more empathic to let learners feel truly cared for. The humorous performance should be tightly related with learning materials and be inserted at proper moments. And the humorous database needs to be much stronger for supporting e-learning system. A great deal of participants is needed to verify the performance of each design.

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References

[1] Bandes, B. (1988). Humor as motivation for effective learning in the classroom.
[2] Berk, R. A. (1996), student ratings of 10 strategies for using humor in college teaching,? Journal of Excellence in College Teaching, 7, 71-92.
[3] Cheng, Y., Chang, C., & Chen, G. (2008). Design an Interactive Agent by Multi-Empathic Strategies to Reduce Student's Negative Emotion.
[4] CHIOU, F., CHEN, H., & CHO, S. (2003). A Course Design for Creative Training of Humor and the Effects of an Empirically Evaluative Study. *Bulletin of Educational Psychology,* 179-198.
[5] Davis, M. (1996). Empathy: A social psychological approach: Westview Pr.
[6] Dirkx, J. (2001). The power of feelings: Emotion, imagination, and the construction of meaning in adult learning. *New directions for adult and continuing education, 2001*(89), 63.
[7] D’Mello, S., Picard, R., & Graesser, A. (2007). Toward an affect-sensitive AutoTutor. IEEE Intelligent Systems, 53-61.
[8] Dormann, C., & Biddle, R. (2006). Humour in Game-Based Learning. Learning, Media & Technology, 31(4), 14.
[9] Ekman, P., & Friesen, W. (1975). *Unmasking the face: A guide to recognizing emotions from facial clues*: Prentice-Hall Englewood Cliffs, NJ.
[10] Givens, D. (2001). The Nonverbal dictionary of gestures, signs and body language cues. *Center for Nonverbal Studies Press*.
[11] HUANG, C., WANG, C., & CHEN, G. Building a Humorous Virtual Human to Enhance Student’s Motivation and Performance in E-Learning Environment.
[12] Influence of managers’ empathic skills on school success
[13] Jaques, P., Lehmann, M., & Pesty, S. (2009). Evaluating the affective tactics of an emotional pedagogical agent.
[14] Johnson, W., Rickel, J., & Lester, J. (2000). Animated pedagogical agents: Face-to-face interaction in interactive learning environments. International Journal of Artificial intelligence in education, 11(1), 47-78..
[15] Kaplan, R., & Pascoe, G. (1977). Humorous lectures and humorous examples: Some effects upon comprehension and retention. Journal of Educational Psychology, 69(1), 61-65.
[16] Kher, N., Molstad, S., & Donahue, R. (1999). Using Humor in the College Classroom to Enhance Teaching Effectiveness in" Dread Courses". College Student Journal, 33(3).
[17] Kim, Y. (2005). Empathetic virtual peers enhanced learner interest and self-efficacy.
[18] Klein, J., Moon, Y., & Picard, R. (2002). This computer responds to user frustration::: Theory, design, and results. *Interacting with computers, 14*(2), 119-140.
[19] Korobkin, D. (1988), Humor in the classroom: Considerations and Strategies, College Teaching, 36, 154-158.
[20] Lee, T. (2007). Building an Interactive Caring Agent for Students in Computer-based Learning Environments.
[21] O’Regan, K. (2003). Emotion and e-learning. *Journal of Asynchronous learning networks, 7*(3), 78-92.
[22] Powell, J. P., and Andresen, L. W. (1985), umor and teaching in higher education, Studies in Higher Education, 10, 79-90.
[23] Robison, J., McQuiggan, S., & Lester, J. (2009). Modeling Task-Based vs. Affect-based Feedback Behavior in Pedagogical Agents: An Inductive Approach.
[24] Sarrafzadeh, A., Alexander, S., Dadgostar, F., Fan, C., & Bigdeli, A. (2008). How do you know that I don’t understand? A look at the future of intelligent tutoring systems. Computers in Human Behavior, 24(4), 1342-1363.
[25] Shade, R. (1996). *License to laugh: Humor in the classroom*: Teacher Ideas Pr.
[26] Wang, C., Chen, G., Liu, C., & Liu, B. (2009). Design an empathic virtual human to encourage and persuade learners in e-learning systems.
[27] Weaver, R., & Cotrell, H. (1987). Ten specific techniques for developing humor in the classroom. *Education, 108*, 167-179.

Blended Learning in Higher Education: An Exploration of Teaching Approaches

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Abstract: The blended mode of learning has become increasingly popular in higher education. The purpose of this study is to explore the pedagogical use of ICT in a blended learning context. Focusing on teachers' and students' experiences in higher education, we examine the following questions: What are the teaching approaches on pedagogical use of ICT across faculties? What are the students' experiences in engaging with different teaching approaches? The findings of four case studies suggest four teaching approaches, namely, online discussion, online resources for teaching and learning, enhancing course management and delivery, and supporting specific pedagogy. It is believed that these approaches are pedagogical practices in transition and provide empirical evidence to shed light on issues in the research of blended learning in higher education.

Keywords: pedagogy, blended learning, teaching approaches, higher education

1. Introduction

Twenty-first century universities are continuing to go through rapid socio-economic and technological changes. These changes have brought a clear call for universities to carefully examine their educational practices from a new perspective and face challenges that lie ahead in knowledge-based societies [1]. These challenges include a large population of learners from varied backgrounds, needs, motivations, abilities, learning preferences, time availability and course content requirements; a greater number and variety of higher education places without corresponding increase in funding [2]; a demand for more "client" responsive and flexible courses; and the drive to use information and communication technology (ICT) in teaching and administration [3]. In facing such challenges, academic leaders in higher education need to rethink organizational structures, operational strategies, and policies appropriate for the ongoing digital age [4].

Despite an evident growth and potential for ICT in higher education [5] [6] [7], studies such as Fox and Herrmann [8] highlight the limitations of teacher and student uptake of ICT for educational purposes. Furthermore, academic e-learning has usually been focused on quantity over quality, and on superficial technological adoption rather than conceptual pedagogical change process [9]. As a result, many university students and teachers make only limited formal academic use of ICT in teaching and learning [10]. Thus, an apparent self-evidence of educational innovation using ICT hardly prompts people in higher education to reflect on the very idea of innovation and consequence [11]. The predicted "paradigm shift" in teaching and learning using ICT has not yet occurred [12] [13], and the impact of ICT on the quality of learning and teaching needs further evidence.

Integration of ICT in teaching and learning should emphasize interaction, flexibility and innovation [14] [10], and it is to be realized by linking purpose, people and pedagogy [15]. ICT implementation in higher education is not a simple technological adoption, and it involves the consideration of a number of issues, such as infrastructure, pedagogical practices, obstacles, student learning, organizational culture, organizational structures, operational strategies, and appropriate policies[4] [16].

Although e-learning is occasionally defined as “the online delivery of information for purposes of education, training, or knowledge management” [17], learning is shifting from teacher-centered to learner-centered and the desire to move from the traditional transmission model to the constructivist and interactionist frameworks [18]. Despite the fact that numerous studies reported ICT is being used by higher education institutions and innovative technology can facilitate educational reform, the diffusion of technological innovation for teaching and learning has not been widespread, nor has ICT become deeply integrated into the curriculum [19]. In fact, ICT-supported innovation in pedagogy, curriculum, and assessment is rare in higher education [12] [13]. As Collis and Wende [20] concluded in the report of an international comparative survey on the current and future use of ICT in higher education, a “business as usual” approach is taken without anticipating any real dramatic changes in mission.

The online learning platform provides an interactive environment for communication among students and teachers, and equips teachers to provide scaffoldings for students to engage in collaborative and cooperative activities even beyond classrooms. It is believed that collaborative learning leads to better student involvement, better performance, and higher productivity [21], which is the case of e-learning systems where students perceive greater opportunities for communication than those in a traditional classroom [22]. There is an emerging trend in higher education to combine online and face-to-face modes of learning, often referred to as blended learning [23]. Garrison and Vaughan [24] define blended learning as the thoughtful fusion of face-to-face and online learning experiences. “The basic principle is that face-to-face oral communication and online written communication are optimally integrated such that the strengths of each are blended into a unique learning experience congruent with the context and intended educational purpose” [26; p. 5]. What makes blended learning particularly effective is its ability to facilitate a community of inquiry. At the heart of a community of inquiry consists of three key elements: cognitive presence, social presence and teaching presence [23].

There is a need to relate the normative interpretations of the potential effects of ICT on teaching and learning in higher education with the empirical realities that higher education institutions are facing [15] because “the successful technology integration is a sociological issue” and “appropriate use of technology in teaching requires the thoughtful integration of content, pedagogy, and technology” [25; pp. 1-2]. To address the complexity of ICT integration in higher education, this paper aims to explore the pedagogical use of ICT in a blended learning context. The exploration is focused on the experiences of teachers and students, and guided by two research questions: What are the teaching approaches on pedagogical use of ICT across faculties? What are the students’ experiences in engaging with different teaching approaches?

2. Methods

Case study is formally defined as an exploration of a bounded system over time through in-depth data collection from multiple sources of information rich in context [30]. Different researchers have different purposes for studying cases, and there are three types of case study, namely intrinsic case study, instrumental case study, and collective case study [29].

This study takes an intrinsic approach. Its major objective is to learn from the rich experiences of the teachers and students in pedagogical use of ICT in a blended learning context, description and interpretation is the main concern.

An inductive coding and grounded approach [30] were adopted in the data analysis to construct categories guided by the research questions. NVivo was employed to analyze the collected data, which provided a computer-based workspace that enables researcher to work through the qualitative data efficiently and powerfully.

We selected four cases of pedagogical use of ICT from a university in Hong Kong, which provided a score of experiences reflecting a range of pedagogical practices using ICT in higher education. The background of the four selected cases is summarized in Table 1. Obviously, these experiences are bottom-up and never theoretically-driven in nature. The criteria for case selection include: (1) courses or pedagogical practices in which ICT played a substantial role; (2) evidence of high level of student participation in blended learning modes; and (3) different learning outcomes exhibited.

Table 1: Background of four cases

Case	Faculty	Course/Program/Level
Case A	Education	Undergraduate course for teacher education
Case B	Arts	“Logic and Critical Thinking” for undergraduate and postgraduate students
Case C	Architecture	“Construction III” for undergraduate students
Case D	Dentistry	Undergraduate course for Dentistry students

For each case, the following data were obtained: documents containing information about the institution and faculty background and history; documents about ICT implementation strategies and policies, resources and infrastructure; curriculum materials; lesson observations; and semi-structured interviews of students and teachers. It is fruitful to compare and contrast different ways teachers and students make use of ICT in different curriculum contexts across academic disciplines.

3. Results

As summarized by Kember [27], the term “teaching approaches” has obvious parallels with the widely used term “student learning approaches”. Teaching approaches have been characterized as having motive and strategy components, and they have been analyzed in terms of strategies with associated intentions. In the analysis of the cases, four categories of teaching approaches in blended learning modes were emerged.

3.1 Online Discussion

Online discussion is a common teaching approach in using ICT in a blended learning context. It is illustrated in Case A. Case A concerned a core course in an undergraduate teacher education program. This course lasted for 21 weeks with a three-week teaching practicum included. The teacher of this course encouraged students to have online asynchronous discussion outside regular classroom meetings. As an experienced and dedicated online facilitator herself, she found this group of students was not engaged with online discussion in spite of her constant encouragement both online and offline. This set the investigation into the factors behind students’ disengagement. Motivating and inhibiting factors that affect students’ participation in voluntary online discussion in a blended learning context are reflected in the following students’ interviews.

Some students took the online discussion as a “resource”, as one student commented: “I think mainly because there is a kind of resource out there other than the face to face meetings in the lectures.” In particular, such online discussion provided opportunities for them to ask questions and form a community, as a student said: “I use the online discussion forum because I want to ask some questions. Like I have some questions in my mind after the lecture and I can’t see the lecturer every day, if there is an online discussion, there is a community and the lecturer encouraged us to use it. Then I’ll just post it.” In such online communication, students’ as well as teacher’s participation is extremely important. When a student was asked why she only read the messages without response, she answered: “Because I don’t think other people are reading. Frankly, most of the professors do not respond to us very often, apart from some of them.”

Students were not very sure about their performance of online discussion being assessed, as a student said: “We are obligated to do that. […] I really don’t like that because at the very beginning, the lecturer told us that this is part of the assessment, so you need to post your findings or insights on the discussion forum.” In addition to assessment, the interplay between online and face-to-face discussion in blended learning needs thoughtful scaffolding, as a student raised: “Another problem towards the course is that when we meet on Wednesday during the lecture, we are required to show our discussion that we have already posted on the discussion forum. And actually in the lecture we are talking about the same thing as we did on the discussion forum. So that is why I really don’t like them. But in [another course] I think it’s a bit different because the discussion on the online community is different from what we have addressed in the [face-to-face] sessions.”

3.2 Online Resources for Teaching and Learning

The second teaching approach is to provide online resources for teaching and learning. The course in Case B was offered to both under and post-graduate students in any year of their study and counts as credit towards completing their formal studies. The aim of the course website was to provide free online learning resources on critical thinking, to assist teachers and students alike, both in Hong Kong and other countries. A range of learning resources, including lectures, powerpoint presentation, critical thinking web, wiki, and blog, was provided to support online tutorial, online quizzes, and class exercises. The teacher gave six two-hour lectures including discussion time. As the objective of this course is to learn, evaluate and apply the critical thinking skills in daily life, the teacher provided rich learning materials and vivid examples in his critical thinking web and wiki for students to refer to. Self-directed learning is also significant in this course as students have to construct their own body of knowledge by choosing and studying the modules freely in the critical thinking web. They are free to take the quizzes and more challenging questions.

The teaching approach of “providing online resources” seems to associate with traditional instructional methods such as exercises and examinations, as reflected in the students’ interviews: “Mostly traditional methods, we study and have exam after the teacher teaches us. […] The notes from the website, for the exercise you can click for the answer. It tells you whether the answer you have chosen is correct or not. […] He got a homepage, you login and there are 20 multiple choice questions. After you complete you press submit. This is the way. We are not using paper sheets for exams.” However, this approach seems helpful and well-received by students, as a student said: “I think the [course] website is helpful. Those theories have been mentioned in the class, but there are more detailed information about their underlying origin on the internet. Also, there are some lovely animations and exercises.” One student took it further and connected the resources with learning, and he commented: “Wiki is used to make announcement and keep notes, it allows all students to access notes. The critical thinking web is for students to do exercise and allow them to further understand the concept. It is also a place for discussing and exploring questions. Whereas in classroom, it provides a space for student discussion and it is the first step towards learning."

3.3 Enhancing Course Management and Delivery

The third teaching approach is focused on enhancing course management and delivery. Case C described a core course for undergraduate students in the Faculty of Architecture. The teacher just started to use WebCT for the sake of the streamlined administrative work and the technical support offered by the centralized unit at the university. The teaching was conducted on WebCT. The course was quite organized. One folder was created for each week. Teaching materials such as notes, links, handouts and assignment were posted in corresponding folder. Students needed to complete the individual assignment for each week and there was an online test at the end of the semester. Students submitted assignments through WebCT and the individual assignment with teachers' grading and feedback was also posted. The main learning objective of the course was for students to grasp the main concepts and principles in the subject area. Students were expected to participate in the weekly learning activities and demonstrate understanding of various concepts.

Students felt there were major differences between face-to-face and online class. As a platform focusing on course management and delivery, students regarded WebCT as mainly a place for downloading materials and submitting assignments, but not a place for teaching and learning, as a student said: "I prefer face-to-face lecture which will help me to concentrate on learning. Online learning is often distracted by other things like going to watch TV." Some students felt uncomfortable with online learning and expressed: "Some notes are difficult to understand without lecturer's explanation. Maybe I'm not used to learn through WebCT and ask questions through Internet." It seems clear that students were in favor of a good blended mode of learning, as a student commented: "Face-to-face lecture is necessary since concepts can be explained more clearly. Using both face-to-face and online is a good combination."

3.4 Supporting Specific Pedagogy

The fourth teaching approach is to use ICT to support a specific pedagogy. Case D concerned integrating ICT with problem-based learning (PBL) in the Faculty of Dentistry, which is student-centred and clinically focused. One teacher expressed: "In the program it's a whole, because we have previously used WebCT in a particular simulation laboratory course. We decide to use the functions of WebCT to support learning in the PBL program. For a number of reasons we want students to have better communication with teachers, one another, and also have access to certain learning resource online. Therefore we set it up. […] We are trying to develop more learning resources, such as video, demonstrations of clinical procedures, a library of resources for the students." Another teacher echoed: "One of the key things is that WebCT is to support student self-centered learning time, because they are not having much time for face-to-face discussion with teaching staff. They are working collaboratively or individually so they are doing a lot of their own research, and that's where the WebCT supports as a platform to bridge them."

Students regarded the major role of WebCT is to provide information, as a student said: "It provides information, and a channel to access notes and data. For me, it assists me in learning." And students can also connect the WebCT with PBL: "When we first entered university, the university had introduced us the function and the use of WebCT. We keep using it throughout our dental course. In our PBL system, a new problem is posted every

week. Apart from the hardcopy provided by the teacher, we can read the notes on WebCT. So you don't have to worry if you lose the notes, because they are accessible online."
Nonetheless, it is important not to overlook the issues of the information selection for PBL in terms of types, quality and usefulness, as reflected in a student's interview: "I think the ICT that the entire university is using is quite ordinary, the information and feedback you obtained do not really help in teaching. For example if you upload notes, it is the same as we look for a book. Powerpoint, etc. is the main and only ICT being used. If you want to be better, I suggest putting some tutorial videos as it is more practical. We can find the information online by ourselves, if the information provided by teachers is unorganized, we would probably use our own way to search for it rather than relying on the system. I think information from videos and Powerpoint is more useful. As we are using PBL, you don't need to give us too much information. For me, PBL is a system that we ourselves decide how much we want to study. After we choose how much we want to study, the teachers can then upload the materials that we need."
There is a small management problem in such a fully integrated PBL curriculum, as a teacher said: "When the student post a question, we have a type of filtering system so the students post a question relating to the problem, then there have to be an interpretive level where that question is then classified to the relevant area. The staff members' responses then return and they are posted and made available for the whole year. In terms of interactivity, I first find that it is a little bit quirky. In a fully integrated curriculum, you really cannot do it in any other way."

4. Discussion

In their position paper, Garrison and Kanuka [23] conclude that blended learning is consistent with the values of traditional higher education institutions and has the proven potential to enhance both the effectiveness and efficiency of meaningful learning experiences. This study provides an empirical exploration of the pedagogical use of ICT in a blended learning context. Focusing on of the teachers' and students' experiences, the findings of four case studies suggest four teaching approaches, namely, online discussion, online resources for teaching and learning, enhancing course management and delivery, and supporting specific pedagogy. These approaches demonstrate a range of strategies and associated intentions in using ICT in a blended learning context. Students' experiences were positive in general. These approaches were well-received by students and stimulated meaningful learning in some sense.
Students' overall attitude towards learning online without face-to-face lectures was rather negative. Learning online was similar to learning by themselves which put considerable strain over their self-discipline and time management skills. The traditional lecture was considered more effective and efficient by many students to understand and grasp concepts and principles. Meanwhile, the web-based platform was acknowledged as flexible and convenient resource when downloading course notes and submitting assignments. It was concluded that ICT might be better as the supplement to face-to-face class rather than a replacement, as Larkin [26] argue that "Generation Y students in general, do not aspire to replace lectures with downloadable, online versions. Many of the students […] valued the opportunity for interactive learning provided by face-to-face teaching." [26; p. 238]

In the cases described above, students still had interaction among themselves on daily basis even though they could not meet their teachers. The social presence within the community was still abundant. It is possible to speculate that an online asynchronous discussion among students would be neither necessary nor desirable though the online community was acknowledged. This is the reason why the teachers mostly considered the learner-content interaction in designing the online component. To ensure the cognitive presence in the online activities, teachers designed a set of structured and assessment-centered tasks. Students needed to read the material and finish weekly assignments or exercises. Assessment was employed as a crucial measure to motivate and engage students. The teacher-student interaction mainly depended on asynchronous tools like email and online feedback to students' work. Such a self-directed mode of learning left students working independently. What was missing was the teacher presence in the online community which students valued very much.

The results indicated that students' disengagement in online discussions was due to a number of factors that can be roughly categorized into course design, students' characteristics as well as community dynamics. It is suggested that the design of online activities plays a critical role in arousing students' interests, engagement and motivation especially at the launching stage of blended learning. Thus, thoughtful design of rewarding system, appropriate online information and tasks to be infused with face-to-face meetings is important. In addition, the teacher's facilitation and support were essential to ensure the focused, meaningful and quality blended learning.

The integration of ICT in higher education is a process both complex and necessarily innovative, involving multi-facet variations on curriculum content, pedagogy, ways of ICT use, teacher practices, student practices, student learning outcomes, and organizational conditions [4] [16] [25]. In conclusion, the four teaching approaches presented in this paper are not meant to be proven cases for blended learning that are able to enhance both the effectiveness and efficiency of meaningful learning experiences. However, these cases are pedagogical practices in transition, and provide empirical evidence to shed light on issues in the research of blended learning in higher education.

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References

[1] Pittinsky, M. S. (Ed.). (2003). The Wired Tower: Perspectives On The Impact Of The Internet On Higher Education. New York: Pearson Education.
[2] Phillips, R. (2005). Challenging the primacy of lectures: the dissonance between theory and practice in university teaching. Journal of University Teaching and Learning Practice, 2(1), 1-12.
[3] Challis, D., Holt, D., & Rice, M. (2005). Staff perceptions of the role of technology in experiential learning: A case study from an Australian university. Australasian Journal of Educational Technology, 21(1), 19-39.
[4] Duderstadt, J.J., Atkins, D.E., & Houweling, D. V. (Eds.). (2002). Issues, Trends, and Themes. Higher Education in the Digital Age. USA: American Council on Education Praeger Publishers.
[5] Green, K. C. (2004). Campus Computing Survey: A National Study of the Use of Information Technology in Higher Education. Encino, California: The Campus Computing Project.
[6] Minielli, M. C., & Ferris, S. P. (2005). Electronic courseware in higher education. First
[7] Gibbons, S. (2005). Course management systems, Library Technology Reports, 41(3), pp. 7-11.
[8] Fox, R., & Herrmann, A. (2004). Unexpected effects of new technology adoption. In D. Murphy, R. Carr, J. Taylor & T.M. Wong (Eds), Distance Education and Technology: Issues and Practice (pp. 56-74). Hong Kong: Centre for Research in Distance and Adult Education, Open University of Hong Kong Press.
[9] Davidovitch, N. (2007). Pedagogy and technology-which has the upper hand? Lessons from technological implementation at the College of Judea and Samaria, Israel. On the Horizon, 15(3), 177-189.
[10] Selwyn, N. (2007). The use of computer technology in university teaching and learning: a critical perspective. Journal of Computer Assisted Learning, 23, 83-94.
[11] Westera, W. (2004). On Strategies of Educational Innovation: Between Substitution and Transformation. Higher Education, 47, 501-517.

[12] Bullen, M., & Janes, D.P. (Eds.). (2007). Making the Transition to E-learning, strategies and issues. USA: Information Science Publishing.(pp.1-366).
[13] Cross, M., & Adam, F. (2007). ICT Policies and Strategies in Higher Education in South Africa: National and Institutional Pathways. Higher Education Policy. 20(1), 73-95.
[14] Bates, A.W. (2000). Managing Technological Change. Strategies for college and university Leaders. San Francisco: Jossey-Bass.
[15] Stensaker, B. et al., (2007). Use, Updating and Integration of ICT in Higher Education: Linking Purpose, People and Pedagogy. Higher Education. 54, 417-433.
[16] Guri-Rosenblit, S. (2005). Eight Paradoxes in the Implementation Process of E-learning in Higher Education. Higher Education Policy, 18, 5-29.
[17] Turban, E., King, D., Lee, J., & Viehland, D. (2004). Electronic Commerce 2004, A Managerial Perspective, New Jersey: Pearson Education.
[18] Zhang, D., & Nunamaker, J.F. (2003). Powering E-Learning In the New Millennium: An Overview of E-Learning and Enabling Technology. Information Systems Frontier, 5(2), 207-218.
[19] Mehra, P., & Mital, M. (2007). Integrating technology into the teaching-learning transaction: Pedagogical and technological perceptions of management faculty. International Journal of Education and Development using Information and Communication Technology, 3(1), 105-115.
[20] Collis, B., & Van der Wende, M. (2002). Models of Technology and Change in Higher Education. An international comparative survey on the current and future use of ICT in Higher Education. Center for Higher Education Policy Studies. (pp.1-85).
[21] Nunamaker, J.F., Briggs, R.O., Mittleman, D.D., Vogel, D.R., & Balthazard, P.A. (1996). Lessons from a decade of group support systems research. Proceedings of the 29th Hawaii International Conference on System Sciences, 418-427.
[22] McCloskey, D.W., Antonucci, Y.L., & Schug, J. (1998). Web-based vs. traditional course development: Identifying differences in user characteristics and performance outcomes. Proceedings of the International Business Schools Computing Association Annual Conference, Denver, Colorado.
[23] Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*, 7(2), 95-105.
[24] Garrison, D. R., & Vaughan, N. D. (2008). *Blended learning in higher education: Framework, principles, and guidelines*. The Jossey-Bass higher and adult education series. San Francisco: Jossey-Bass.
[25] Mishra, P., Koehler, M.J., & Zhao, Y. (Eds.). (2007). Faculty Development by Design, Integrating Technology in Higher Education. USA: Information Age Publishing. (pp.1-225).
[26] Larkin, H.E. (2010). “But they won’t come to lectures…” The impact of audio recorded lectures on student experience and attendance, *Australasian Journal of Educational Technology*, 26(2), 238-249.
[27] Kember, D. (1997). A Reconceptualisation of the Research into University Academics’ Conceptions of Teaching, *Learning and Instruction*, 7(3), pp. 255-275.
[28] Creswell, J. (1998). Qualitative inquiry and research design: Choosing among five traditions. Thousand Oaks, CA: Sage.
[29] Stake, R. E. (1994). Case Studies. In Denzin, N.K., & Lincoln, Y. S (Eds.), Handbook of Qualitative Research. USA: SAGE.
[30] Miles, M.B. & Huberman, A.M. (1994). Qualitative Data Analysis: An Expanded Sourcebook, 2nd Ed., London: Sage Publications.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Pre-Service Teachers' ICT Experiences and Competencies: New Generation of Teachers in Digital Age

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Abstract: This study is to gather baseline data on the technology experiences and competencies of the new generation of pre-service teachers who were born after 1980. This paper presents findings from a survey study conducted in 2009 with 1554 young pre-service teachers in Singapore. The results show that ICT permeates all aspects of the new generation of pre-service teachers' lives. It is found that they own the mainstream ICT devices (such as desktop and laptop computers) and they are comfortable with a core set of ICT applications but have less access to emerging devices (such as smartphone, PMP) and are less comfortable with specialised technologies. Student use of ICT and competency with emerging technologies is far from universal. Only a minority of the students are engaged in content creation activities using multimedia tools. There is a gap between their everyday ICT skills and the skills of ICT for teaching and learning. The findings are discussed in light of Prensky's notions of the 'Digital Natives'. The implications for using technology to support teaching and learning in teacher education are discussed.

Keywords: digital immigrant, digital literacy, digital native, ICT competency, teacher education

Introduction

The rapid development of Information Communication Technology (ICT) affects the way in which people, largely the younger generation, interact, socialize and work. ICT skills and knowledge have been considered as the core literacy which students need to possess for the 21st century. The new generation of students born roughly after 1980 is considered to be "Digital Natives" who are fundamentally different from previous generation [1]. "They've had digital technology surrounding them from the time they were infants. …That digital world affords them many things that the previous world didn't."

In the past decade, there has been a considerable amount of discussion on "Digital Natives". The main argument is that the digital culture in which the Digital Natives have grown up has influenced their preferences and skills in a number of key areas related to education (see [2], [3], [4], [5]). Digital Natives are said to prefer receiving information quickly; be adept at processing information rapidly; prefer multi-tasking and non-linear access to information; have a low tolerance for lectures; prefer active rather than passive learning; and rely heavily on communication technologies to access information and to carry out social and professional interactions [1], [2], [4]. [6], [7], [8], [9].

Given that teachers have tremendous potential to affect the beliefs and values of the students, it is important to understand teachers' ICT experiences and competencies. Teachers need to adjust their pedagogical models to suit the new kind of learner they are encountering in this

new generation of students [1], [2], [7]. Some researchers expressed concern at the lack of technological literacy among teachers who are labeled as “Digital Immigrants” - foreigners in the digital lands of the Net Generation, and regarded the disparity between the Natives and the Immigrants as the “the biggest single problem facing education today” [1, p. 2].
To ensure that teachers are able to integrate technology into the curriculum to better engage the Digital natives, the groundwork must be laid at the pre-service teacher's level. A decade has passed since Prensky first coined the term Digital Natives. In recent years, many “Digital Natives” have grown up and become pre-service teachers. This new generation of pre-service teachers could be different from previous generation of teachers. Are these new generation pre-service teachers who were born after 1980 “Digital Natives” or “Digital Immigrants”? Do they have universal sophisticated ICT knowledge and skills?
So far little empirical research has been published on ICT experiences and competencies of this new generation of pre-service teachers (born after 1980). The “Digital Natives” issue for the new generation pre-service teacher is far from clear. This study focuses on the new generation Singapore pre-service teachers’ ICT experiences and competencies. Since 1997, the Singapore Ministry of Education (MOE) implemented three Masterplans for IT in Education [10], [11], [12] to prepare students for the knowledge economy in the 21st century. To prepare teachers for better integration of ICT in teaching, MOE and the National Institute of Education (NIE) Singapore weaved ICT pedagogical training into the pre-service and in-service teacher training. With the ever changing and often diverse characteristics of the pre-service teacher cohorts, understanding who they are is an important factor in knowing how to enhance the learning experiences of new generation teachers through the use of technology. The aim of this study is 1) to investigate the new generation pre-service teachers’ access to and use of an array of ICT devices and applications, 2) to examine their competencies of ICT applications for daily use and for teaching and learning. The three research questions of the study are:

1. What is the overall profile of pre-service teachers' experiences with ICT?
2. What are the pre-service teachers' competencies towards ICT for daily use?
3. What are the pre-service teachers' competencies towards ICT for teaching and learning?

2. Method

2.1.1 Sample

The participants in this research were first year pre-service teachers who were commencing their studies at the National Institute of Education (NIE) Singapore in July 2009, and were eligible to receive a laptop loan from NIE. 2278 students were eligible, and of these, 1886 students opted to take up the laptop loan. These 1886 students were the study population. When the pre-service teachers went to collect their laptops, they were invited to take the online survey on the spot. In total, 1787 pre-service teachers completed the questionnaire. The response rate is 94%, which is 78.5% of the July 2009 intake of students eligible for the laptop loan at the institution. This study focuses on pre-service teachers age 30 and below.
There are 1554 pre-service teachers age 30 and below, which accounts for 87% of the survey respondents. Among these pre-service teacher respondents, 280 (18%) are under 25 years, 987 (64%) are from 21 to 25 years, and 287 (18%) are from 26 to 30 years. 447 (29%) are enrolled in the 4-year Undergraduate teaching degree programme (for those who hold either GCE 'A' Levels or polytechnic diplomas), 815 (52%) are enrolled in the one year Postgraduate Diploma in Education (for those who hold at least a Bachelor's degree), and 292 (19%) are enrolled in the 1-year Diploma in Education programme (for those who hold

either GCE 'A' Levels or polytechnic diplomas). The population includes more females (71%) than males (29%). 1125 (72%) are Chinese, 229 (15%) are Malay and 133 (9%) are Indian. More than half (52%) have some sort of working experience.
The respondents were asked about at what age they started using computers. About half (52%) started using computers at the age of 11-15 years, 1/3 started using computers at the age of 6-10 years, 13% started using computer at the age of 16-20. 2% started using computers even below 5 years old. A very low percentage (0.5%) of pre-service teachers started use computer from 21 years onwards.

2.2 Instrument - questionnaire

A questionnaire, developed specifically for this study, asked students about their access to, use of, and skills with an array of established and emerging technologies and technology based tools and their attitudes towards ICT for teaching and learning. The questionnaire has been validated by more than 120 pre-service teachers in the July 2008 cohort. The questionnaire comprised four main sections:

1. Demographic information (including gender, race, nationality, age, education level, programme enrolled, curriculum subjects, previous working experience etc)
2. The ownership and experiences of a range of ICT devices (e.g., desktop, notebook, netbook, smartphone, Portable Media Player (PMP) and game console). The computer experience in this study was measured by asking the participants "how often do you use a computer?” and “On average, how many hours do you spend on the computer on a typical day?”
3. The use of ICT applications/tools. This was measured by asking “How many hours do you spend in a week to use the following applications/tools?”
4. The competency with ICT applications/tools. The perceived competency was measured by asking “How do you rate your skill level for each of the following applications/tools?” with responses on a 4-point scale where 1= I have never used this, and 4 = I am able to teach this to others”

2.3 Procedure

Data was collected during August and September 2009 when the students collected their laptops at the computing department. All the students who took the laptop loan were invited to participate in the study. The survey was on a voluntary basis and no course credits were given for participation. Twenty desktop computers were provided at the notebook collection site with the online survey URL at the front page of the computer. At all occasions, a member of the research team was present throughout the data collection process. The researcher firstly briefed pre-service teachers about the project and informed them that participation was voluntary and confidential. They were told that they could withdraw their participation during or after the data collection. They were informed that they could ask the researcher if they have a query when filling in the questionnaire. Then the students used the desktop or their newly acquired laptop computers to go to the online survey URL to complete the survey. On average, students took about 15 minutes to complete the survey questionnaire.

3. Findings

3.1 Ownership and usage of ICT devices

Table 1 shows the results of the access to ICT devices. Among the 1554 new-generation pre-service teachers who participated in the survey study, most commonly a moderate to high proportion have access to the mainstream ICT devices. The vast majority (n=1336, 86%) have laptops before coming to the institution to study, and more than half (n=875, 56%) have desktops at home. Additional analyses show that 43% (n=667) have access to both a desktop and a laptop computer while only 0.6 % of students (n=10) have access to neither. Less than 10% (n=118, 8%) have access to a netbook computer. It is interesting that most of the netbook users (n=92) have a laptop as well. For those who have laptops, about 47% carry their laptops with them 1-2 times a week, 18% carry laptops 3-4 times a week, 4% carry laptops 3-4 times a week and less than 5% carry their laptops everyday. About ¼ of them never take the laptop out of their homes.

Table 1. Ownership of ICT devices (N = 1554)

	Freq	**%**
Desktop	875	56.3
Laptop	1336	86
Netbook	118	7.6
Ultra Mobile PC	20	1.3
Game Console	408	26.3
Portable Multimedia Player (PMP)	795	51.2
Smartphone/PDA	665	42.8

As for the emerging handheld mobile technologies, while the access to mobile phones is universal, less than half (n=665, 43%) have smartphones. Half of them have portable multimedia player (PMP) (n=795, 51%). About ¼ (n=408, 26%) have handheld gaming console. Additional analyses show that about ¾ of pre-service teachers have one other type of mobile device besides the mobile phone. Around 10% (n=146) of the pre-service teachers have all mobiles device types including laptop, smartphone, game console and portable multimedia player, and they carry multiple devices with them all the time. These ICT devices are nearly ubiquitous with this group of pre-service teachers.
When asked about "How many hours do you spend on the ICT devices on a typical day", about ¼ of the pre-service teachers reported that they spent less than 3 hours, about 1/3 of them spent 3-5 hours, ¼ of them spent 5-7 hours, 14% spent 7-11 hours, 5% spent even more than 11 hours on the devices per day. Those who spent a high amount of time on the ICT devices are roughly the same group of pre-service teachers who own many different ICT devices.

3.2 Usage of ICT applications

The pre-service teachers were asked how long they spend in a week using ICT applications, and the results are presented in Table 2. In general, many pre-service teachers surveyed in this study are 'tech-savvy' and incorporate a range of traditional and emerging technologies in their daily lives. However, areas clearly exist where the use of ICT applications is far from universal or uniform among the new generation of pre-service teachers.

Table 2. Usage and skills of different ICT applications (N=1554)

		Adoption (%)	Time spent in a week within those who use it (Hours)		Skills (1 = do not know how to use it, 4 = can teach others how to use it)	
			Mean	SD	Mean	SD
Communication/ Networking	Send & receive emails	100	2.03	1.991	3.73	.472
	Chat online	95	3.35	2.630	3.67	.523
	Social networking website	95	3.10	2.475	3.45	.674
	Participate in message boards	57	1.42	1.368	2.95	.897
Media Consumption	Watch videos/ videocasts	96	4.24	2.075	3.57	.554
	Listen to music / audio podcasts	91	3.75	1.926	3.52	.606
	Read online news	83	1.71	1.712	3.38	.706
	Use RSS	21	1.48	.968	1.67	.960
	Social booking marking/tagging	14	1.16	.653	1.50	.851
Content Creation	Write blogs/ microblogs	53	1.73	1.531	2.54	1.102
	Create graphics	34	1.67	1.310	1.94	.980
	Create or edit wiki	34	1.25	.955	1.80	.903
	Design websites	23	1.56	1.060	1.84	.969
	Produce videos	19	1.38	.870	1.72	.956
	Create online mindmap	18	1.09	.639	1.58	.858
	Produce audio podcasts	11	1.36	.669	1.53	.869
Others	Search information online	99	3.17	2.304	3.59	.578
	Use productivity tools	98	3.42	2.327	3.41	.648
	Shop online	59	1.84	1.668	2.95	1.005
	Maintain online photo album	41	1.53	1.321	2.39	1.095
	Play online games	48	2.05	1.796	2.38	1.907
	Participate in multi-user virtual environment	14	1.79	.938	1.62	.956

As shown in Table 2, more than 90% of pre-service teachers use core ICT applications such as email, chatting, social networking, watching video, listening to music, searching information online and using productivity tools. However, the adoption rate of other specialised technologies is lower. Many ICT tools were not used by a substantial proportion of pre-service teachers. Moreover, for a number of emerging technologies, the proportion of students who have never used a particular application outstripped those who had (e.g. create a website (23% vs 77%), create graphics (34% vs 66%), create/edit wiki (34% vs 66%) and online mindmap (18% vs 82%), produce video (19% vs 81%) and audio podcasting (11% vs 89%), use RSS feeds (21% vs 79%) and social bookmarking/tagging (14% vs 86%), maintain online photo album (41% vs 59%), participate in multi-user virtual environment (14% vs 86%)).

Examination of the usage of different applications shows a pattern that pre-service teachers use ICT for media consumption intensively. More than 80% of pre-service teachers use media consumption tools such as video, audio, podcasting and online news. Among those who use media consumption applications, on a typical week, they spent 4.2 hours watching videos, 3.8 hours listening to music and 1.7 hours reading online news.

A high percentage of pre-service teachers use ICT for communication and social networking. Among those who use the communication applications, on a typical week, they spent 2 hours sending and receiving emails, 3.4 hour chatting online, 3.1 hours on social networking websites, and 1.4 hours participating on message boards. A comparatively lower percentage of pre-service teachers use ICT applications for content creation. Slightly more than half write blogs/microblogs. Less than 1/3 create or edit a wiki, design websites, create graphics, or produce videos. Those who use the content creation applications spent less than 2 hours per week on content creation activities.

3.3 ICT Competency

The pre-service teachers were asked about their perceived competency with ICT applications. The results in Table 2 show that they perceive themselves as comfortable and capable with the core technology applications such as email (mean = 3.73), chatting (mean = 3.67), networking (mean = 3.45), watching video (mean = 3.57), listening to music (mean = 3.52), reading online news (mean = 3.38), searching information online (mean = 3.59) and using productivity tools (mean = 3.41). A majority of them are very tech savvy with different media tools in that they can teach others how to use computers to watch videos, read online news, and listen to music.

The results show that pre-service teachers perceived themselves as competent in using ICT applications for communication/networking and media consumption. However, they perceived themselves as less comfortable with the emergent applications related to content creation. A majority of them are unfamiliar with creating or editing digital images, audio and video files (mean < 2).

3.4 Competency in using ICT for teaching

Since these pre-service teachers will influence future generations of students, we obtain the baseline data on their competency in using ICT for teaching. Results are shown in Table 3.

Table 3. Skills in using ICT for teaching

	Mean	**SD**
Create online assessments, quizzes & activities	1.80	.862
Use learning management systems for teaching	2.20	.925
Use presentation software for instruction	3.32	.643
Create a learning environment using Web2.0	2.57	.970
Use online resources to prepare lessons	2.79	.858
Create lessons using videos	2.24	.997
Create lessons using podcasts	1.61	.832
Incorporate online games in lessons	1.77	.886
Use live conferencing platforms to manage projects	1.36	.677
Use storyboarding or comic creation tool in curriculum	1.40	.716
Use virtual learning environments in schools	1.44	.741
Use email to communicate with students	3.10	.935
Create digital portfolios	1.73	.930

Table 3 shows that pre-service teachers are very familiar with presentation software (mean =3.29, SD=.660) and communication tools (mean = 3.08, SD = .934) for teaching. They tend to be unfamiliar with storyboarding/comics creation tools, virtual learning and conferencing platforms (over 70% have not used these tools). Apparently the pre-service teachers' perceived ICT competency for teaching is lower than their perceived ICT competency for everyday use. The pre-service teachers are not yet ready for effective integration of ICT for teaching. This is understandable as they have just commenced their teacher training when they participated in the survey.

4. Conclusion and Discussion

This study investigates the new generation pre-service teachers' ownership of, uses of and competency with a range of ICT devices and applications. Overall, the participants have good access to mainstream ICT devices such as desktop and laptop computers. ICT permeates all aspects of their lives. They have a high level of usage of the core set of ICT applications, which could be attributed to the technology emphasis given to the pre-service teachers at various stages of their education. This had taken place prior to the participants enrolling in the teacher training program. This young generation of pre-service teachers has been through the *MasterPlans.* Chronologically, they would have benefited from the goals of the *MasterPlans* in ways that may have shaped their computer access/ownership, uses and competency in a positive way. However, when one moves beyond the basic computer device and the core set of ICT applications, the patterns of access/ownership, use of and competency with a range of other emerging ICT applications show considerable variation. The core ICT application skills do not necessarily translate into sophisticated skills with other applications.

The pre-service teachers make intensive use of ICT for media consumption, communication, information searching, and productivity tools. A low percentage of pre-service teachers perform content creation activities. While some pre-service teachers have embraced the technologies and tools as the "Digital Natives", this is by no means the universal pre-service teacher experience. The results of this study highlight the lack of homogeneity in young pre-service teachers with regards to ICT and a potential "digital divide" between them. This finding echoes Caruso and Kvavik's [13] finding that while the majority of university students possess a core set of technology based skills, beyond those a diverse range of skills exist across the student population. It is clear that there is a more complex mix of technology experiences and skills among the young generation of pre-service teachers.

The final set of analyses in this study assessed the pre-service teachers' competency in using ICT for teaching and learning. ICT can *enable* new forms of teaching and learning to take place, they cannot *ensure* that effective and appropriate learning outcomes are achieved. It is not technologies, but educational purposes and pedagogy, which makes the use of ICT for teaching and learning more meaningful. This study found that a gap exists between pre-service teachers' everyday ICT competency and that of ICT for teaching and learning. They embrace technologies for non–educational purposes intensively but they may not have the expertise to judge how to best use ICT for educational purposes. The transfer from a social or entertainment technology to a learning technology is neither automatic nor guaranteed [14], [15]. This study suggests a need for teacher educators to provide a conducive and non-threatening environment for pre-service teachers to experience success in ICT for teaching and learning.

An evidence-based understanding of pre-service teachers' technological experiences and competencies is vital in informing education policy and practice. This study has significant implications for the Singapore teacher education sector. The findings run counter to key assumptions underpinning Prensky's [1] construct of the Digital Natives. The findings show that the new generation pre-service teachers do not have universal and uniform technology experiences and competencies. Not all the new generation pre-service teachers are digital natives with a sophisticated knowledge and understanding of ICT. It comprises a highly diverse pre-service teachers body with a wide variety of information literacy capabilities. Given this diversity within a single cohort of pre-service teachers, the challenge is how to cater for the broad range in students' levels of access to, usage and familiarity with, different ICT devices and applications. This study clearly provides sufficient evidence to negate the 'one size fits all' approach to the integration of ICT into teacher education curricula.

Certain limitations exist in this study. The data was collected using a cross-sectional, single administration design, and it was not possible to establish the stability of the technology experiences and competencies of the participants. The investigation reported in this paper would have benefited from more in depth, qualitative investigation of pre-service teachers' perspectives on technology. Future studies could include a systematic examination of all aspects of pre-service teacher experiences with ICT devices and applications. Also, more attention could be paid to the way in which their technology experiences impact competence in technology integration for teaching and learning. Finally, future studies could assess if and how the pre-service teachers' learning abilities and teaching competencies are correlated with their mastery of technology.

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References

[1] Prensky, M. (2001a). Digital Natives, Digital Immigrants. *On the Horizon, 9*(5), 1-6.
[2] Oblinger, D. (2003). Boomers, Gen-Xers and Millennials: Understanding the new students. *EDUCAUSE Review*, July/August, 37-47.
[3] Oblinger, D. (2006). Listening to what we're seeing. Keynote Paper presented at ALT–C 2006. Retrieved November 8, 2009, from http://www.cic.org/conferences_events/caos/2006_CAO_Resources/2006CAO_oblinger2.pdf.
[4] Gros, B. (2003). The impact of digital games in education. *First Monday, 8*(7). Retrieved February 21, 2007, from http://www.firstmonday.org/issues/issue8_7/xyzgros/index.html.
[5] Gibbons, S. (2007). Redefining the roles of information professionals in higher education to engage the Net generation. Keynote Paper presented at Educause Australasia 2007. Retrieved August 12, 2009, from http://www.caudit.edu.au/educauseaustralasia07/authors_papers/Gibbons2.pdf.
[6] Prensky, M. (2001b). Digital Natives, Digital Immigrants, Part II. Do they really think differently? *On the Horizon*, 9(6), 1-6.
[7] Frand, J. (2000). The information-age mindset: Changes in students and implications for higher education. *EDUCAUSE Review*, September-October, 15-24.
[8] Oblinger, D. & Oblinger, J. (2005). Is it age or IT: First steps towards understanding the net generation. In D.Oblinger & J. Oblinger (Eds.), *Educating the Net Generation* (pp. 2.1-2.20). Boulder, CO: EDUCAUSE. Retrieved March 31, 2010, from http://www.educause.edu/educatingthenetgen.
[9] Tapscott, D. (1999). Educating the Net Generation. *Educational Leadership*, 56(5), 6-11.
[10] Ministry of Education (1997). MasterPlan for information technology. Singapore: Ministry of Education.
[11] Ministry of Education, Singapore (2006). Overview of the Masterplan for IT in education. Retrieved March 15, 2007, from http://www.moe.edu.sg/edumall/mp2/mp2.htm.
[12] Ministry of Education, Singapore (2008). Masterplan III for IT in Education. Retrieved May 1, 2009, from http://www3.moe.edu.sg/edumall/mp3/mp3.htm.
[13] Caruso, J. B. & Kvavik, R. (2005). *ECAR study of students and information technology 2005: Convenience, connection, control, and learning*. EDUCAUSE. Retrieved January 15, 2010, from http://connect.educause.edu/Library/ECAR/ECARStudyofStudentsandInf/41159.
[14] Kirkwood, A. & Price, L. (2005). Learners and learning in the 21st century: What do we know about students' attitudes and experiences of ICT that will help us design courses? *Studies in Higher Education*, *30*(3), 257-274.
[15] Katz, R. (2005). Foreword: Growing up digital. In J. B. Caruso & R. Kvavik (Eds.), *ECAR study of students and information technology, 2005: Convenience, connection, control, and learning.* EDUCAUSE. Retrieved January 15, 2010, from http://connect.educause.edu/Library/ECAR/ECARStudyofStudentsandInf/41159.

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Enabling Students to Seek Computer-based Scaffolds for Solving Mathematical Word Problems

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Abstract: Scaffolding can develop a student's ability to internalize new information on the basis of prior knowledge. However, it assumes that all students are novices and likely limits students' way of thinking. Therefore, this paper incorporates the concept of help seeking in the usage of scaffolds, so that students can think as a whole before using scaffolds. The authors preliminarily designed an activity flow of seeking scaffolds. Furthermore, a trial study was conducted to investigate students' behaviors of choosing and using scaffolds. The result showed that the activity flow encouraged students to make attempts first without the limitation of scaffolds. Yet, it was also found that students lacked the ability to use scaffolds appropriately, suggesting further improvement.

Keywords: scaffolding, help seeking, mathematical word problems, problem solving

Introduction

Scaffolding is widely used as a tutoring strategy, because it can expand a student's capability by linking prior knowledge and new knowledge. In terms of Vygotsky's theory [9], capable people (e.g. parents, tutors, or capable peers) as a form of scaffolding can help students develop their potentials that they cannot reach alone. In a technology supported learning environment, the forms of scaffolding have been shifted and extended from the interaction with capable people to the support of artifacts, resources, and environments [5]. When the students who are scaffolded become capable, the scaffolds should be faded in order to return controls back to the students. Even so, the students still need to be monitored until they can really do it on their own.

When students start to solve a new mathematical problem with computer-based scaffolds, they are usually assumed to be novices in the beginning. However, even if they know nothing about the new problem, they still have an opportunity to solve it by themselves. This is due to the fact that their prior knowledge may be enough to solve the new problem. They are likely able to develop their own solutions even if they are not scaffolded. However, scaffolds may limit students' ways of thinking and students may thus feel annoyed and bored. As if a dish washer takes several years to learn cooking from a chef, students sometimes spend too much time on following what computers do until they meet the requirements of fading. Scaffolds may leave too little space for students' development. This phenomenon refers to 'over-scaffolding' [2][10], students being supported too much, irrespective of students' abilities. Students need to develop higher-level ability besides knowing how to do.

Aleven and his colleagues [1] concerned students' metacognitive ability instead of cognitive ability. More specifically, they aimed at developing students' ability of help-seeking by computers. Their research was based on a finding that students who rarely asked for help usually needed help [3][6][8]. For this reason, they have established a help-seeking metacognitive model [7], which described a student's legitimate activity flow with a large number of production rules. More specifically, before trying to solve a problem, a student had to take reasonable time thinking about the solution plan. If he was not familiar with the problem, he had to ask for a hint. If he was familiar with it but still did not know what to do, he had to search if there was any helpful information.

Although scaffolding and the help-seeking model both support the concept of learning by doing, they have differences from the following perspectives. First, the former asks students to follow parts of a certain procedure to achieve the goal, while the latter allows students to do the whole procedure in the beginning. Second, even if students are scaffolded, they still need to finish the rest of procedure. Yet, when students get helps, they actually get hints and information without paying efforts for the helps, which likely result in abusing the helps [1][7]. For avoiding the situation, when students need helps, system should provide them with a small task that requires students to accomplish instead of hints only. To this end, this paper aims at designing a system that enables students to seek scaffolds for solving mathematical word problems.

1. System Design

1.1 Background

In an ongoing research project, all students in a third-year class have been equipped with personal tablet PCs. In particular, they received computer-based scaffolds to learn solving mathematical word problems for six months. The scaffolds were designed based on Mayer's cognitive process of solving mathematical problems [4]. Furthermore, students were required to follow four steps to solve a problem: restructuring the problem texts, using a line segment diagram, formulating equations, and checking the solution (see Figure 1(a)). Students were scaffolded in the first three steps. More specifically, in the first step, restructuring the problem texts referred to arranging the pieces of information in the problem in order to determine known variables, unknown variables and even superfluous information, if exists. In the second step, students were supported to use a line segment diagram to reorganize the problem. And then, in the third step, students formulated one or more equations by deciding the operator and operands. Students were allowed to use a stylus to write down and calculate the equations on a digital sheet (see Figure 1(b)). Finally, students contextualized the solution with an appropriate unit in the last step.

(a) Four steps to solve a problem (b) A digital sheet

Figure 1. Original computer-based scaffolds

Although the way to scaffold students seemed reasonable to help them learn, it actually assumed all students were beginners who learned from an experienced tutor. The scaffolds would be faded only if there was enough evidence to show they have learnt. Such philosophy may look down on the students. Furthermore, a preliminary finding of the project showed that when the students used these scaffolds to solve mathematical word problems for a long time, they thought problem solving as a repetitive job and became bored in the end. The finding suggested a reverse philosophy that all students should be assumed to be able to solve problems in the beginning. In other words, they were provided with scaffolds only when encountering difficulties.

1.2 Seeking scaffolds

Figure 2 illustrates the activity model of seeking scaffolds. When a student starts to solve a mathematical word problem, he can choose to solve the problem on his own or choose a scaffold, depending on whether he can solve it or not. If he chooses the former, he is free to use his stylus to draw representations, to formulate equations, and to do calculation on his digital sheet on the screen (Figure 3(a)). Otherwise, he can choose one from three kinds of scaffolds. The three scaffolds are modified from the aforementioned project, i.e. restructuring the problem texts, using a line segment diagram, and formulating equations.

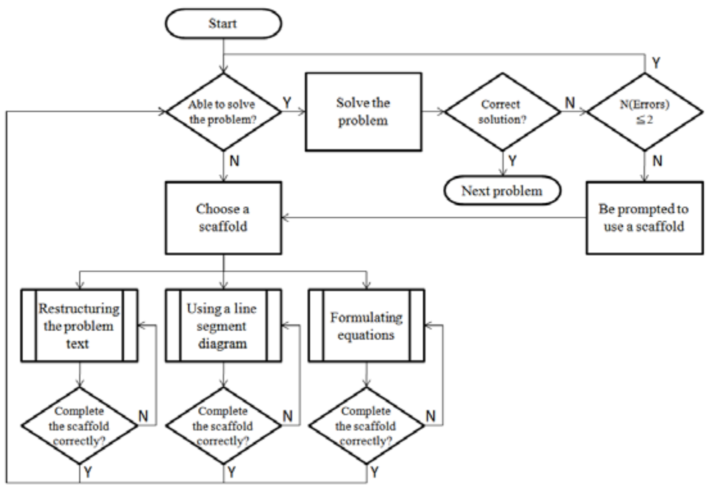
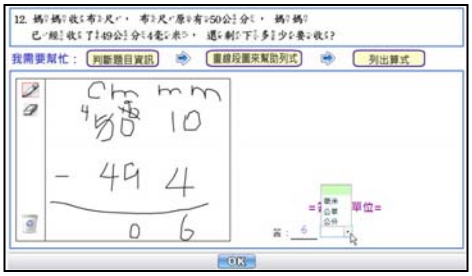


Figure 2. The activity model of seeking scaffolds

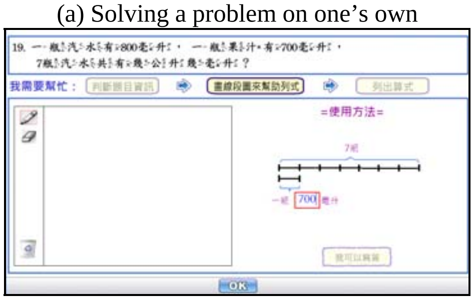
In the first scaffold (Figure 3(b)), the student is required to categorize the problem texts into a goal, useful information and superfluous information. He has to drag texts colored blue in the problem and drop them in an appropriate category. The goal represents an unknown variable, which may derive from known variables in the useful information. The task of categorization may simplify the problem, so that students can focus on the important part. In the second scaffold (Figure 3(c)), the student is required to complete a line segment diagram representing the problem. In the diagram, there are several pieces of key information missing. For entering the missing pieces, he has to read the problem again. The line segment diagram presents the problem in a visual way, so that students can easily understand its meaning. In the third scaffold (Figure 3(d)), the student is required to formulate one or more equations. He has to enter the operands and decide the operator. Besides, he is also asked to point out which statement determines the operator.

After the student completes a scaffold, he may click the “OK” button to check his answers in the scaffold. If the answers are wrong, the system colors the frames of the wrong answers red immediately, indicating which answers the student needs to correct. When he finishes a scaffold successfully, he still can choose another one or solve the problem by himself. After solving the problem, he may check his solution by clicking the “OK” button. Similarly to the feedback in scaffolds, the system colors the frame of the wrong solution red. If the solution is wrong more than twice, the system would force him to choose a scaffold.

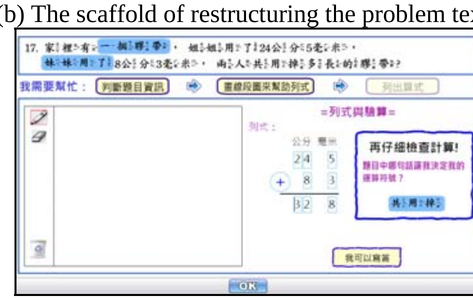


(a) Solving a problem on one's own

(b) The scaffold of restructuring the problem texts



(c) The scaffold of using a line segment diagram



(d) The scaffold of formulating equations

Figure 3. Snapshots of the system

2. Trial Study

The purpose of the trial study was to explore participants' behaviors of seeking scaffolds. The participants were selected from the aforementioned project. As mentioned earlier, all of them have been trained to use computers to learn mathematics. They particularly received computer-based scaffolds to learn solving mathematical word problems. When they used the new activity model of seeking scaffolds, their perceptions and behaviors may change. The behaviors could be observed when they used the system; and their perceptions could be revealed by querying after they did an action.

2.1 Participants selection

Three participants were selected according to the following procedure. The authors conducted a paper-and-pencil test to the third-grade class who participated the project (N=28) for examining students' abilities to solve mathematical word problems. The test was consisted of 20 multiple-choice questions (2.5 points per question, 50 points in total) and 10 word problems (5 points per questions, 50 points in total). The 20 multiple-choice questions were used to test five sub-abilities to solve word problems, which are described as follows: (1) to eliminate superfluous information, (2) to locate known variables, (3) to locate unknown variables, (4) to identify correct line segment diagrams, and (5) to use appropriate operators. Each sub-ability included four questions. The 10 word problems were used to test their synergetic ability to use the five sub-abilities.

By the scores in the test, all students were divided into three groups: high-ability, medium-ability, and low-ability groups. The authors selected one participant in every group (see Table 1). Owen (pseudonym) was selected from the high-ability group. In the test, his answers were almost right except a multiple-choice question about line segment diagrams and a word problem because of his wrong calculation. For the medium-ability group, Vicky was selected. Although she was not good at finding information in word problems and, in particular, identifying line segment diagrams, she could solve word problems 80% correctly. This may imply that she tended to pay attention only to the numbers in the problem without understanding its meaning. Finally, Sean was selected from the low-ability group. His weakness was mainly locating known variables, identifying line segment diagrams, and using operators. Although he scored almost the same as Vicky in multiple-choice questions, he could solve word problems only 50% correctly. The test showed that he had a worse synergetic ability than Vicky.

Table 1. The participants' scores of an ability test in mathematical word problem solving

	Eliminating Superfluous Information	Locating Known Variables	Locating Unknown Variables	Identifying Line Segment Diagrams	Using Appropriate Operators	Solving Word Problems	Total
Owen	10	10	10	7.5	10	45	92.5
Vicky	5	5	5	0	7.5	40	62.5
Sean	7.5	2.5	7.5	5	2.5	24	49.0

2.2 Setting

The three participants were separately invited to use the system. The trial study took place in the library of their school. Every participant was requested to sit on a seat with a tablet PC on a desk. To lessen the pressure to use the system, before the participant used the computer, he/she was told that the trial study was not to test his/her ability; rather, to help us to improve the system. The participant was also told that when using the system to solve problems, he/she was likely queried about his/her actions. Two researchers accompanied and queried the participant during the process. The queries were based on direct observation of the behaviors of seeking scaffolds, especially when and how they chose a certain scaffold. The participant was queried only after they took an action. Besides direct observation and queries, their operations on computers were also recorded and logged. During the process, the researchers would not give any instructions about how to solve the problem. However, when a participant spent more than one minute on thinking without any actions, the researchers may prompt him/her to use scaffolds.

Every participant was required to use the system to solve mathematical word problems in 30 minutes. The word problems included two levels of difficulty. The first level had 12 questions (denoted by P1-1 to P1-12) involving addition and subtraction, and the second level had 13 questions (denoted by P2-1 to P2-13), further involving multiplication. If a participant performed well at the first level and never used scaffolds in solving the first three problems, which were representative of the level, the researchers may suggest him/her to solve the second level of word problems. After using the system, the participant was required to answer several questions, such as, when and why he/she decided to use scaffolds. In particular, he/she was also required to compare the preference between the system of seeking scaffolds and the system of using scaffolds by force.

2.3 Results

Figure 4 illustrated the three participants' process of solving word problems and using scaffolds. Every participant solved problems from left to right (i.e. from P1-1 to P2-13). For solving a problem, each action was illustrated as a box in a sequence from top to bottom. The color of the box represented different types of actions. For example, a gray box followed by a white box meant that the participant first attempted to solve the problem and the solution was correct. The number labeled in the box showed that the participant use a certain scaffold. For example, when Vicky solved P1-4, she chose the first scaffold and then solve the problem correctly.

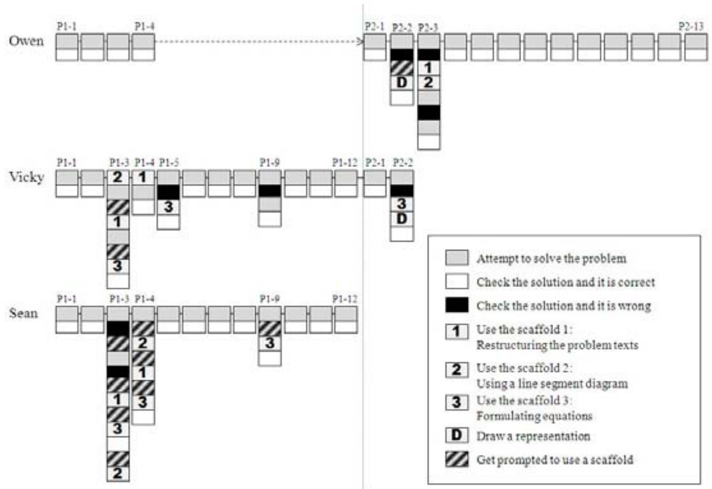


Figure 4. The participants' process of using the system

As indicated in Figure 4, Owen could correctly solve the problems of the first level without using any scaffolds. For this reason, he was suggested to solve the problems of the second level. He appeared very confident and thus decided to solve harder problems after solving P1-4. He finally solved 17 word problems, including 13 of the second level. Among these problems, he only used scaffolds for solving P2-3. Additionally, when solving P2-2, he drew a diagram on a digital sheet to help him solve the problem (Figure 5(a)).

As for Vicky, she solved 14 word problems, including 2 of the second level. Among these problems, she solved four problems by using scaffolds. In the beginning of solving P1-3 and P1-4, she had no idea to solve them and decided to use scaffolds. For P1-5 and P2-2, after her failed attempt to solve the problem by herself, she decided to use the scaffold of formulating expressions. Like Owen, when solving P2-2, she also drew a diagram to solve the problem after she used the third scaffold (Figure 5(b)).

Sean solved 12 word problems of the first level, and none of the second level. When solving P1-3, P1-4, and P1-9, he usually spent a lot of time on thinking without doing any actions. The researchers thus followed the rule to prompt him to use a scaffold. In addition, it was also noteworthy that he attempted twice to solve P1-3 on his own and finally decided to take researcher's prompts to use the scaffolds. However, after solving it correctly by the scaffold of formulating expressions, he still did not understand the problem visibly. Although his answer was correct, the researchers use the scaffold of using a line segment diagram to help him understand the problem.

Although the participants were few, their behaviors could still carry several implications, which described as follows.

<u>Attempts first instead of scaffolds first</u>

It was observed that all of the participants tended to solve problems at the start without using scaffolds. Owen was very self-confident. Even if he met a new problem he had never learnt, he said "*[I] will try to solve it at first; unless [I] cannot do it, [I] will ask for helps*". For Vicky, although she bashfully said that "*I don't believe I can solve it (a mathematical word problem) correctly*", she was still willing to make attempts. Sean was also observed to solve a problem by himself even though the problem is obviously hard for him. Such behavior was usually labeled as 'help avoidance' [1]. However, it could be regarded as a behavior of active attempts before the request of scaffolds.

Compared to the previous learning model of passively receiving scaffolds in the last several months, what students had to do was only to follow what the scaffolds had defined in advance until they were faded. They did not have to think why they need the scaffolds in the beginning. Although Vicky and Sean did not have any comments about it, Owen particularly complained about the previous learning model: "*It was annoying! ... In the beginning [of learning a new lesson], it was fine, but [I] feel annoyed later*". He preferred the model of seeking scaffolds, because of its way to "*choose which help I wanted*". Therefore, seeking scaffolds may provide students with an opportunity to explore how to solve a problem instead of mimicking the scaffolds.

<u>Relieving the constraint of scaffolds</u>

Because the activity model did not limit students' actions, they likely exhibited some behaviors that the researchers did not expect in advance. In this trial study, Owen and Vicky were found to draw their own representation on screens to solve P2-2. The problem was to calculate the distance from the first plants to the last plants, given that there were 10 plants in a row with the same interval of 80 centimeters. Ideally, students had to calculate the number of intervals (10-1=9) first, so that they can get the total distance ($80\times9=720$). However, both Owen and Vicky had the same wrong answer ($80\times10=800$) for the first time. The reason may be that they only paid attention to the numbers within the problem rather than read it carefully. In the case of Owen, later when he drew ten bars for the ten plants on the screen (Figure 5(a)), he finally figured out the relationship between the numbers of plants and intervals. This was an example that students did not have to follow the scaffold to solve the problem; rather, they could develop their own representations and solutions.

On the other hand, although Vicky drew a similar representation, her case showed a different story. When she chose the scaffold of formulating equations, the scaffold suggested her to calculate the number of intervals first. Then she drew the ten bars to represent the ten plants (Figure 5(b)). By counting the intervals, she could finally get the answers. The case implied that even though students used a scaffold, they still need to express their thinking. The digital sheet encouraged students not only to do calculation but also to draw representations by pen-based interface.

(a) Owen's diagram (b) Vicky's diagram

Figure 5. Drawing representations by pen-based interface

<u>Lacking the ability to choose appropriate scaffolds</u>

Although Owen chose advanced exercises, he still thought the exercises were easy and thus rarely asked for scaffolds. By contrast, Vicky and Sean used the scaffolds more often. It was noticed that they may have a common behavioral pattern in choosing scaffolds. When Vicky tried to solve P1-3 but got stuck, she chose all of the three scaffolds. But when she encountered difficulty again in P1-4, she only chose the first scaffold and solved the problem successfully. Later in P1-5 and P2-2, she tended to use the third scaffold. Similarly,

Sean chose almost all scaffolds in P1-3 and P1-4, but finally chose the third scaffold in P1-9. Such changes could be viewed as a consolidation of seeking-scaffold behaviors. After several time of using scaffolds, they may eventually find their preferred ways.
Nevertheless, what students liked may be not what they really needed. Vicky and Sean both preferred the scaffold of formulating equations and chose it when meeting difficulty. The scaffold only helped them write down the equation, not understand the problem. In Sean's case, after he used the scaffolds of restructuring the problem texts and formulating equations to solve P1-3, he changed the operator from addition to subtraction and solved it correctly. Even if he found the answer, however, he still did not understand the reason for subtraction. For this reason, the researchers asked him to use the last scaffold of using a model and explained why using subtraction rather than addition. However, the successful experience using the scaffolds of formulating equations led him to choose it again. Similarly, Vicky also showed the tendency to use the scaffold of formulating equations in solving later problems. These excerpts showed that some students may not learn how to choose appropriate scaffolds unless they received further instructions.

3. Concluding Remark

This paper designed an activity model to support the concept of seeking scaffolds. The result of the trial study showed that the model encouraged students to solve mathematical word problems by themselves rather than follow scaffolds. Additionally, pen-based interface allowed students to express their thinking without the limitation of scaffolds. Although these features also meant that students may make mistakes in the process, they were provided with more opportunities to correct those mistakes and experience the change. However, the result also revealed that students lacked the ability to choose appropriate scaffolds, suggesting further improvement in the model.

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References

[1] Aleven, V., McLaren, B., Roll, I., Koedinger, K. (2006). Toward meta-cognitive tutoring: A model of help-seeking with a cognitive tutor. *International Journal of Artificial Intelligence in Education, 16*(2), 101-128.

[2] Guthrie, J. T., Wigfield, A., & Perencevich, K. C. (2004). Scaffolding for motivation and engagement in reading. In J. T. Guthrie, A. Wigfield, & K. C. Perencevich (Eds.), *Motivating Reading Comprehension: Concept-oriented Reading Instruction* (pp.55-86). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

[3] Karabenick, S. A. & Knapp, J. R. (1988). Help seeking and the need for academic assistance. *Journal of Educational Psychology, 80*, 406-408.

[4] Mayer, R. E. (1992). *Thinking, problem solving, cognition* (2nd ed.). New York: Freeman.

[5] Puntambekar, S., & Hübscher, R. (2005). Tools for scaffolding students in a complex learning environment: What have we gained and what have we missed? *Educational Psychologist, 40*(1), 1-12.

[6] Puustinen, M. (1998). Help-seeking behavior in a problem-solving situation: Development of selfregulation. *European Journal of Psychology of Education, 13*(2), 271-282.

[7] Roll, I., Baker, R. S., Aleven, V., McLaren, B. M., & Koedinger, K. R. (2005). Modeling students' metacognitive errors in two intelligent tutoring systems. In L. Ardissono, P. Brna, & A. Mitrovic (Eds.), User Modeling 2005 (pp. 367-376). German: Springer.

[8] Ryan, A. M., Gheen, M. H., & Midgley, C. (1998). Why do some students avoid asking for help? An examination of the interplay among students' academic efficacy, teachers' social-emotional role, and the classroom goal structure. *Journal of Educational Psychology, 90*(3), 528-535.

[9] Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA: Harvard University Press.

[10] Wood, D. (1999). Social interaction as tutoring. In P. Lloyd, & C. Fernyhough (Eds.), Lev Vygotsky: Critical Assessments (Vols. 4, pp. 282-304). NY: Routledge.

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Researching Online Learning Activities: What counts?

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Abstract: Researching online offers endless possibilities for educators regardless of how the environment need to be understood and analysed. The emergence of the internet creates accessibility and opportunities for asynchronous and synchronous communication. Despite its advantages, research on online teaching and learning do represent problems in terms of observing the activities as meaningful learning are concerned. The activities of teaching and learning often vary and sometimes misunderstood. Teachers should no longer be viewed as the main source of knowledge. Likewise, students should no longer be seen as individuals who only absorb what is taught. Through discussion, students mutually learn from each other (peer-learning). This study investigates 'teaching' behavior evidenced in activities involving a group of university students using the Learning Management System (LMS) as a tool for discussion. This paper aims to address part of the problems that are faced by researchers when exploring the online tasks in the teaching-learning process, namely in trying to find meaningful contributions from learning participations in non-experimental conditions. Taking a sociocultural perspective, an argument is offered for the theorisation of peer to peer learning as a variety of 'assisted performance'. Using this theoretical lens, a case study is then offered which uses this model to frame an analysis of the nature and occurrences of online exchanges between students and the tutors. Assisted performance categories were used to analyse the message transactions and they are: Scaffolding, Feedback on Performance, Cognitive Structuring, Modelling, Contingency Management, Instructing and Questioning. The problems discussed in this paper focus on the difficulties when facing a unique form of qualitative data for indication of activities particularly the 'assistances' and the capacities of assistance in the learning tasks, which is analysed by quantitative means – Content Analysis. Analysis reveals the problems in researching online learning tasks in the aspects of methodology which is in trying to find what is most significant for evidence of meaningful postings. Instead of looking at the number of messages or number of assistances, researchers have found the solutions by taking 'proportions' of assisted performance in the learning performance. Teaching behaviour could be occurring in peer learning in students' interactions that were evidenced in online learning tasks in this study.

Keywords: Assisted performance; Online Learning; Peer Learning; Learning tasks; Learning activities.

Introduction

Educators are often challenged by the ongoing debate on learning design [1] [2] [3] for online learning especially when initiating tasks to get the utmost involvement from students. With the advent of technologies in the form of the Internet, the possibilities of asynchronous and synchronous practices become inevitable; both presenting its own challenges.

Recent studies have documented how online learning; a form of network-based teaching and learning that links learners using Internet-mediated communication tools, can be used as a face-to-face session alternative for meeting a range of pedagogical goals [4] [5] [6]. [7] and [2] emphasise that 'activities' and 'tasks' are distinguishable in which "tasks are required of learners by the demands of the curriculum. Meanwhile, activities are engaged in by learners in response to the demands of a task" [2]. Attention has recently turned to look at evidences of both learning activities and tasks taking place in an online learning environment ([8], [3]). However, the key problem identified in this research methodology is in trying to look at the evidence of learning activities in the records of online learning tasks.

The study was intended to investigate the occurrences of 'teaching' behaviour in peer learning in online discussion and how are they different to tutors' behaviours, and how these roles are enacted within tasks. Having defined teaching as assisted performance [9], the strategy for the study was to look at the occurrence and nature of assisted performance in CMC in higher education courses (that used CMC to extend the face-to-face discussion). However, for the purpose of this paper, two main problems are highlighted here with solutions which are proposed to be useful in handling such problems which are: (1) determining evidence; and proceed to the next step (2) what should be counted?

1. Assisted performance in Learning Interaction

Existing research predominantly acknowledges the need for support in order to achieve productive interactions in online learning environments. Littleton concludes in the final chapter of Learning with Computers – Analysing productive interaction: 'Underpinning many of the contributors' interest in understanding productive interaction is that through the study of collaborative interactions we can come to understand how better to support learners' joint endeavours' [10]. An alternative concept to support is offered by Rogoff [11] in the form of guided participation. The crucial factor of this concept is that it emphasises on participation, which has important implications for 'how children gain knowledge from social interaction' .

Communication between children and their caregivers involves two focal processes: creating bridges, and structuring the children's participation. This process shows how learners could be assisted: first, by developing an engaging atmosphere for participation between learner and the other parties; and second, by monitoring and managing the learner's participation. However, the concept of 'guided participation' is different for a study that involved more than one learner participating in the learning activities together. In terms of scope of observation: 'The concept of guided participation is used in an attempt to keep individual, interpersonal, and cultural processes simultaneously in focus, representing inseparable aspects of whole events in which children and communities develop' [12]. The question here is whether this notion of assistance can persist in an online environment when all the other non-textual manifestations are absent. Furthermore, it could be argued, students still may be able to learn in online learning contexts, without participating or communicating with other group members. Indeed there is a question of whether contributors to an online forum do in fact represent a community of practice rather than a group who choose to share an affinity space [13].

The term 'scaffolding' has been generally attributed to Wood, Bruner, and Ross [14] who describe it as a: 'process that enables a child or a novice to solve a problem, carry out a task or achieve a goal which would be beyond his unassisted efforts'. The term is used as a metaphor for the situation in which an adult assists a child to carry out a task beyond the child's capability. This metaphor is parallel to the concept of the Zone of Proximal Development (ZPD), developed by Vygotsky. The term 'scaffold', like the term 'support', has been used more widely in the literature as, generally, the concept of scaffolding has been accepted and applied in educational settings (e.g. [15]; [16]; [17]; [18]; [19]; [20]; and [21]). Compared to 'support', 'scaffolding' is seen as more theoretical and therefore there were efforts by educational practitioners to re-conceptualise the term. However, assistance goes beyond scaffolding and Tharp and Gallimore [9] put forward reasons why the 'scaffold' metaphor needs more refinement:

> the field has advanced to the point that a more differentiated concept can be developed. For example, scaffolding suggests that the principle variations in adult actions are matters of quantity – how high the scaffold stand, how many levels it supports, how long it is kept in place. But many of the acts of the adult in assisting the child are qualitatively different from one another. [9]

Given the above discussion, this paper highlights the importance of 'assistance' rather than 'support', 'guided construction' and 'scaffolding'. The reason for using 'assistance' rather than 'support' is to humanise this particular action. Similarly, 'guided construction' is not used as it does not stress the assistance provided by the person or persons around the learner and the word 'construction' emphasises the processes only on the learner side. As to the data availability factor (which is obtained through messages only, the full process of the activities that took place could not be captured hence, the concept of 'guided participation' was not reflected in this study. The 'scaffolding' concept is important for understanding how 'help' could be given through interactions. However, the terms/assumptions presented above imply intent on the part of the provider, which it is not always the case. Someone might assist another person's performance just simply by stating what s/he thinks, or by asking a question the reader had not thought of. Therefore, 'assisted performance' and the categories developed from this notion were seen as suitable for the study described here, which intends to identify meaningful peer supported learning interactions, through seeking for evidence of assistance provision. The following categories developed by Gallimore and Tharp [22] adapted in Kirkley *et al*. [23] were used to analyse the message transactions, or means of assistance, in CMC 'Discussion Board'. They are: Scaffolding, Feedback on Performance, Cognitive Structuring, Modelling, Contingency Management, Instructing and Questioning.

If teaching is defined as assisted performance [9], the categories of assisted performance suggest that teaching behaviour can also be seen in the students' contributions. For example, assistance in the form of questioning and modelling may be serendipitously delivered by anyone participating in online discussions. Assisted performances provided by the participants in online discussion are therefore the evidences of occurrences of opportunities for learning through social interactions [24] [25].

If assisted performance is indeed a useful theorisation of peer to peer learning, the questions that arise are what would it look like in an online discussion, and is there any evidence to support this interpretation of online interaction? To understand the nature of assisted performance in online discussions, the following research questions were developed:

1. Do students offer assisted performance within online discussion threads and how are they different to tutors?
2. What types of assistances are provided by students compare to tutors?

2. Methodology

2.2 Participants

This study involved a total of 48 participants consisting of 36 students and 12 tutors. The 36 students represented two groups of 19 and 23 students respectively. Both groups consisted of tutors and students in a Masters programme. The programme ran on a one-year basis for the full-time students and up to five years for the part-time students. It consists of eight taught units and a dissertation. Six of ten part-time students in the first group were also enrolled in the second group. Even though there were two series of year group used, entire units were not included in the study. Seven out of eight units in the first year and six out of eight units in the second year were chosen for this study. Some units were not included in the study because they had used the CMC too little or not at all. In this study, the first group is labelled 'Year 1' and the second group is labelled 'Year 2'. Most of the findings are presented according to year groups, (i.e. Year 1 and Year 2) to get an overview of the pattern of assistance.

2.3 Procedures

Assistance offering and giving, captured in the messages, are evidence of teaching in this context. Content analysis was one method used to investigate the circumstance of assistance through discussion. All circumstances of assistance, such as the total number of assistance and types of assistance by group (units), role and different task types were counted and diagnosed. Content analysis was performed on all the messages in the 'Forum' for all courses selected. Quantitative analysis of the data, through regularities or frequencies, showed the nature of assistance in tutor-student/s and student-student interaction.

3. Methodological issues

3.1 Number of messages, number of assistance or the portion of the messages?

It should be noted that analysing information regarding the number of messages is rather conventional. Regardless of how conventional this type of analysis is, the total number of messages per se has little significance. Rather, this study clearly exhibits that, the key variable in fact, is the number of incidences of assistance provision in the messages. Accordingly, the number of assistance on it own is still less meaningful as it is dependable to the number of messages. An alternative term might be: the 'proportion' of assistance. The proportion of assistance can be obtained with the following equation of:

Proportion= number of assistances ÷ number of messages x 100

This equation helps to answer the question, in any given message, what is the probability of an instance of assistance? It is very important to keep in mind that 'assistance' throughout the analysis refers to the instances of assistance, rather than occurrences of messages because one sent message could contain more than one instance of assistance.

Table 1: Overall number of messages posted by the participants in each unit

Unit in Year 1	1-1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	Total
Total messages	124	88	18	73	16	75	132	-	526
Unit in Year 2	1-2	2-2	3-2	4-2	5-2	6-2	7-2	8-2	Total
Total messages	88	26	37	96	14	-	-	45	306

As an example, this sub-section identifies the pattern of assistance provision (assistance given by the tutor and the students) across the units in each year group. Numbers of messages posted according to units in each year group are as follows:

Table 2: Overall number of assistance given by the participants in each unit

Unit in Year 1	1-1	2-1	3-1	4-1	5-1	6-1	7-1	8-1	Total
Total assistance	197	54	33	53	29	16	150	-	532
Unit in Year 2	1-2	2-2	3-2	4-2	5-2	6-2	7-2	8-2	Total
Total assistance	138	52	21	131	19	-	-	32	393

The total number of messages in both groups is unequal and there is no specific pattern for the number of messages posted. This inequality is partly because there were more units in Year 1 that had active discussion groups. Moreover, the number of participants in each year varies. As mentioned earlier, the total number of messages se is not what is significant here; rather it is the number of incidences of assistance provision that is the key variable in this study. Therefore, the information on number of assistance provision instances is as follows:

To get the exact proportion of assistance in the messages posted in each unit, the number of assistance is divided by the number of messages and multiplied by a hundred. The outcomes are as follows:

Table 3: Overall proportion of assistance in each unit

Unit in Year 1	1-1	2-1	3-1	4-1	5-1	6-1	7-1	8-1
Instances of assistance	158.9	61.4	183.3	72.6	181.2	21.3	113.6	-
Unit in Year 2	1-2	2-2	3-2	4-2	5-2	6-2	7-2	8-2
Instances of assistance	156.8	200	56.8	136.5	135.7	-	-	71.1

In both year groups it is clear that the pattern of assistance does not follow the frequency of posting. For example in Unit 2-2, the number of assistance is twice the number of messages posted; in Unit 3-2, it is as low as only 56.8 % of the messages could possibly contain a single assistance.

4. Findings

Table 4: The number of occurrence assistance and percentage of type of assistance overall by tutor and students in Year 1 and Year 2 according to type of assistance

Assistance	Group Year 1				Group Year 2			
	S_1	%	T_1	%	S_2	%	T_2	%
Scaffolding	112	21.1	85	16	132	33.6	69	17.6
Feedback	17	3.2	59	11.1	9	2.3	40	10.2
Cognitive Structuring	0	0	2	0.4	5	1.3	9	2.3
Modelling	4	0.8	6	1.1	8	2.0	1	0.3
Contingency Management	0	0	9	1.7	1	0.3	7	1.8
Instructing	7	1.3	140	26.3	4	1.0	33	8.4
Questioning	25	4.7	66	12.4	35	8.9	40	10.2
Total	***165***	***31***	***367***	***69***	***194***	***49.4***	***199***	***50.6***

S_1: by students in Year 1; S_2: by students in Year 2; T_1: by tutors in Year 1; T_2: by Tutors in Year 2; %: percentage of assistance according to type of assistance overall.

The Table above identifies the number of occurrences of each form of assistance in Year 1 and Year 2. The Table above shows that in Year 1, more assistance was from the tutors even though the students posted more messages than the tutors (tutors provided 367 assistances in Year 1 compared to 165 from students). In Year 2, however, there is no significant difference in terms of total number of instances of assistance from the tutors (199) or students (194). Compared to the number of messages sent in this year group (75 from the tutors and 231 from the students) and since there are far fewer tutors than students, it seems that assistance is more still likely to be provided by an individual tutor than a student.

In Year 1, Scaffolding at 37% is the type of assistance most commonly found in the units' discussion compared to the other types of assistance. Cognitive Structuring is the type of assistance that is least commonly found (0.4%). Feedback (14.3%), Instructing (27.6%) and Questioning (17.1%) are quite common type of assistance found between the two end points, suggesting that these types of assistance have significant roles in such interactions.

In terms of which type of assistance is most prevalent in the tutor or students' postings, it shows that in Year 1, most of the instances of Scaffolding (as the most popular type of assistance) were from the students. This is followed by Instructing, although most of these were from the tutors. Questioning and Feedback were less used and mostly by the tutors. The least common form of assistance given by the students were Instructing, Modelling, Contingency Management and Cognitive Structuring. From the Table, it can be seen that assistance was more frequently given by the tutors than the students for all types of assistance except for Scaffolding, where 112 (56.9%) out of 197 incidents of assistance were given by the students.

The finding also indicates that the number of assistance occurrences is not related to the number of messages posted, but to the participants' role. Students were more likely to provide a simple form of assistance, such as Scaffolding. Even though the tutors sent the

least number of messages overall, they remain the main source of support. They used most of the opportunities in their posting to give assistance while students did otherwise.
In Year 2, the total number of assistance from both tutors and students are almost equivalent, which illustrates an increase of students' role in giving assistance, in contrast to Year 1. Compared to Year 1, Year 2 shows a higher percentage in type of assistance used that were the least used in Year 1. These types of assistance are Cognitive Structuring, Modelling and Contingency Management.

In Year 2, the most common form of assistance given was still Scaffolding (51.1%) and mostly (two-thirds) from the students. This is followed by Questioning (19.1%), Feedback (12.5%) and Instructing (9.4%). The least common forms of assistance given by the students were still Cognitive Structuring (3.6%), Modelling (2.3%) and Contingency Management (2.0%). From the Table, it can be seen that while the students posted more messages, the total number of assistance given by the tutors and students was fairly equal (199 and 194 respectively). This instance shows the consistent contribution of tutors' assistance throughout the courses/units. Assistance was given more frequently by the tutors for all types of assistance except for Scaffolding and Modelling. From these results, tutors have shown a larger contribution in their role of giving Feedback and Instructing compared to students. These analyses of assistance suggest that assistance is more likely to be found in tutors' postings compared to the students'. The balance of most type of assistance to be given by either role (tutor and student) in both year groups shows a similar pattern i.e. students are most likely to provide assistance through Scaffolding and tutors through Feedback and Instructing.

5. Conclusion

To sum up, this paper discusses the methodological choices related to problems occurring in researching online learning task. Some main considerations for this study are as follows: (1) Some of the messages may not appear to display any sign of participants' interaction of learning, for example 'isolated' postings. However, in trying to find the evidence of assistances and to put them into a particular perspective, these messages are included in the total numbers of messages as they have, to some extent, 'contributed' to the learning as a whole. As the messages might have been read by someone or someone could have learnt something from reading them, interactions are no longer important here but the evidence of assistances. (2) Even though the findings show conventional role of the tutors in providing assistances, assisted performance still can become a useful tool in judging a meaningful posting for learning activities in online environment. Teaching behaviour could be occurring in peer learning interactions that were evidenced in online learning tasks in this study. As teaching in peer learning situation is conceptualised as assisted performance, the methodology proposed in this study, is to look at the 'proportions' of assistance (i.e. counting the frequencies of assistance relative to the number of messages) to commensurately understand the learning evidence in such an environment.

References

[1] Ravenscroft, A. & Cook, J. (2007). New horizons in learning design. In H. Beetham & R. Sharpe (Eds.), *Rethinking Pedagogy for a Digital Age: Designing and delivering e-learning*. London & New York: Routledge.
[2] Beetham, H. (2007). A approach to learning activity design. In H. Beetham & R. Sharpe (Eds.), *Rethinking Pedagogy for a Digital Age: Designing and delivering e-learning*. London & New York: Routledge.

[3] Masterman, L. & Vogel, M. (2007). Practices and Processes of Design for Learning. In H. Beetham & R. Sharpe (Eds.), *Rethinking Pedagogy for a Digital Age: Designing and delivering e-learning*. London & New York: Routledge.

[4] Beauvois, M. H. (1998). E-Talk: Computer-assisted classroom discussion - attitudes and motivation. In J. Swaffar, S. Romano, P. Markely, & K. Arens (Eds.), Language learning online: Theory and practice in the ESL and L2 computer classroom (pp. 99-120). Austin, TX: Labyrinth Publications.

[5] Toyoda, E., & Harrison, R. (2002). Categorization of text chat communication between learners and native speakers of Japanese. Language Learning & Technology, 6(1), 82-99. Retrieved on November 29, 2003, from http://llt.msu.edu/vol6num1/TOYODA/

[6] Kelm, O. (1996). The application of computer networking in foreign language education: Focusing on principles of second language acquisition. In M. Warschauer (Ed.), Telecollaboration in foreign language learning (pp. 19-28). Honolulu: University of Hawaii Press.

[7] Jones, C. (2007). Designing for Practice: Practicing design in the social science. In H. Beetham & R. Sharpe (Eds.), *Rethinking Pedagogy for a Digital Age: Designing and delivering e-learning*. London & New York: Routledge.

[8] Conole, G. (2007). Describing learning activities: tools and resources to guide practice. In H. Beetham & R. Sharpe (Eds.), *Rethinking Pedagogy for a Digital Age: Designing and delivering e-learning*. London & New York: Routledge.

[9] Tharp, R. G., & Gallimore, R. (1988). *Rousing minds to life: teaching, learning, and schooling in social context*. Cambridge: Cambridge University Press.

[10] Littleton, K. (1999). Productivity through interaction: an overview. In K. Littleton & P. Light (Eds.), *Learning with Computers - Analysing productive interaction*. London & New York: Routledge.

[11] Rogoff, B. (1990). *Apprenticeship in Thinking - Cognitive Development in Social Context*. Oxford: Oxford University Press.

[12] Rogoff, B., Mistry, J., Göncü, A., Mosier, C., Chavajay, P., & Heath, S. B. (1993). Guided Participation in Cultural Activity by Toddlers and Caregivers. *Monographs of the Society for Research in Child Development, 58* (8), i+iii+v-vi+1-179.

[13] Gee, J.P. (2007). *Good Video Games + Good Learning: Collected Essays on Video Games, Learning and Literacy (New Literacies & Digital Epistemologies)*. New York: Peter Lang.

[14] Wood, D., Bruner, J. S., & Ross, G. (1976). The role of tutoring in problem solving. *Journal of Child Psychology and Psychiatry, 17*, 89-100.

[15] Salmon, G. (2000). E-Moderating - The key to teaching and learning online. In (pp. viii). London, Sterling: Kogan Page.

[16] Oliver, R., & Herrington, J. (2001). *Teaching and learning online - A beginner's guide to elearning and e-teaching in higher education*. Edith Cowan University: Centre for Research in Information Technology and Communications.

[17] Masters, J., & Yelland, N. (2002). Teacher Scaffolding: An Exploration of Exemplary Practice. *Education and Information Technologies 7*(4), 313 – 321.

[18] Yelland, N., & Masters, J. (2005). Rethinking scaffolding in the information age. *Computers & Education, In Press*.

[19] Choi, I., Land, S. M., & Turgeon, A. J. (2005). Scaffolding peer-questioning strategies to facilitate metacognition during online small group discussion. *Instructional Science 33*, 483-511.

[20] Jeong, A., & Joung, S. (2005). Scaffolding collaborative argumentation in asynchronous discussions with message constrains and message labels. *Computers & Education, In Press*.

[21] De Laat, M. (2006). *Networked Learning.* Unpublished PhD, Universiteit Utrecht.

[22] Gallimore, R. & Tharp, R. (1990). Teaching mind in society. In L. Moll (Ed.). *Vygotsky and education: Instructional implications and social applications of sociohistorical psychology*. New York: Cambridge University Press.

[23] Kirkley, S. E., Savery, J. R., & Grabner-Hagen, M. M. (1998). Electronic Teaching: Extending Classroom Dialogue and Assistance Through E-mail Communication. In J. C. Bonk & K. S. King (Eds.), *Electronic Collaborators - Learning-Centered Technologies for Literacy, Apprenticeship, and Discourse.* London: Lawrence Erlbaum Associates.

[24] Ab Jalil, H., McFarlane, A., Yunus, M. M., & Saufi, M. M. (2004a). *Assistance in Electronic Discussions.* Paper presented at the 5th International Conference on Information Communication Technologies in Education (ICICTE), Samos Island, Greece.

[25] Ab Jalil, H., McFarlane, A., & Shariman, T. N. T. (2004b). *Role of Assistance in Computer-mediated Communication in Higher Education.* In Cook, J. (Ed). Blue skies and pragmatism: learning technologies for the next decade. Research Proceedings of the 11th Association for Learning Technology Conference (ALT-C 2004). Held 14-16 September 2004, the University of Exeter, Devon, England.

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Towards creative reasoning: Scaffolding systems thinking and decision-making

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Abstract: This paper addresses three questions. First, how students can be guided to learn from examples and generate their own ideas without falling into mechanistic substitution from the examples learnt; second, how students can be guided to elaborate on their own ideas; third, how students can be guided to associate concepts in a systemic whole into order to make holistic decisions. Concepts from the learning and decision sciences are applied to address these three questions. Findings indicate positive generation, elaboration, evaluation, reflection and association of concepts culminating in feasible, interesting and systemic decision-making. Three implications to technology-mediated design conclude.

Keywords: Systems thinking, creative reasoning, decision-making, scaffolds

1. Introduction

Making decisions is integral to every aspect of our lives. Hence, it is crucial to train students to reason critically amidst multiple alternatives. However, to create any breakthrough, critical thinking is not sufficient. One needs to reason creatively.

[1] defines creativity as being more than mechanistic substitution of elements, which meet analogical requirements. Instead, creativity requires incremental reflection that facilitates backtracking to consider more alternative search opportunities and consequently elaboration and evaluation of these alternatives in relation to the learning or task goal. To encourage iterative and incremental reflection and the search for alternatives and evaluations of these alternatives, [2, 3] stress that peers or experts who evaluate and determine whether an idea is feasible and worthy of further exploration are crucial.

The underlying factors that contribute towards the need for peer or expert feedback are highlighted by [4, 5]. [4, 5] point out that the building up of schema through the association of concepts and the evaluation and refinement of these associations creates meaning, structure and a basis for further assimilation and accommodation of new concepts. If schema is accurate, then students will be able to draw meaning from what is learnt. However, if schema is inaccurate, reflection and re-evaluation of schematic associations need to be carried out.

The building of schema is characterized by systems thinking. [6] defines a system as "a set of interacting units or elements that form an integrated whole intended to perform some function" (p. 53). In other words, systems thinking aims to help the learner think from a big picture perspective. Thus, to inculcate creativity, [7] suggests that students need to first use systems thinking to identify which and how subsystems contribute to the systemic whole and subsequently reason critically to compare and contrast these information, evaluate the credibility of the information and finally make decisions and solve problems. Hence, scaffolds aimed at inculcating systems thinking should help students to search and reason in a goal-based iteratively deepening manner [8].

1.1 Research objectives

This paper will investigate how to design reflective and evaluative affordance that would increase systems thinking, which would form the basis for creative reasoning in an ill-structured domain, i.e. the business domain. Questions of interest are:

1) How can students be guided to learn from examples and generate their own ideas without falling into mechanistic substitution from the examples learnt?
2) How can students be guided to elaborate on their ideas?
3) How can students be guided to associate concepts in a systemic whole?

The outline of the paper is as follows: Section 2 reviews foundational theories related to creativity. Section 3 presents the research design. Section 4 presents the study outcomes and discussion. Section 5 concludes with implications to technology-mediated design/learning.

2. Related work

2.1 Goals as contextualization and self-regulation scaffold

Goal-based scenarios (GBSs) emphasize on the development of procedural skills as these skills operationalize and enable refinement of schema. Learning of procedural skills occurs within an overriding mission context. The mission context consists of themes that can be adapted into different cover stories (situations, roles and challenges) [9]. These cover stories are woven into interrelated smaller missions structured from easy to difficult situations, roles and challenges.

2.2 Case-based reasoning as adaptation scaffold

Case-based reasoning (CBR) requires students to reflect on their past experiences and to transfer these as heuristics to solve the current problem [10]. Each set of problem-outcome-solution-success/failure and corresponding reasons is a case. Each case is indexed by applicability (situations in which the case can be used) and retrieved based on the learner's current goal and interpretation of what the current problem requires. Hence, the more specific and cohesive the cases (prior problems-solutions) are, the better the quality of emergent solutions. Similarly, the more creative the learner's interpretations of the design/problem requirements, the more optimal the solution will be. However, CBR's value is best seen when students are guided to access and assess information from multiple perspectives, creating cognitive flexibility (CF) [11].

2.3 Summary

The above studies show that meaning is constructed through scientific reasoning and goal-guided reflection. To reason scientifically, students need to learn how to generate alternatives, identify evaluation criteria and the constraints specific to the context, evaluate the strengths and weaknesses of these alternatives and determine possible tradeoffs. To reason creatively, students need to first view creative design/problem-solving as a goal-based iterative design-simulate-test process while working from multiple perspectives. The question remains however, how to use examples as a launching pad and avoid mechanistic substitution based on these examples, how to guide elaboration and how to guide associations of parts to the whole.

3. Research Design

This paper presents an experiment with creative scaffolding in the business domain. The students involved in this study are 20 groups of students; the population of students taking the course TDS3281 Decision Support Systems. Decision support systems have been presented to them as a response to dynamic business challenges. They have also learnt of processes in decision support as stipulated by [12]: identifying the problem or opportunity, generating intelligence (scanning the environment and reports, making queries and comparisons), designing (creativity, finding alternatives and solutions), making choices (comparing and selecting) and implementing (acting out the solutions).

3.1 Approach

In this paper, to guide students to learn from examples and generate their own ideas without falling into mechanistic substitution from the examples learnt, learning from examples occur only in the first step, i.e. at the generating intelligence stage. Subsequently, to guide students to elaborate on their ideas, students are asked to generate their own ideas using a what-if analysis. Finally, to guide students to develop systemic associations between part and whole, students are asked to rank the opportunities that they have proposed based on feasibility and interestingness, identify possible constraints in their implementation, carry out a drill down analysis to identify means to address these constraints and finally re-evaluate their ranking of proposed solutions/opportunities.

3.2 Methodology

Students are asked to take on the role of chief technological officer for a popular e-card website, i.e., 123greetings.com. Their goal (GBS) is to suggest strategies to increase revenue generated from the website. The mission is structured according to the first three processes of the decision support process. Scaffolds are as follow:

a) Generating intelligence:
- Scaffold: Compare the technical features in 123greetings.com with 3 competitors (CBR).
- Activity 1: Mark the features, which exist, as Strengths and those absent, Weaknesses.
- Activity 2: Identify **O**pportunities and **T**hreats from the above **S**trengths and **W**eaknesses comparison study to complete a **SWOT** analysis.
- The instructor provides feedback on whether the comparison criteria and comparisons among competitors are accurate.

b) Designing:
- Scaffold: Traversal between different levels of abstractions to guide systems thinking.
- Activity 1: Students identify the concept behind each opportunity suggested. For example, the concept behind connecting 123greetings.com to Facebook is social networking. (Asking students to identify these concepts has 2 purposes. First, to

raise the students' reasoning abstraction from technical features to the value that each new opportunity is adding to the business, which contributes to the goal of increasing revenue of the website. Second, to help students generate alternatives at a higher level of abstraction (concept) and not just at the features (opportunity) level.

- Activity 2: Suggest alternatives and solutions from the opportunities that they have identified (what-if analysis). Visualize the alternatives and solutions using a concept map relating each opportunity with how these contribute to the overall goal.
- Activity 3: Evaluate alternatives in terms of feasibility (likelihood to overcome constraints) and interestingness (how much users will be attracted to the new feature) on a scale of 1 to 5. Rank the opportunities based on an average of feasibility and interestingness score for each opportunity and identify the top three ranked opportunities.
- Making choices:
- Activity 1: Identify and elaborate on possible constraints to implementation of the top three ranked opportunities.
- Activity 2: Determine whether it is possible to overcome constraints identified earlier by carrying out a drill-down analysis.
- Activity 3: Based on the outcome of the drill-down analysis, re-evaluate the ranking of opportunities.
- Activity 4: The instructor provides feedback on the coherence of the what-if analysis and drill-down analysis outcomes.

Creative reasoning is evaluated based on the number of new opportunities generated, justification for the proposal, coherence between what-if analysis and drill-down analysis associations and logical outcomes in the students' conclusion.

4. Findings and discussions

As mentioned in Section 1, to *generate* ideas, students did a comparative analysis from existing examples. To *elaborate* on their ideas, students did a what-if analysis, provided justification, and identified the implementation methodology. To encourage *systems thinking*, they ranked their proposals, did a drill-down analysis to identify the constraints to the proposals' implementation and if necessary, reevaluate the ranking of their proposals. The following subsections show examples.

4.1 Designing opportunities/proposals

4.1.1 Number of examples adopted (reused) and number of new opportunities generated

Table 1 shows the number of examples adopted (indicated by the first number) and the number of new opportunities generated per group (indicated by the second number). Due to lack of space, only examples from students with at least three new opportunities generated are shown.

Table 1. Number of adopted examples and new opportunities generated per group

	G1	G2	G3	G4	G5	G6	G7
No. of concepts generated	0, 3	1, 3	1, 5	2, 3	2, 3	2, 3	4, 3

Among the groups, the top 3 groups with the highest ratio of adopted-new opportunities are G1, G2 and G3. The group with the highest number of adopted opportunities is G7, with 4 adopted opportunities and 3 new ideas whereas the group with the highest level of creativity (most number of new proposed opportunities) is G1. Examples from both groups are compared.

G7 Opportunities adopted from other websites:
Online shopping links, related links, photo gallery, mobile e-card

G7 New opportunities:
Create game e-card, relate online shopping links with the E-card to attract the user to see and shop while he/she is sending the card, share e-cards with social websites like Facebook.

G1 New opportunities:
International appeal, integration with social networking sites, integration with video sharing sites

Interviews with both groups of students indicated that they seldom thought of using other websites to generate their own ideas. They also found that marking the presence of a technical feature as strength and the absence of a technical feature as a weakness useful as an evaluation means. Learning this way from examples made sense to them.

4.2 Traversing between different levels of abstraction

G7 students were able to successfully elaborate from the proposed opportunity but were not accurate in identifying the root problem to be addressed for all the new opportunities proposed. For example, for the new opportunity relating online shopping links with the e-card to be sent, the root problem identified was how to attract users to choose another service that is related to the event that he/she wants to send a card for. The next question was what types of services would be attractive. This provided the basis for elaboration. Students identified the need to link to a party/celebration agent who could provide advice what to do and new places to celebrate in.

G1 students were able to identify the root problem without difficulty:
Opportunity: Reach more people internationally

Concept: Diversification through localization (Translating the service into different languages, and hosting some of the service in areas with highest interest) and International advertising online (by using services like AdWords provided by Google the advertising potential for web sites and regions would be maximized).

The ability to go up a higher level of abstraction, to identify the root problem to be addressed, by G1, later resulted in two additional ideas in the what-if analysis (presented in the next subsection). G7 however, did well in elaborating their ideas.

4.3 What-if analysis and ranking of opportunities

The what-if analysis for one of G7's adopted opportunities, i.e., related links, is presented in Fig. 1. The numbers in Fig. 1 refer to the students' ranking of their own proposals. Ranking was carried out on a scale of 1 to 5, with 1 being least feasible/interesting and 5 most feasible/interesting.

Compared with what was proposed initially in Section 4.1, students were able to elaborate on the type of related links (online consultation agent, online traveling agent and event planning agent) as well as what types of services these agents should provide. Hence, self-evaluated what-if analysis did help the students to design, elaborate and concretize their ideas. After evaluating all proposed opportunities, the students decided that the top three opportunities they were going to seriously venture into were photo gallery, online shopping links and provide services and update website.

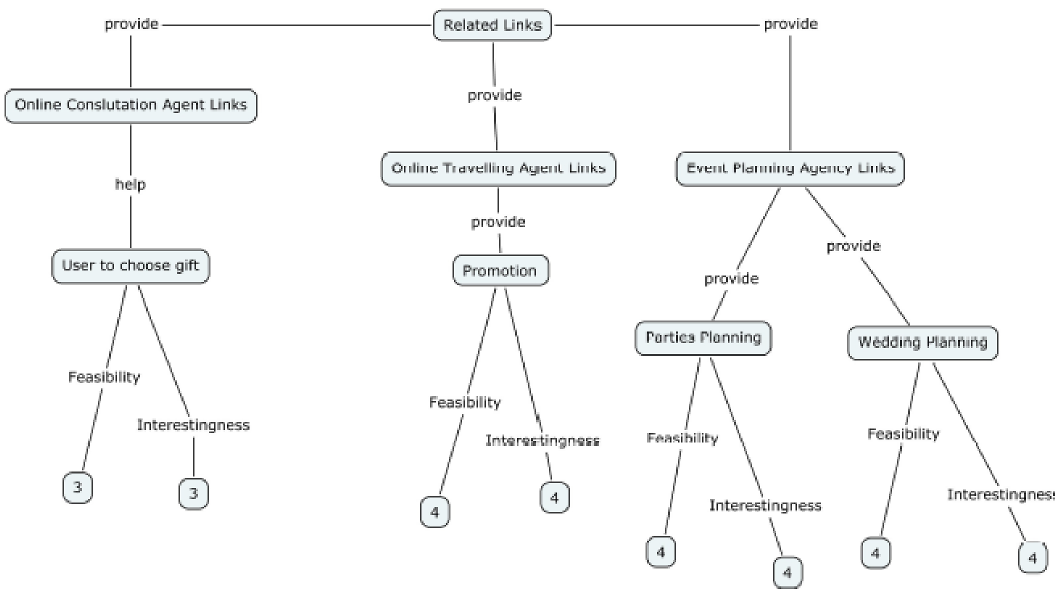

Fig. 1 G7's what-if analysis

As for G1, when asked to do the what-if analysis, they added 2 other new opportunities: personalized cards and printable cards. After self-evaluating each of the 5 opportunities based on feasibility and interestingness and averaging the combined scores, they decided that the top three opportunities that they would venture into are: integration with social networks, integration with video sharing sites and personalized cards.

Reasons for the change in ranking were:

We cannot pursue improvement internationally at the moment due to lack of capital and staff. Although, the most important opportunity from the business point of view, it would not be very interesting to explore since it would involve mainly administration.

Printable cards should not be explored in this time period because they involve entering another field: publishing. Once again, that would involve a lot of paperwork and administration as well as other legal procedures in order to make sure that no intellectual property rights are being violated.

For the sake of contrast it is important to mention the constraints of the opportunities that were not chosen. Firstly, promotion of brand internationally: this would require at least 3 full time persons travelling extensively. The persons would need to be experienced and would need to know what they are doing. This would also require setting up things like a trademark and *registering with various authorities in the region: authorities that may not always be lenient. Secondly, printable cards: first a printer and all the necessary equipment would be needed, then the person who would set all the equipment up, another person who would operate it, and another who would maintain it, in addition to contact with vendors for both the hardware and the materials used.*

Based on interviews with the students, having to rate what they proposed in the what-if analysis forced them to really look at what they had proposed and forced them to come up with better ideas to get better grades.

4.4 Drill-down analysis

The drill-down analysis gave them an insight into actual implementation issues. G7 Students were able to identify the constraints for each of the top 3 opportunities mentioned above. For photo gallery, the constraints were the need for big storage space and the cost incurred. On the other hand, for the online shopping links opportunity, constraints identified were attracting vendors to promote their online stores/shopping mall in 123greetings.com, creating a user-friendly user interface to help users navigate through the multiple online shopping links and cost. Finally, for the provide services and update website opportunity, students foresee constraints in terms of getting new ideas, getting developers due to budget constraints, contacting users who often use the website, hiring someone to follow other websites' updates and updating web site security to prevent viruses and hackers as well as to secure customers' privacy.

After considering these constraints, this group of students decided to venture only into the opportunity ranked highest in terms of feasibility and interestingness but lowest in terms of the number of possible constraints, i.e. creating a photo gallery for users. They preferred to leave the other two opportunities to the next phases of development pending new budget outcomes. Hence, drill-down analysis was effective in helping students make choices.

As for G1 students, after self-evaluation, the top three opportunities identified were integration with social networking sites, integration with video sharing sites and finally personalized cards. The main reason for the choice of these three is that there is currently an up-trend in these three opportunities. Constraints identified corresponding to opportunity proposed were lack of capital and staff who are experienced in branding and intellectual property and willing to travel extensively (international branding), lack of expertise and possible violation of intellectual property (printable e-cards). Finally, they decided on the top three new opportunities for the following reasons:

- *Integration with social networking sites: Interesting to make, only cost is time, can be maintained by current staff, social networking is very popular now*
- *Integration with video sharing sites: similar to that of social networking sites*
- *Personalized cards: It's a challenge, would add a personal touch to the site and the cards, it's not currently available everywhere*

The above examples show that drill-down analysis successfully helped students from both groups to associate concepts more holistically, taking into consideration actual implementation issues and subsequently, possible re-evaluation of earlier rankings of proposed solutions. The difference between G7 and G1 however, was the breadth of general knowledge that G1 group members had, which enabled them to think from a broader and deeper perspective.

5. Conclusion

This paper has investigated three research questions. The first question was how students could be guided to learn from examples and subsequently generate their own ideas without falling into mechanistic substitution from the examples learnt. SWOT analysis was used to address the former. As for the latter, generation of new opportunities as opposed to adopted/reuse of other’s ideas was emphasized. The second question was how to guide students to elaborate on their own ideas. What-if analysis was used successfully to elaborate on opportunities initially proposed in the gathering intelligence stage. Subsequently, students evaluated their own opportunities, ranked them and identified the top three opportunities in terms of feasibility and interestingness. Finally, the third question investigated how students could be guided to associate concepts in a systemic whole. A drill-down analysis identifying actual constraints that implementers would face during implementation helped students to associate the outcome of the what-if analysis to their company’s current resources. The drill-down analysis also helped students to think deeper what they perceived as feasible in concrete operational terms.

Three implications related to technology-mediated design/learning can be derived from this study. First, SWOT analysis was used effectively to help students learn from examples for a website most students are familiar with. However, how can we provide guidance to help students learn from examples in domains which students are not familiar with? Second, technology should help the visualization of what-if analyses. In this study, concept mapping was used. However, how can we scaffold concept mapping more effectively to help students identify root problems? Third, how can we scaffold students who lack general knowledge without incurring information overload? These questions will provide the bases for future investigation.

References

[1] Kolodner, J. L. (1993). Understanding creativity: A case-based approach. In Weiss, S., Althoff, K. D. and Richter, M. M. *Topics in case-based reasoning, First European workshop on case-based reasoning*. Germany: Springer-Verlag.

[2] Couger, D. (1996). Creativity and Innovation in Information Systems Organizations. Danvers, MA: Boyd and Fraser.

[3] Csikszentmihalyi, M. (1996). Creativity: Flow and the Psychology of Discovery and Invention. New York: Harper Perennial.

[4] Rumerlhart, D.E. (1980). Schemata: The building blocks of cognition. In R.J. Spiro, B.C. Cruce, & W.F. Brewer (Eds.) *Theoretical issues in reading comprehension: Perspective from cognitive psychology, linguistics, artificial intelligence, and education*, Lawrence Erlbaum Associates, Hillsdale, NJ.

[5] Minsky, M. (1975). A framework for representing knowledge. In P.H. Winston (Ed.) *The Psychology of Computer Vision*, McGraw Hill, New York, NY.

[6] Skyttner, L. (2001). General systems theory: opportunities and applications. London: World Scientific.

[7] Schneiderman, B. (2000). Creating creativity: User interfaces for supporting innovation. *ACM Transactions on Computer-Human Interaction. 7* (1), pp. 114-138.

[8] Lee, C. S. (2009). Scaffolding everyday creativity: A spiral cascaded development approach. *World Conference on Educational Multimedia, Hypermedia and Telecommunications,* Honolulu, HI, USA, June 22-26, 2009, pp. 770-775.

[9] Schank, R. C., Fano, A., Bell, B. & Jona, M. (1993). The design of Goal-Based Scenarios. *The Journal of the Learning Sciences*, *3* (4), pp. 305-345.

[10] Kolodner, J. L., Cox, M. T., & González-Calero, P. A. (2005). Case-based reasoning-inspired approaches to education. *Knowledge Engineering. Review. 20* (3), pp. 299-303.

[11]Spiro, R. J., Coulsen, R. L., Feltovich, P. J., & Anderson, D. K. (1988). Cognitive flexibility theory: Advanced knowledge acquisition in ill-structured domains. In *Proceedings of the Tenth Annual Conference of the Cognitive Science Societ*y. Hillsdale, NJ: Erlbaum.

[12]Turban, E., Aronson, J. E., Liang, T. P. & Sharda, R. (2005). Decision Support Systems and Intelligent Systems, 7th Edition, Pearson International Edition.

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Children Transmedia and Virtual Experiences Inside and Outside the Classrooms

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Abstract: This presentation examines, from an ethnographic perspective, innovative education settings where children explore media as proactive participants in virtual and transmedia universes. The main goal of the project has been to identify innovative educational practices whenever commercial video games, combined with other new or traditional technologies, are present in the primary and secondary education classroom to develop new media literacies in students. Analyses have been carried out following an interpretative and discourse analysis approach. The results show how video games, combined with other technological tools, could be educational tools contributing not just to motivation in the learning processes but also to children develop new ways of being literate persons.

Keywords: videogames, children, informal learning, popular culture, children as producers, new literacies

1. Aims

This presentation includes the results of a **systematic study on children's transmedia experiences in the classrooms when commercial video games become educational tools**. Specific aims of this presentation are the following:

1. To identify what children and adults can learn from certain commercial videogames and how to learn from their hidden curricular perspective.
2. To explain why they can be combined with other media and information technologies to develop students' new media literacies.

2. Living transmedia experiences in digital worlds

Let us focus on our theoretical approach. Some years ago Henry Jenkins set the context of the transmedia concept, meaning information comes from multiple channels and diverse media. According to Jenkins [5] we have entered an era of media convergence that makes the flow of content across multiple media channels almost inevitable. In some way **being digital in 2010 means also being transmedia**. Even further, in the context of the new media people can be much more than just receivers of information. We are moving away from a world in which some produce and many consume media, towards one in which **everyone has a more active stake in the culture that is produced**, says Jenkins [5]. Furthermore, participation is related to the output of ideas, materials and other products viewed as valuable within a certain culture**.** Other perspectives on participatory culture can be found in several theoretical authors (for example [2]) especially those who are close to the socio-cultural approaches [1] [3]. To sum up, in order to live transmedia experiences and to act proactively in virtual worlds, as citizens engaged in civic endeavours, children need to develop new literacies allowing them to be not just receivers but also producers of contents in the digital universes [2] [5].

3. Methodology

The research has been conducted from an ethnographic and action research approach from the 2006/2008 school year until now in three Spanish public schools. One of them is a Secondary Education institution and the other two teach Primary level. The research team collaborated with educators and students adopting the role of participant observers. We were interested in observing, analyzing and explaining these practices, learning their meaning; hence, our results may help to enable educational and innovative scenarios in school and families.

As mentioned, the project has been carried out within the elementary and secondary *school environment where very differentiated experiences took place;* each one of them is defined by the following features: a) the *participants*, namely boys and girls, their teacher and the research team; b) *the school*, as the physical and social context where the activity takes place ; c) *the video game* around which the different activities are organized..

We worked with the following data types [4]:

- **Ecological observation of the work sessions** with support from audio and/or video recordings of the events.
- **Oral discourse that serves as the means of communication among participants in a classroom environment.**
- **Written documents, photographs and audiovisual documents** provided by the researchers and by other participants, in small groups or individually.

In relation to the anaysis and interpretation processes we adopted a combination of ethic (in accordance with the meaning assigned at the completion of the anthropological research) and emic perspectives, the former giving priority to an objective approach, the latter taking into account interpretations from the participants. This analysis methodology is not new to educational and developmental psychology. Silvia Scribner [6] first used it in the 70s, adopting the approach from social-cultural psychology. Other authors have also used it recently both in the educational field as well as in the study of the media. We understood analysis as a circular process in which interpretations begin even during the fieldwork. Analysis has being carried out using both AtlasT 6 and NVivo 8 software.

4. Working with the teachers and children inside and outside the classroom

The activities in the classrooms were organized around **different workshops.** We define them as innovative scenarios where new technologies coexist with other already consolidated ones; in these scenarios, opportunities are created for boys and girls to gain new abilities related to digital literacy. In the workshops, video games coexist with the Internet and the blogs, as well as with other tools (for example photo or video cameras), which contribute to educating in the use of multiple communication codes.

For each of the groups, researchers and teachers jointly determined a set of educational objectives closely linked to the presence of video games in the classroom. Moreover, before starting the workshop sessions we worked on preparing the teachers for the experience. The activities carried in and outside of the classroom were as follows: **Collective sessions to inform** about the project and discuss proposals; **Training sessions** in which the research team shared with the group of teachers the purpose and methodology for the workshops; **Individual interviews** between teachers and the research team; **Practical playing classes and multimedia production training,** in order to help students become familiar with the games and multiples discourses to express their opinions and ideas about the games.

5. Some results

The results of this project have been discussed around the different emerging issues that constituted the subject of our investigation. Two main reports have been elaborated, both for Primary and Secondary Education, in relation to this research (http://uah-gipi.org/ingles.htm). In this paper we will just focus on some results that show how children and young people establish relationships between virtual and real world in multimedia productions. The main results could be discussed around the following topics:

5.1 Virtual and real life working with the Sims 2 Pets in primary schools

As we said before, one of the main goals of the project has been to explore new ways to bring children closer to the media in order to enable them to become citizens capable of dealing with themin a critical way. One of the main characteristics of The Sims 2 is related *to its potential for creating new content by transforming other content or by being inspired by other content.*

The classroom as a multimedia studio
The classroom became a photo studio where children performed the same activities as the research team. This was a preliminary step before they were given cameras to be used at home with their families, outside the school and the virtual world of The Sims. Through the game, digital pictures and by publishing children's texts in a class weblog http://ceiphenares.blogspot.com/ they were able to discover their own familar environments.

Remaking and reconstructing
We try to act in a creative way; this applies not only to the children but also to the teachers and investigators. Rather than repeating the same activity, once we´ve departed from the video game we can "reconstruct", "remake", and "rethink" it. This is a way of re-making creatively what others have done. In this context it was necessary to look for new resources. This example shows how video games combined with other media and cultural instruments, in this case photography, become a tool that allows children to build relationships not only between the family and the school, but also among transmedia phenomena present in popular culture and also in the virtual world.

5.2 New languages and literacies in Adolescents: maquinimia and media production

Audiovisual productions represent a specific means of expression that teenagers have access to in their leisure time, but that are scarcely present in schools even today. Technological advances from the last few years have eased access to these creations online through sites such as MySpace, Facebook or YouTube. They have become producers of content and not just recipients.We will focus now in another example in order to show how adolescents can combine transmedia experiences in their own productions.

Being conscious of the rules of the game using multimedia productions

The example that we present now is part of a biology class, with the participation of adolescents between 16 and 17 years of age, along with their teacher, in an ongoing program of bilingual (English and Spanish) course of biology. In this case we worked with the game Spore.

Adolescents Between real and virtual worlds

The students' final multimedia productions are available on YouTube[1]. A quick look at this audiovisual product shows how these small groups of students introduced themselves in the multimedia and digital universe and how they presented some issues that related to their own identity.

6. Some general conclusions

These pages try to show how commercial video games may be turned into educational instruments. It is clear that this goal is closely linked to the fact that people tend to resist the idea of videogames as educational tools; sometimes they prefer to believe more in society´s static models to explain this society rather than to accept that social relationships may be mediated by new as well as by old technologies. Therefore, once we have explored the power of videogames in the generation of a creative thinking process, expressed when children created transmedia productions in digital worlds, we have showed how we were able to introduce them into the classrooms and collaborate with children and teachers in order to create innovative educational settings. Following the ideas by Jenkins (2006) and Gee (2003) and our own experiences in some classrooms, we have discovered the importance of living in digital worlds, creating context multimedia, and offering new ways of thinking and reasoning.

7. References

[1] Bakhtin, Mikhail (1965/1984). *Rabelais and his world. Translated by Hélène Iswolsky*. Bloomington, IN: Indiana University Press.

[2] Castells, Manuel (2009). *Communication power*. Oxford ; New York: Oxford University Press.

[3] Gee, James (2008). Video Games and Embodiment. *Games and Culture, 3*(3-4), 253-263.

[8] Green, Judith L., Camilli, Gregory, & Elmore, Patricia B (2006). *Handbook of complementary methods in education research*. Washington DC: AERA & LEA.

[5] Jenkins, Henry & Lacasa, Pilar (2010). Learning in a Participatory Culture: A Conversation About New Media and Education. *The Official Weblog of Henry Jenkins, http://henryjenkins.org/2010/02/_children_and_young_people.html* (February 8, 2010 (Access, April 26, 2010)).

[6] Lacasa, Pilar, Méndez, Laura, & Martínez, Rut (2008). Developing new literacies using commercial videogames as educational tools. *Linguistics & Education, 19,* (2), 85-106.

[1] http://www.uah-gipi.org/multimedia/

[7] Scribner, Silvia. (1985/1997). Thinking in action: Some characteristics of practical thought. In E. Tobach, R. J. Falmage, M. B. Parlee, L. M. Martin & A. Scribner (Eds.), *Selected writings of Silvia Scribner* (pp. 319-337). Cambridge, UK: Cambridge University Press.

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Web-based Tools for Science Teaching in Lower Primary School

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Abstract: This paper presents the preliminary findings of the use of Web-based Tools, like Tagul for generating Word Cloud and Forum for Asynchronous Online Discussion, in Science Teaching for a class of 9-year old pupils. The affordances and the implementation of the tools for Science Teaching are discussed in this paper. This exploratory case study of such tools provides encouraging evidence that the tools have the potential to engage the pupils in meaningful learning.

Keywords: AOD, Word Cloud, Web-based

Introduction

Currently, Primary 3 pupils have only 2 45-min periods weekly for Science. The pupils are generally very enthusiastic about Science and always want to share. Usually, there is no enough time for class room discussion for all to participate. There is thus a need to look at how Web-based tools can help to solve such problem. In this paper, a set of free an easily available Web-based IT Tools (like Tagul and Forum) are used. Due to the Web-based and the asynchronous nature, such tools allow Science learning to take place even outside the physical classroom. Such tools allow the pupils to construct and share what they have known with their peers. In the process of such construction, the pupils are engaged in higher order thinking like critical thinking and analytical reasoning [1]. They need to make “certain choices and it is in those choices that the learning process lies" [2]. Such construction of their own knowledge makes learning more meaningful as the learners own their learning [3].

1. Literature Review

1.1 Tagul - The Word Cloud Generator

Tagul (http://tagul.com/) is free online word cloud generator. A word cloud is a visual depiction of word frequency in a given text. Greater emphasis (it may be font size or colour) will be placed on word with higher counts. One unique feature of Tagul, unlike other word cloud applications, is that the word is actually a hyper-link to a Google Search of that word. This allows the pupils to easily navigate to find out more about the word. Although the usual word cloud generators are not designed for teaching, there are potential uses in education as "astute teachers recognize that such toys are much more than that when they can be used to engage students in creative and critical thinking” [4]. Tagul can be used as knowledge construction and co-construction tool as the pupils contribute words on the topic of the interest. Together with their classmates, they are building a model of their understanding of the topic. The Word Cloud is generated, thus helping the pupils to externalize their mental model.

1.2 Forum - The Asynchronous Online Discussion

Forum supports asynchronous online discussion (AOD). AOD provides a platform where all pupils can participate in discussion, without the need to meet face to face. This will help to encourage the shy pupils to participate [5]. AOD allows the instructors and pupils to keep a record of their discussion [6]. This can allow the pupils to reflect and review on their learning progress from time to time. By reading, critiquing on others' posts, AOD allows the pupils to collaborate, gain different perspective and construct their knowledge together [7].

1.3 Pedagogical Approaches Supported by Tagul and Forum

During self-regulated learning, the learner owns the learning and takes initiative to work toward self-improvement. As proposed by Pintrich [8], self-regulated learning will involve the use cognitive learning strategies, self-regulatory strategies and resource management strategies. The Web-based tools proposed, Tagul and Forum, provide pedagogical affordances that support some of these strategies. For example, the Web-based tools can support elaboration (one of the cognitive strategies). The tools require the learners to post what they have known, or comment on others' posts. Unlike the traditional face-to-face teaching, the Web based-tools allow all the pupils to have equal opportunities elaborate on what they have known. Such questions asking and answering are important as it supports comprehension, reasoning and problem solving [9].

The asynchronous nature of the Web-based IT Tools supports the use of self-regulated strategies as it allows the learner to have time to plan, monitor and regulate their learning. They have time to think and reflect before they contribute their post/comment [3]. The word clouds by Tagul, the asynchronous discussion in the Forum are always be available on the Web. As such, there is a record of their learning and the learners can track and monitor their learning progress from time to time.

To achieve effective self-regulated learning, the learners must be motivated and eager to learn [10]. The use of the proposed Web-based tools will engage the learners in active learning as they are "compatible with the way students now prefer to learn" [11]. Web-based activity will appeal to the young learners who are digital natives [12].

The Web-based tools also support dialogic discourse which can enhance the learning experience for the pupils. Scott [13]. suggests that learning will be improved if the learners have a well-mixed of both authoritative (teachers' talk) and dialogic discourse (teacher and pupils' talk). A typical classroom setting will favour authoritative discourse as it saves time. The Web-based tools can help to complement the classroom teaching by supporting dialogic discourse outside classroom time. The Web-based nature of the proposed IT tools means that question asking and answering can take place anytime so long there is Internet connection. Such questioning activities will help the learners to construct their own knowledge as questions can encourage the learners to think and help the learners to discover their misconceptions [14].

2. Implementation of Web-based Tools for Science Teaching

2.1 Method

In this case study research, the research questions of interest were:
(1) How effective can the tools help the pupils to learn Science Concepts like Animals and Plants?
(2) What are the necessary conditions for engaged learning to take place using these tools?
In this case study, a class of 34 pupils (mixed ability) is chosen. They are to use Tagul to contribute their answers to question on Diversity. For example, the questions can be “Name the different type of non-flowering or flowering plant” or “Name the different materials that objects are make up of”.
A Forum was created in the school Learning Management System (powered by Moodle). As suggested by Wong, Hew and Cheung [15], the pupils were organized into groups of 5. Each pupil is to contribute to the Group Forum. The questions posted in the Forum are mainly used for the pupils to reflect on what they had learned (like “Describe an animal” or “Creating ‘Material’ Riddle).
This is a work-in-progress paper. The preliminary finding is based on both the qualitative and quantitative data which complemented each other. The qualitative data (provided the dept) collected were teacher’s reflection and observation, focus group discussion with pupils and the forum postings. On the other hand, the quantitative data (provided the breath) collected were statistics logs in the Moodle and the pupils’ perception survey.

2.2 Findings

Tagul provides opportunities for pupils’ inputs to be recorded on the Web. The pupils can use the Tagul to reflect and rehearse on what they have learned. With the possibility that the inputs are viewed by others, some pupils tried to come up with interesting word. For example, in asking for the inputs on the different flowering plants, one pupil suggested Titan Arum. His contribution was acknowledged in class and pupils were encouraged to click on the word to find out more. It was observed that the pupils were simply awed by such "big names" given by their classmate and wanted to find out more by clicking on the big words.

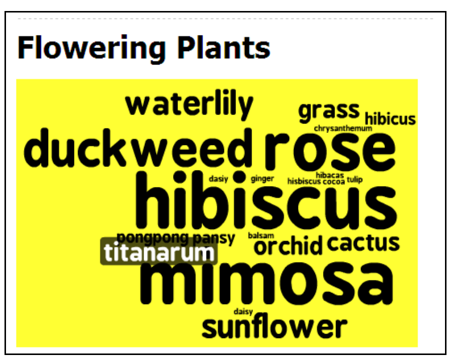

Fig 1.1: Word Cloud on Flowering Plants

From classroom observations, the pupils were generally interested in reading what their friend have written and answer the posting. Such view is supported by the perception survey in which more than 70% of them enjoyed contributing and viewing other post. From the Forum Postings, the high ability pupils were more likely to build on and criticize their friends' ideas. Some pupils even suggested new topics like cells or posting questions for their classmates (See Figure 1.2).

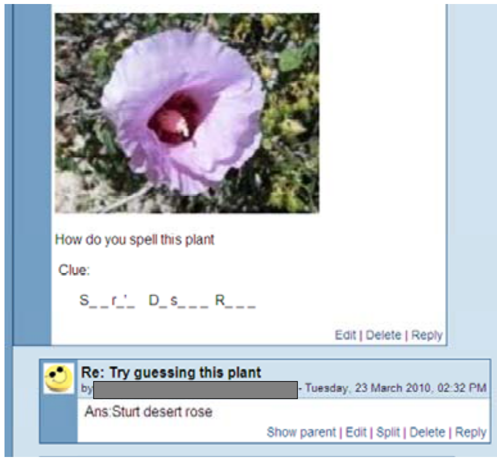

Figure 1.2. Pupils' Initiated Topic

The low ability pupils were also contributing their views too. For example, they were supposed to post a riddle on Material on the Forum. As shown in Figure 1.3, Pupil B, the weak pupil, modified Pupil A's riddle by changing the properties. This illustrated that Pupil B was thinking and not just copying blindly.

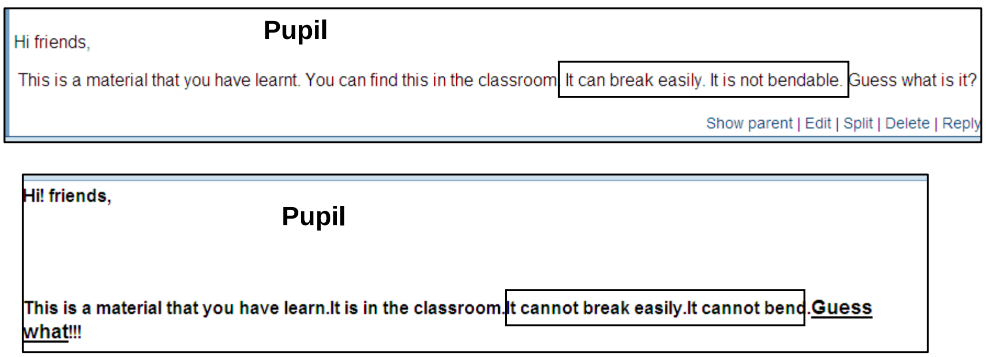

Fig 1.3: Pupils' Posting

From the experience of using the tools for the past few months, these were the possible conditions for engaged learning to take place using the tools:
(1) There is a constant to promote the Web-based Tools in class. Pupils, who make it a point to access the Web-based Tools, at home will be praised and outstanding post/contributions are highlighted. Moreover, the pupils are also allowed to use the Web-based Tools during school time. Such access in class will hopefully get them "hooked" to the tools and they will be motivated to access them at home. The access to computers in class also provides opportunities for pupils without Internet access at home to use the ICT-tools.
(2) As in any technology intervention, the teacher plays an important role. The use of the tools must be in line with the teacher's pedagogical belief and they view "technology as the means to an end, rather than an end itself" [16]. This will give the teacher the discipline and motivation to facilitate the pupils' postings almost daily and promote the use of such tools (for example, encouraging and acknowledging their contributions). The teacher must also constantly reflect on the use of the tools and how best this can engage the pupils.
(3) The pupils must find the questions posted of interest to them. In this way, they are more likely to contribute and build on their friends' views. For example, for teaching on Diversity of Materials (Non-Living Things), the pupils are more interested in the posting and answering riddles posted by their friends. Another question posted on the same topic (on getting them to explain why the material is used for making an object), the contribution rate

is lower. Designing the right question is important as the right question will enthuse and get the excited about posting their views.
(4) There must be parental support at home to encourage the pupils to use the tools even at home. From this study, 60% of the Forum activity occurred in school despite a letter being sent out to explain the rationale for such Web-based activities. Most parents still believe in the traditional "worksheet" way of learning. Thus, there is a need to promote such Web-based activities so that they can see the educational value of such tools.

Conclusion

The exploratory study of the Web-based tools provides encouraging evidence that there is potential for use in teaching of Science. The Web-based tools provide opportunities for discussion to take place even outside the physical classroom. Pupils are engaged in meaningful learning as they are learning from their friends and owning their learning. They are externalizing what they have learned. Such externalization of their model is important as this will engage them in higher order thinking as they need to make sense of what they have known. One of the greatest challenges is to get the pupils to actively participate in the Web-based tools even at home. Parents do not view such Web-based activities as "real learning" and would rather their child to be doing learning sheets.

References

[1] Jonassen, D.H., & Reeves, T. C. (1996). Learning with technology: Using computers as cognitive tools. In D.H. Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 693-719). New York: Macmillan.

[2] Jonassen, D., Strobel, J., and Gottdenker, J.(2005). Model building for conceptual change. *Interactive Learning Environments, 13*(1), 15-37.

[3] Jonassen, D., Howland, J., Marra, R.M, & Crismond, D. (2008). *Meaningful learning with technology*. NJ: Pearson.

[4] Hayes, S.(2008). Wordle Students' words. *Voices From the Middle, 16*(2), 66-68.

[5] Bali, M., & Ramadan, A. (2007). Using Rubrics and Content Analysis for evaluating online discussion: A Case Study from an Environmental Course. Journal of Asynchronous Learning Networks, 11(4), 19-33.

[6] Salmon, G. (2002). Mirror, mirror, on my screen. Exploring online reflections. British Journal of Educational Technology, 33(4), 379-391.

[7] Hew, K. F., & Cheung, W. S. (2003). Evaluating the participation and quality of thinking of pre-service teachers in an asynchronous online discussion environment: Part 1. *International Journal of Instructional Media, 30*(3), 247–262.

[8] Pintrich, P. R. (1999). The role of motivation in promoting and sustaining self-regulated learning. *International Journal of Educational Research, 31*(6), 459-470.

[9] Otero, J. & Graesser, A.C. (2001). PREG: Elements of a Model of Question Asking. *Cognition and Instructions, 19*(2), 143–175.

[10] Driscoll, M.(2005). Psychology of learning for instructions (3rd ed.). Boston: Allyn and Bacon.

[11] Owston, R.D. (1997). The World Wide Web: A Technology to Enhance Teaching and Learning?. *Educational Researcher, 26*(2), 27–33.

[12] Prensky, M. (2001). Digital Natives, Digital Immigrants. Retrieved 5 April, 2010, from http://www.twitchspeed.com/site/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.htm

[13] Scott, P. (1998). Teacher talk and meaning making in science classrooms: A Vygotskian analysis and review. *Studies in Science Education, 32*(1), 45–80.

[14] Chin, C. (2007). Teacher Questioning in Science Classrooms: Approaches that Stimulate Productive Thinking.Journal of Research in Science Teaching, 44(6), 815-843.

[15] Wong, W.C., Hew, K. F., & Cheung, W. S. (2008). Exploring Singapore Primary school students' perceptions of Chinese Asynchronous Online Discussions. *New Horizon in Education, 56*(1), 1-13.

[16] Zhao, Y., Pugh, K., Sheldon, S., & Byres, J.L. (2002). Conditions for classroom innovations. Teacher College Record, 104(3), 482–515.

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An evaluation of a specialized portable system for tertiary distance teaching of ESOL

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Abstract: This paper reports on the piloting in Thailand of a prototype English for Speakers of Other Languages (ESOL) learning appliance. Two evaluations were held with volunteers from a Thai open university. The participants worked through a set of scenarios designed to evaluate their ability to use all the principal features of the appliance while remaining focused on the learning content. The results confirmed the feasibility and utility of the concept of a learning appliance for ESOL, while highlighting the importance of a close match between the learning content and the forms in which the content is presented. Lessons were also learnt about the special challenges involved when evaluating software across multiple cultures and countries.

Keywords: e-learning, ESOL, invisibility, usability evaluation, information appliance

Introduction

In order to support learning, educational software should be designed by considering the way students learn. The software should provide good usability so that student's interactions with the software are as natural as possible, without the student having to think about the technology. When the technology fits the need so perfectly that the user forgets that a complex technical device underpins it, then the technology is regarded as invisible [4]. It is this approach that the design of a distance learning appliance for teaching second languages, IMMEDIATE (Integrating MultiMEdia in a DIstAnce learning and Teaching environment) was based on [2, 3].
White has written extensively about the distance teaching of second languages [9]. She observed that "finding the right fit between technology choice, institutional objectives, pedagogical aims and learner needs in particular socio-cultural contexts is complex and frequently problematic". What has to be supported is the interaction between the students and learning context to enable them to become autonomous learners. Whilst the emphasis has moved to a communicative/immersion approach to the teaching of second languages, there are still self-directed learners who prefer to engage in a community once they have sufficient confidence in their language skills [1]. Appropriate teaching material and its organization are important issues in both students and learning contexts. Levy [6] believes that a modular approach to the teaching of language should be employed in computer-based systems centered around Grammar, Vocabulary, Reading, Writing, Listening and Speaking. IMMEDIATE provides all the technology required to support this modular approach. It has also been specifically developed to allow student autonomy within either a self-directed or social constructivist framework. The challenge now is to explore how these teaching techniques can benefit students of a different learning culture while maintaining good usability and invisibility of its application.
In this paper, we describe the piloting of IMMEDIATE prototype at an open university in Thailand. The learning appliance, developed in collaboration with language teaching and distance teaching experts in Thailand and New Zealand, was designed to enhance the open

university's established distance ESOL program, by linking with native English tutors based in New Zealand. In this study, our goal was to test the usability and the invisibility of the prototype interface with real users of the learning appliance, in preparation for a full-scale evaluation with distance ESOL students in Thailand. Before elaborating on the evaluations, the learning appliance (IMMEDIATE) is described in the following section.

1. Background

IMMEDIATE is a customizable e-learning system designed to support distance learning for off-campus students. With IMMEDIATE, students can work from anywhere as the course material is mounted on a portable flash drive, which can be plugged into and run from any available computer. Unlike a web-based Learning Management System (LMS), access is not dependent on a reliable Internet connection as the course content is stored at the student end. The content is updated periodically in the background while the student works via the Internet or portable storage media.

The focus in the development of IMMEDIATE was on designing for *form*, which is to consider the students' roles as a computer user [2]. Our goal in the development of this tool is to minimize the visibility of the computer for the user, in order to maximize the visibility of the teaching content for the learner.

IMMEDIATE has been customized for teaching intermediate-level English for speakers of other languages (ESOL). Several learning modes were incorporated in the material supported including reading practice, writing exercises, listening practice, vocabulary, and live audio and text conversations between students and with the tutor.

2. Evaluation Plan

The goal of the pilot tests was to test and refine the teaching module, to tune the software to the ESOL requirements, identify and fix any remaining usability issues, and to refine our plan for a subsequent full-scale evaluation with distance students in Thailand and determine the feasibility of continuing to the next stage.

Our evaluation plan has the following features. A set of scenarios are developed and translated into Thai. The participants are required to follow the tasks defined in the scenarios when evaluating the system. In order to capture immediate responses on the participants' learning experiences, a total of 15 statements to which the user rates agreement on a 5-point scale of "Strongly Agree" to "Strongly Disagree" are built into the scenarios. The participants rate the statement immediately on the sheet of paper as they proceed with their tasks. These statements focus on four study modes (*listening, assignment, reflection, and interaction*) and four features (*ask the tutor, self practice, messaging, and self assess*) of IMMEDIATE. Upon completion of the tasks, the participants complete a questionnaire in Thai on their experience using IMMEDIATE. The questionnaire is based upon an extension of the SUMI [5] questionnaire. It consists of 30 statements to which the user also rates agreement on a 5-point scale of "Strongly Agree" to "Strongly Disagree". The statements are worded both positively and negatively and are evaluated based on ten factors which include Helpfulness, Efficiency, Effectiveness, Affective, Online Medium, Privacy, Timeliness, Focus, Error Prevention, and Learnability. These factors have been identified from our previous study [2] as key factors for measuring the invisibility of a technology.

To analyze the statements from the scenarios and questionnaires, the median value for each response is calculated. The median values are represented as 1 = Strongly Agree, 2 = Agree, 3 = Undecided, 4 = Disagree, and 5 = Strongly Disagree. We also look at the top-2 and bottom-2 responses to support the median values. The top-2-response score refers to someone choosing a 1 or 2: those who agree with the statement (somewhat or strongly agree), and the bottom-2 refers to someone choosing a 4 or 5: those who disagree with the statement (somewhat or strongly disagree). The top-2 and bottom-2 data are reported as a percentage of the participants. A bilingual focus group discussion is then conducted, using simultaneous translation, to solicit feedback and comments that may not be covered in the questionnaires. This discussion provides a semi-structured environment for evaluation feedback, which is transcribed and translated.

Table 1: Scenario questionnaire results from Second Evaluation

No	Mode/Feature	Statement	Median	Top-2	Bottom-2	Respondent
1	Listening Mode	1. This mode is stimulating and motivating	2	100%	0%	11
		2. This mode supports the learning process	1	100%	0%	10
2	Assignment Mode	3. This mode is stimulating and motivating	1	100%	0%	9
		4. This mode supports the learning process	1.5	100%	0%	8
3	Reflection Mode	5. I like the use of this mode to monitor my progress in this subject	2	70%	10%	10
		6. This mode supports the learning process	2	67%	11%	9
4	Interaction Mode	7. Using this mode is frustrating	3	44%	33%	9
		8. This mode supports the learning process	1	100%	0%	9
5	Ask the Tutor	9. This feature assists in the learning process	2	80%	10%	10
6	Self Practice	10. The exercises are stimulating and motivating	1	89%	0%	9
		11. The exercises can be completed easily	2	78%	11%	9
7	Messaging	12. Sending the message is easy	1.5	63%	25%	8
		13. This feature supports the learning process	2	78%	11%	9
8	Self Assess	14. This feature is stimulating and motivating	1	88%	0%	8
		15. This feature supports the learning process	1.5	100%	0%	8

3. Results

The pilot evaluation was conducted in two stages with volunteers from the Thai university. The first pilot involved 5 participants with limited computing and English language experience, while the second evaluation had 11 participants who were current or former ESOL students and used computers on a daily basis.

In the first pilot, the focus group discussion highlighted that these users had difficulty conceptualizing the tasks outlined in the scenarios, and lacked the minimal English language skills to fully interact with the system, including understanding the help features which were written in English. They felt that the multiple modes made e-learning more attractive than learning through textbooks, although they found the *interaction mode* frustrating to use.

While the number of participants was small, the results from the analysis of the statements in the scenarios and questionnaire have helped us prepare for the second pilot study. As a result, further improvements were made to the software (mainly the *interaction mode*) and the instructions in the scenarios. A user manual summarizing the features of IMMEDIATE was also prepared and translated into Thai to assist the participants in the second pilot.

The first pilot conducted earlier was regarded as a baseline study to help us in our preparation for the second pilot. In the second pilot we had a larger number of participants with more experience in learning English as a second language. The majority of the questions in the scenarios received positive scores for median and top-2 (Table 1). However, similar to the first pilot, the interaction mode was still perceived as frustrating to use (median=3, top-2=44%).

The responses from the questionnaire revealed that the majority of the participants were satisfied with the system's *Efficiency* (58.2%), *Affectiveness* (56.4%), *Timeliness*, *Focus* (51.5%), *Privacy* (59.1%) and *Online Medium* (54.5%). However, the system's *Error Prevention* mechanism needs to be further improved as the results were similar to those from the first evaluation (median=5, top-2=0%).

From the focus group discussion, several encouraging suggestions and comments were collected. In particular, the learning support was regarded as very useful and should be incorporated in other e-learning system such as Mathematics. Some also felt that more feedback was required to users indicating that their assignments and messages have been sent or received. They should also know when an invitation to talk was denied. And some felt that the layout design for some appliance features should be more like other software products with similar functionality in order to reduce confusion among the users

4. Discussion and Conclusion

This paper presented the results of initial pilot evaluations of a prototype ESOL learning appliance in Thailand. In the first pilot, the participants had difficulty following the instructions in the scenarios. Their lack of understanding the English language and computer experience could have led to the unfavorable responses to the factors that were being evaluated such as *Learnability* and *Effective*. This feedback confirmed the need for learners to master the English language well enough to undergo electronic training where no human instructor is available [7]. We also discovered from the focus group discussion that the participants were not aware of the type of evaluation they would be involved in. This highlighted the importance of recruiting participants with an interest in the learning activity supported by the appliance rather than recruiting participants at random.

On the other hand, the participants in the second evaluation experienced some initial confusion as to how to operate IMMEDIATE because of an expectation that the interface would be similar to the Windows and Microsoft software that they used on daily basis. Nevertheless, the majority of the factors were rated positively as these participants' experience of English language learning was quite high. In the second evaluation only 24% of the participants claimed they were distracted by the technology when trying to focus on their work compared to 40% of the participants in the first evaluation. The technology certainly appeared to be less visible. This result could be due to the improvements made to the learning appliance following the feedback received in the first evaluation.

Both evaluations received unfavorable feedback for *Error Protection.* These were expected as the problems encountered were mostly from features which were not part of our earlier heuristic evaluation. These features underwent several changes which were not fully tested before the first and second evaluations. Both evaluations also highlighted the need to have translations in Thai included in the learning material (i.e. the recording in the listening mode). Some instructions in the learning material were also perceived as not clearly stating how the exercises should be completed. These highlighted the cross-cultural usability issues and the need to design e-learning content incorporating native language instructions in order to serve the large non-English speaking learners. Several collaborative works on e-learning with people in Asian countries [7, 8] have revealed the need to have learning content developed in both English and the native language. They highlighted that language difficulty should be taken into consideration when e-learning is carried out across borders and the lectures are given in English.

The findings from these evaluations have revealed to us that in addition to usability, designing for invisibility requires a close match between the learning content and the forms in which the content is presented. We have discovered that invisibility will be negatively affected when the learning content does not match the student's expectation. The next step in our study is to work on the usability and content problems brought out during the pilot. Heuristic evaluation will have to be conducted on the added features of the learning appliance and materials in both English and Thai will need to be developed to improve the learning ability of the students.

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References

[1] Garret, N. (2009). Computer-assisted language learning trends and issues revisited: Integrating innovation. The Modern Language Journal, 93(s1):719-740.
[2] Johnson, R., Kemp, E., R., & Blakey, P. (2007). The learning computer: low bandwidth tool that bridges digital divide. International Forum of Educational Technology & Society, 10 (4), 143-155.
[3] Kemp, E., Thompson, A., Johnson, R. (2008). Interface Evaluation for Invisibility and Ubiquity – An example from E-learning. CHINZ 2008, July 2, 2008, Wellington, New Zealand.
[4] Norman, A. D. (1998). The Invisible Computer, MIT Press, Cambridge, Massachussetts.
[5] SUMI questionnaire. Retrieved from http://www.ucc.ie/hfrg/questionnaires/sumi/index.html.
[6] Levy, M. (2009). Technologies in use for second language learning. The Modern Language Journal, 93:769–782.
[7] Toh, C. E-learning Implementation Preparation in Asia Region. Retrieved from http://hrdgateway.org/hub5/research.
[8] Urano, Y. and Wu, J. (2004). Lessons Learned through Joint Research Projects on e-Learning in Asian Areas. National Institute of Multimedia Education, 64-71.
[9] White, C. (2006). Distance learning of foreign languages. Language Teaching , 39 (4), 247-264.

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Investigation and Analysis on the Development Trends of Learning Management System over the Past Five Years (From 2005 to 2009)

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Abstract: The booming of information technology has influenced the evolution of learning patterns and the integration of information technology into teaching has became one of the mainstream methods. The teaching and delivery of knowledge are no longer restricted to traditional lectures. As Learning Management System (LMS) at the present stage can accommodate a diversity of learning requirements and functions, there are many literatures to study on the application of the LMS. However, as the development of relevant industries and technologies, users' requirements on the LMS may be influenced and changed. How will these changes affect the development of the LMS? What are the changes and developments of the LMS required for addressing the current and future requirements of the users? To address these questions this study aims to perform a comprehensive investigation on the technologies, applications, and analysis of the LMS to realize the developments of the LMS.

Keywords: E-Learning, Learning Management System (LMS), Information and communication technology (ICT)

1. Introduction

In recent years, the rapid development of Information and Communication Technology (ICT) has created impacts on traditional education [18]. In this context, the role of the teachers can change from a knowledge provider to a facilitator and the role of the students can also changed from a knowledge receiver to a knowledge provider [4]. In the web-based environment, administrators, instructors, and students can apply a learning management system (LMS) to manage individual resources conveniently. Moreover, through computer technologies, the students' learning behaviors can be real-time recorded that can assist the teachers in tracking and realizing the students' learning status immediately. Kirschner and Paas [13] suggested that such an environment can bring new experience to the users.

The LMS can leverage interactivity, multimedia, knowledge management, and customized learning [7][9][10][16]. By using internet, the users can take teaching and learning on the learning platforms without the restrictions of time and space. Therefore, so far, many organizations have invested a lot of time and fund in the development of LMS [1]. Nevertheless, as the advances of ICT, users may change their requirements on using the LMS and the development of the LMS may be influenced from human and technology aspects. Therefore, this study intends to conduct a thorough investigation and analysis to realize the development of the LMS from an academic view.

2. Methodology

The purpose of this study is to investigate and analyze the development of LMS in depth. Hence, to conduct this work, this study collated, analyzed, and summarized relevant articles published by five SSCI (Social Sciences Citation Index) journals in the field of E-Learning from January 2005 to October 2009. The five journals are Computers & Education (C&E), Journal of Computer Assisted Learning (JCAL), Journal of Educational Technology & Society (ETS), Innovations in Education and Teaching International (IETI), Educational Technology Research and Development (ETR&D).

Figure 1. Research framework and process

As shown in Figure 1, this study was administered by five Ph.D. students and two professors who defined aims, collected data, surveyed articles, analyzed data, validated results, and summarized investigations. Each stage of this process was began with an open-ended discussion and ended in a convergent thought. The results were produced by detailed assessments, clarification, and validation. In order to ensure the investigation is correct, three domain experts were invited for examining the results during the process.
In this study, a total of 1,545 articles were sampled from the five journals in SSCI database. To screen these articles, a definition of LMS was identified in this study. According to Hall [9], Hall [10], and Ellis and Ryann [7], a LMS is served for the functions of learning management, process recording, issue discussions and online learning. Based on the definition, a total of 90 articles were selected for further investigation. The detailed results are summarized in Table 1.

Table 1. Number of articles related to the study of learning management system in each year (from 2005 to 2009) and journal

	C&E	JCAL	IETI	ETS	ETR&D	Total
2005	1/48 (2.08%)	3/38 (7.89%)	9/29 (31.03%)	3/69 (4.35%)	1/37 (2.7%)	17/221 (7.69%)
2006	2/56 (3.57%)	2/36 (5.56%)	3/33 (9.09%)	2/86 (2.33%)	1/43 (2.33%)	10/254 (3.94%)
2007	6/123 (4.88%)	2/41 (4.88%)	3/32 (9.38%)	2/83 (2.41%)	2/37 (5.41%)	15/316 (4.75%)
2008	9/228 (3.95%)	3/45 (6.67%)	6/38 (15.79%)	7/85 (8.24%)	0/35 (0.0%)	25/431 (5.8%)
2009	17/178 (9.55%)	5/35 (14.29%)	1/27 (3.7%)	0/44 (0.0%)	0/39 (0.0%)	23/323 (7.12%)
Total	35/633 (5.53%)	15/195 (7.69%)	22/159 (13.84%)	14/367 (3.81%)	4/191 (2.09%)	90/1,545 (5.783%)

3. Results

Based on the research issues of the 90 articles, four categories were classified that are technology development, educational application, analysis of user intention, and analysis of system development.

3.1 Technology Development

To enhance LMS performance, many studies applied novel approaches to develop an innovative service for the LMS, such as the Data mining technique analyze learners' behaviors and provide feedbacks [20]. Some studies utilized proxy technique to develop a diagnostic and learning system for analyzing and evaluating online learning status of learners. Additionally, in order to achieve interoperability of LMS, Wang and Hsu [23] proposed a system based on SCORM (Sharable Content Object Reference Model) and ontology technique to restructure curriculum that can reduce teachers' burden and empower the curriculum with interoperability over internet.

Many users adopted open source software to develop their LMS. The users can amend original functions or add new functions based on their requirements in order to improve the performance of the LMS, for instance Moodle, blog and Wiki.

A general LMS may not be able to serve all teaching purposes or facilitate special learning. To address this problem, therefore, a new LMS was developed. Chen, Ko, Kinshuk, and Lin [5] developed an online simultaneous learning system to enhance learners' conversation skills and improve peers' interactions. Méndez, Casadesús and Ciurana [17] proposed a virtual company that allows fresh graduates to learn how to cope with a problem in real life.

3.2 Educational Application

By definition, digital learning is an application of ICT to improve learning. The use of ICT in teaching activities on LMS can eliminate the gap between cities and rural areas and break the traditional boundary between teachers and students, as well as facilitate the cooperation, communication, and knowledge sharing of learners [14][15].

Interactive services on LMS can encourage self-learning and active learning, as well as facilitate knowledge sharing. In this way, learning environments can integrate teaching strategies with activities to allow cooperative learning [11], such as Cortez et al. [6] used a face-to-face computer supported collaborative learning system to enable teachers and students to share learning contents and take a dynamic teaching and learning on a real-time basis.

Diverse presentations and functions of teaching material prompt teachers to introduce their conventional curriculum into LMS. Rich functionality can also be used to enhance teaching and learning performances. In 2005, Peat, Taylor, and Franklin introduced natural science curricula into a virtual learning environment [19]. The sharing, both real-time and non-real-time, on the platform can enhance verbal and written communication skills of learners to reduce cultural differences and barriers by leveraging the relevance mechanism of high interactivity [25].

3.3 Analysis of User Intention

Good learning methods and teaching strategies can effectively improve learning outcomes and encourage learning intents. Many scholars studied the theoretical structures, learning models or teaching strategies of LMS, such as Alexander and Golja [2] evaluated the experiences of teachers and students on using LMS to analyze the usability and application purpose of the system.

Innovative technologies have resulted in constant evolution of technical tools on LMS. A number of literatures have researched and analyzed the two dimensions to investigate the transformations and impacts. Schaik, Barker, and Moukadem [21] developed a virtual university system and applied TAM to examine learners' intention to use. Eynon [8] examined whether the integration of ICT into LMS is beneficial to improve teaching and learning performances.

When using LMS, different contexts would be bring about different intentions and effectiveness. Weller, Pegler, and Mason [22] evaluated users' experiences from two virtual learning environments and investigated the integration methods and relevant components for the two learning environments.

3.4 Analysis of System Development

LMS can be benefited certainly if the LMS can fully incorporate the advantages of teaching theories. In case of cooperative learning, Wang [24] designed a test item analysis system and discussed how the system, cognitive patters, and learners' attitudes influence the system effectiveness. Blin and Munro [3] applied the activity theory to analyze virtual learning environments. Furthermore, the changes of external environments are also one of the key factors to influence system effectiveness. The empirical analysis found that better interactivity between teachers and students, curriculum structure, system support, and system flexibility would improve the users' satisfaction [26].

If systems can achieve interoperability effectively, users can work with the systems better. When the roles of main users are different, learning systems have to take corresponding developments. In 2005, Kim and Santiago analyzed the E-Learning development and digital content management of nowadays and future in Korea [12]. They indicated that many learning systems lack dynamic feedback mechanisms.

4. Conclusions

The investigation results of this study provide insights for educators and researchers into research trends and patterns of the development of the LMS in the field of E-Learning. A well LMS should be developed based on the features of technologies and the requirements of users. Moreover, it is also necessary to examine how to integrate pedagogies into the LMS to improve teaching and learning performances. The following points concern the development directions and research issues for the LMS in the next 2 to 3 years.

- Designers and educators have to attend to plan supporting measures according to the use of LMS in real educational contexts.
- The development of LMS has to tend towards learner-oriented environments and satisfy users' requirements, rather than only focus on applying novel techniques to the LMS.
- The development of LMS should consider how to provide personalized learning and adaptive feedback mechanisms to improve students' learning outcomes.
- A LMS needs more suitable educational activities and rich interactions to support enterprise applications and personalized learning.

Acknowledgements

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References

[1] Avgeriou, P., Papasalouros, A., Retalis, S. & Skordalakis, E. (2003). Towards a pattern language for learning management systems. *Educational Technology & Society*, *6*(2), 11-24.

[2] Alexander, S. and Golja, T. (2007). Using students' experiences to derive quality in an e-learning system: An institution's perspective. *Journal of Educational Technology & Society*, *10*(2), 17-33.

[3] Blin, F. & Munro, M. (2008). Why Hasn't Technology Disrupted academics' teaching Practices? Understanding Resistance to Change Through the Lens of Activity Theory. *Computers & Education*, *50* (2), 475-490.

[4] Cummings, J. A.; Bonk, C. J., & Jacobs, F. R. (2002). Twenty first century college syllabi: Options for online communication and interactivity. *Internet and Higher Education, 5*(1), 1–19.

[5] Chen, N. S., Ko, H. C., Kinshuk and Lin, T. (2005), A model for synchronous learning using the Internet, *Innovations in Education and Teaching International*, *42*(2), 181–194.

[6] Cortez, C. Nussbaum, M. López, X. Rodríguez, P. Santelices, R. Rosas, R. & Marianov, V. (2005), Teachers' support with ad-hoc collaborative networks, J*ournal of Computer Assisted Learning*, *52*(1), 171–180.

[7] Ellis, Ryann K. (2009), *Field Guide to Learning Management Systems*, ASTD Learning Circuits, http://www.astd.org/NR/rdonlyres/12ECDB99-3B91-403E-9B15-7E597444645D/23395/LMS_fieldgu

[8] Eynon, R. (2008). The use of the world wide web in learning and teaching in higher education: reality and rhetoric, *Innovations in Education and Teaching International*, *45*(1), 5-23.

[9] Hall, B. (2001). Learning management systems 2002, Retrieved march 1, 2004, form http://www.brandonhall.com.

[10] Hall, J.L. (2003). *Assessing Learning Management Systems*. Feature Article for Chief Learning Officer. January. http://www.clomedia.com/content/templates/clo_feature.asp?articleid=91.

[11] Jara, C. A., Candelas, F. A., Torres, F., Dormido, S., Esquembre, F., & Reinoso O. (2009), Real-time collaboration of virtual laboratories through the Internet, *Computers & Education*, *52*(1), 126–140.

[12] Kim, C. J. & Santiago, R. (2005). Construction of E-learning Environments in Korea. *Educational Technology Research & Development*, *53* (4), 108-115.

[13] Kirschner, P. A., & Paas, F. (2001). Web-enhanced higher education: a tower of Babel. Computers in Human Behavior, 17, 347-353.

[14] Lee, G. C. and Wu, C. C. (2006), Enhancing the teaching experience of pre-service teachers through the use of videos in web-based computer-mediated communication (CMC). *Innovations in Education and Teaching International*, *43*(4), 369–380.

[15] Lopez-Morteo, G. and Lo´ pez, G. (2007). Computer support for learning mathematics: A learning environment based on recreational learning objects, *Computers & Education*, *48*(4), 618–641.

[16] Lin, Y. T., Lin, Y. C., Huang, S. H., Wu, T. T., Yang, Y. S. and Huang, Y. M. (2010). *A Survey of Developments on Learning Management System in the Field of E-Learning from 2005 to 2009*. The 2010 International Conference on Business and Information (BAI2010), July 5-7, 2010, Kitakyushu, Japan.

[17] Méndez, E., Casadesús, M. and Ciurana, Q. (2006), Gironacel®: a virtual tool for learning quality management, *Innovations in Education and Teaching International*, *43*(3), 313–324.

[18] O'Hear, S. (2006), *e-learning 2.0 - How Web Technologies are Shaping Education*, Aug. 2006. http://www.readwriteweb.com/archives/e-learning_20.php.

[19] Peat, M., Taylor, C. E. and Franklin, S. (2005), Re-engineering of undergraduate science curricula to emphasise development of lifelong learning skills, *Innovations in Education and Teaching International*, *42*(2), 135–146.

[20] Romero, C., Ventura, S. and Garcı'a, E. (2008). Data mining in course management systems: Moodle case study and tutorial, *Computers & Education*, *51* (1), 368-384.

[21] Schaik, P. V., Barker, P. & Moukadem, I. (2005). Using a digital campus to support electronic learning in Lebanon. *Innovations in Education and Teaching International*, *42* (2), 157-166.

[22] Weller, M., Pegler, C. & Mason, R. (2005). Students' experience of component versus integrated virtual learning environments. *Journal of Computer Assisted Learning*, *21* (4), 253-259.

[23] Wang, H. C. and Hsu, C. W. (2006), Teaching-Material Design Center: An ontology-based system for customizing reusable e-materials, *Computers & Education*, *46*(4), 597-614.

[24] Wang, T. H. (2007). What Strategies are Effective for Formative Assessment in an E-learning Environment? *Journal of Computer Assisted Learning*, *23* (3), 171-186.

[25] Xing, M. and Spencer, K. (2008), Reducing cultural barriers via Internet courses, *Innovations in Education and Teaching International*, *45*(2), 169–181.

[26] Yukselturk, E. & Yildirim, Z. (2008). Investigation of Interaction, Online Support, Course Structure and Flexibility as the COntributing Factors to Students' Satisfaction in an Online Certificate Program. *Journal of Educational Technology & Society*, *11* (4), 51-65.

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Online Originality Checking and Online Assessment - an Extension of Academics or Disruption for Academics

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Abstract: There are many computer technologies being used in modern higher education. However, an investigation of when technology becomes extension of academics or disruption for academics is necessary to find out the key concerns about both the pedagogical use of technology and underachievement in the pedagogical use of technology. The paper discusses the key findings of a pilot research project, the academic experiences for an innovative online originality checking and assessment system". Academics from 4 faculties in the University of Glamorgan have provided experience sharing of both positive and negative experience of the system. The main finding is that such an excellent tool did enhance learning and assessment experience. Academics, regardless of their technological competence, experienced an innovative end-to-end online submission and assessment which eliminated the frustration of storing uncollected or unread assignment feedback, a speeding up of the assessment process and were provided with a flexible marking facility. Interestingly, "computer technology as an extension of academics" only realise when priority is given to the pedagogy over technology; whereas "computer technology is a disruption for academics" when sole focus is given to the technology.

Keywords: online assessment, technology enhanced learning, higher education, pedagogy and education

Introduction

There are many computer technologies available in higher education, however, Pelletier [1] argues that sometimes pedagogy has been overlooked. Taylor [2] points out that most often technology is shaping pedagogy but pedagogy is not shaping technology in learning. Thus, there is a need to investigate pedagogy is shaping the use of technology and vice-versa. This paper reviews a funded project of investigating how technology enhanced learning and assessment experiences in an UK university and reflects on areas of underachievement.

1. Behind the Scene of the Pedagogical Ground – "Extension or Disruption"?

A few decades ago McLuhan [3] first claims that media is the "extension of man" and "the medium is the message" because "it is the medium that shapes and controls the scale and form of human association and action". It plays an influential role not by the content delivered but by its own characteristics. Postman [4] further explores McLuhan's notion that it is not the content of cultures that shapes ideologies, but the shape of the culture's media in relation to human communication and thought that produces the field and scope of ideologies [5]. Thus, we would argue that pedagogy should shape computers and its uses. To borrow McLuhan's terms, computer technology is then the "extension of academics" and along with technology, other educational factors, such as socio-cultural conditions, peer-support and an emphasis on the learner as an active learner are essential elements to improve the learners' ability to learn – technology enhanced learning experience.

Brabazon [6] states that “money is being thrown at **technology in education**, not education in technology.” By this she means that in higher education, where technology and education meet in educational design, priority is give to technology. This is normally conceived as a transmission model, with the technology being used to “deliver” content. Brabazon draws a distinction between technology for education and for operational purposes. The selection of technology must be based on the consideration of the aims of the pedagogy, not of the limits of the technology. When the emphasis is placed on meeting the educational purposes the result is, Brabazon argues, “**education in technology**”. On this ground, we would assert that that technology is not an extension for academics but of disruption if it is “technology in education”, where as it is an extension when vice-versa. Therefore, an investigation of when technology becomes extension of academics or disruption for academics is necessary. The University of Glamorgan has adopted an innovative online assessment system, GradeMark by Turnitin since 2009. GradeMark (see Figure 1) is a computer-aided assessment and feedback tool which integrated with the University’s Virtual Learning Environment (VLE), Blackboard. It allows academics to provide grades and feedbacks [7]. Clipboard (the “feedback bank”), QuickMark (the quick marking palette) and Rubric Scorecard (assessment criteria) are the main functions of GradeMark. There is no similar research or empirical studies since GradeMark is newly introduced to the UK universities. Hence, a pilot study of “Turn it in or Turn it off” was carried out in the University to investigate the experience for such tool pedagogically.

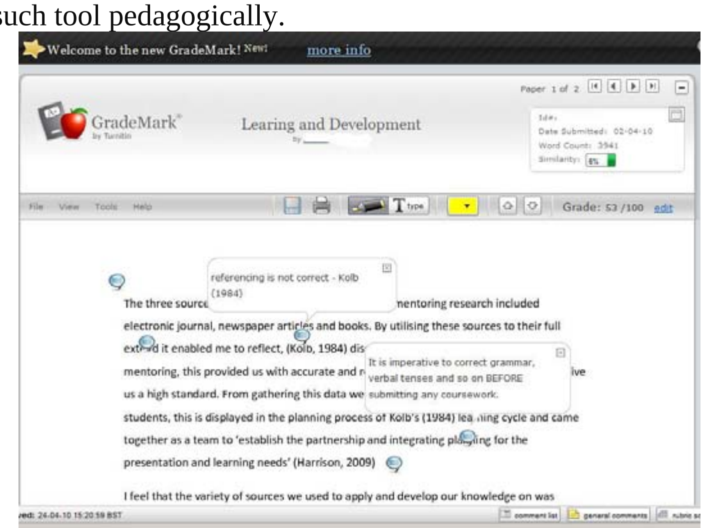

Figure 1. Sample of GradeMark

2. Research Design and Methodology

The aim of this project is to investigate the technology enhanced learning and assessment experiences at the University. This is a collaborative project of academics from 4 faculties, which provide experience sharing and critical analysis of the pedagogical and technological impact of GradeMark. The project responds to the needs of research agenda with the following objectives: (1) To support and develop academics to use GradeMark in online assessment and feedback; (2) To identify the academics’ positive and negative experiences on GradeMark; and (3) To reflect on areas of achievement and underachievement in the pedagogical use of GradeMark. To maximise the experience findings, a range of formal and informal data collection instruments were used. These included video recorded interviews with six academics and site visits to individual office for support and observation. Questions were designed in a way to capture openly academics’ positive and negative experiences. The data analysing phase commenced with direct interpretation from interview transcripts through open coding, to obtain the themes and category aggregation. Drawing heavily on

Ryan and Bernard [8], the project used a number of ways in which those coding could discover new themes, such as word repetitions, keywords in context, compare and contrast, metaphors and analogies used by interviewees. List of debates and discussion is suggested to academics for potential future enhancement and best practice for the use of the system.

3. Findings and Discussions: Analysis and Summary from the Interviews

3.1 The Extension - Positive Experiences

The findings of the project confirm that all academics gave very positive views towards GradeMark. Apart from the technical difficulties and learning curve, they acknowledged the benefits and enhancement brought to their students' learning experience especially in the aspects of **interesting, easy access and individualised assessment feedback**:

> "I find it quite easy to do. I think it's flexible and students enjoy it. The feedback I have got from students is that they are more than happy to use GradeMark…I think it is a positive tool!" ~Academic F

> "Students are really really happy and excited about GradeMark…week after week they are anxiously waiting for the apple to turn red so that they can know the mark and feedback!" ~Academic C

GradeMark provides useful tools such as the in-text clipboard and rubric scorecard to enhance the assessment experience, in terms of **prompt, more detailed, better quality and richer feedback compared with the traditional paper-based feedback**:

> "I use everything, from Clipboards to general comments and rubric scorecards, I use them all. All of them are useful! We have to give feedback almost line by line – from grammar to actual content, from the thought process to critical analysis… it is unbelievable, we really have done that and GradeMark does help!" ~Academic B

> "I have given more feedback than I probably would have done in a paper method with a pencil because the clipboard was there…and the comments were there...Before, I would probably just put a tick." ~Academic A

> "I quite like the facility where you could review the comments at the bottom and you can glance at the comment list. I think this is a really good tool…when you come to the final comment, it informs it...So I think students get quite good feedback from us." ~Academic D

GradeMark also speeds up the marking process and provide a flexible marking facility – academics could mark students' assignments from anywhere. The below outlines the academics' positive comments about how GradeMark **eliminates the trouble of carrying bulky hard copies and uncollected or unread assignment feedback**:

> "It speeds up my marking. I love the fact that I can mark online from anywhere as long as I have got Internet access, such as home, Cardiff Central Library and on the train - that's the main benefit for me. Marking online with the bank of feedback is also very helpful. In my group I have a hundred of students and I love the fact that I don't have to write the same whole thing 30 or 40 times so that customised feedback bank was really helpful. " ~ Academic E

> "It is positive because…I don't have to have them in the office and knowing that students are never going to collect them because most don't but in this way they do, they get the feedback as it is online, it is there!" ~Academic C

Crudely speaking, academic and research life can be isolated. Academic usually stay in individual rooms and busy themselves with class preparation, marking and research. Individuals may have very distinct views and practices about the same subject in the academic world. Pedagogically, **community of learning and practice are essential. Vygotsky's Zone of Proximal Development (ZPD)** indicates a simple but powerful educational principle - the quality of individuals' thinking and performance is much better if they were aided by more skilful and knowledgeable individuals rather than working independently [9]. Vygotsky recognises this kind of peer-assistance is needed to help individuals develop new or better skills within their ZPD. Interestingly, two experienced lectures from different faculties experienced this after using GradeMark:

> "Although the rubric didn't work out, we had a really good discussion and spent time on what we were looking for in it. So that was good for the students. When you have a team of people marking work, you all have a common agreement about what you are looking for. I think that's an advantage. " ~Academic D

"We also get the support from our office mates and our colleagues. I felt that everybody here is working towards implementing GradeMark…so that kind of peer support, discussion and debates are more since introducing GradeMark." ~Academic B

3.2 The Disruption - Negative Experiences and the Reflection on Areas of Achievement and Underachievement in the Pedagogical Use of GradeMark

There are top 3 negative experiences raised by academics: (1) Initial learning curve and confusion with the terminology on GradeMark; (2) stability of the network connection – caused the loss of comments or marked work and slowed down the marking process; (3) technological constraints such as GradeMark interface is too small and not resizable. Table 1 exhibits the comparative experiences of academics in using GradeMark, and the category of these experiences. This finding apparently affirms that, in overall, GradeMark enhanced the teaching and assessment experiences from a pedagogical-oriented aspect. In contrast, the main disruption came from technological aspects and issues.

Table 1. Comparative Positive and Negative Experiences with GradeMark

Positive	Negative
T&P: Convenient, flexible and fast coursework receiving and grading process - can be done at anytime and from anywhere and a speeding up of the assessment and marking process	**T&P:** Initial learning curve
P: The originality reports help in preventing plagiarism by providing formative feedback before the due date	**T:** System or network not available
P: Provide better, richer, helpful, and more detailed assessment feedback and eliminate the frustration of storing uncollected or unread assignment feedback	**T:** Technological constraints: interface too small and not resizable
P: Create the community of learning and practice (Vygotsky's ZPD)	**T:** Confusion with the terminology used on GradeMark
	P: Pedagogical practices: it is difficult to compare two student assignments side-by-side, the clipboard comment list is not in alphabetical order

Note: T&P: Both Technological and Pedagogical Aspects; T: Technological Aspects; P: Pedagogical Aspects

However, the academics across the faculties overcame these technological issues by seeing the student-driven benefits. Such commitment to enhance student learning and assessment experiences led to the individual's persistency and patience towards the technological constraint. These are described next:

"…students are more than happy to use GradeMark once they have got over the initial 'shock' of using technology to do this… I still want to use the system but just have to be patient." ~Academic F

"From what I have heard, students are really really happy. They feel that it is a much more individualised way of submitting their work to tutors as they have got wonderful support in terms of the comparative report where they may need to improve their work, and the feedback is instantaneous from the tutor; whereas in the past they took much longer to get their feedback - from that perspective, this system is very very good." ~Academic B

Besides, being tolerant of the new system and the technical limitations, and being flexible to try out or switch to different methods with the positive attitudes to confront the negative experiences:

"The one about the sorting feedback, I just browse through the list and it was annoying…I tried to use the QuickMark palette as much as possible…" ~Academic E

"We backed up all rubrics and comments in 'Microsoft Word'… and I obsessively hit the save button!" ~Academic D

Hence, all these commitment and flexibility clearly provide insights on how educational values and pedagogy shape the use of technology – from disruption to extension. On the other hand, the following is the top list of debates and discussion extracted from the underachievement in the pedagogical use of GradeMark*:*

1. Consistency in use of GradeMark by academics – not all modules are available for GradeMark (some academics refuse to use the system) and this may cause confusion for students. Would it be appropriate for the University to make the use of GradeMark mandatory?
2. Double works for students - some academics require students to submit both online and printed copies. Would it be possible to enforce only one submission route?
3. “Mechanical” and less personal-touched feedback – the assessment feedback may be similar due to the use of the assessment feedback “bank”. Would it have more pedagogical value to enrich the bank or provide more individualised feedback?
4. Formative assessment or summative assessment – some academics do not allow the student to view the originality report and some academics prefer the “first submission as final”. Would it have more pedagogical value if all students could access the originality report before the due date?
5. The community of learning and practice brought by GradeMark – not all academics prefer such “community learning” due to the long tradition and culture. Would it be possible to develop the Vygotsky’s ZPD with intended benefits?

4. Conclusions

With the experience sharing of academics across 4 faculties in the University of Glamorgan, the project successfully identified, both technologically and pedagogically, positive and negative experiences for embedding GradeMark in the 2009/10 academic year. Such an innovative assessment and feedback tool is an extension of academics, which benefits both academics and students pedagogically. Taylor [2] asserted that educational values should be driving technology development, not the other way round. Findings of this research indicate that pedagogy should shape the use of technology and it would become the “extension” of academics. Hence, we would assert that the commitment of academics to enhance student learning and assessment experiences led to the individual’s positive attitudes such as persistency, patience and flexibility towards the technological constraint and issues. In summary, it is all about “education in technology”, not “technology in education”. The computer technology as an extension of academics only realise when priority is given to the pedagogy over technology; whereas computer technology is a disruption for academics when sole focus is given to the technology. In closing, an interesting quote affirms the analogy of the research:

> “At the beginning students were fearful when GradeMark came across in class, both consciously and unconsciously, they thought that this thing is going to ‘catch’ them! But slowly through a lot of us explaining this tool is not to ‘catch’ them at all but a tool to actually support them in their learning experience of how they referenced and how they actually use materials and information in writing their assignments…and since then they were much more positive and they like it!” ~Academic C

References

[1] Pelletier, C. (2005). New Technologies, New Identities. In Land, R. & Bayne, S. (Eds.) *The University in the Information Age*. London: Routledge Falmer, (pp.11)

[2] Taylor, J. (2009). Keynotes of Learning in Digital Worlds: What are we talking about? *Proceedings of the Computer-aided Learning 2009 (CAL09) – Learning in Digital Worlds*, 23-25th March, Brighton, UK.

[3] Mcluhan, M. (1964). *Understanding Media: The Extensions of Man*. London: Routledge & Kegan, (pp.9)

[4] Postman, N. (1990). Media and Ideology. *ACA Bulletin*. January, 1990, 63-72.

[5]Wikiversity (2007). *Intellectual Traditions in Media Literacy*. Retrieved 20th August 2008: http://en.wikiversity.org/wiki/Intellectual_Traditions_in_Media_Literacy

[6] Brabazon, T. (2007). *The University of Google: Education in the (post) Information Age*. Humphries: Ashgate Publishing, (pp.145)

[7] Turnitin UK (2010). *TurnitinUK The JISC endorsed solution for institutions in the UK*. Retrieved 8th March 2010: http://submit.ac.uk

[8] Ryan, G., W. and Bernard, H., R. (2003) ‘Techniques to Identify Themes’, *Field Methods*, 15(1), 85-109.

[9] Alexander, P. A. (2006). *Psychology in Learning and Instruction.* New Jersey: Pearson Prentice Hall.

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Aesthetic Aspect of CAI Courseware to Developmental Disability Children Learning

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Abstract: In this paper, aesthetic aspects of Computer-Assisted Instruction (CAI) courseware, especially the number of colors used in the software to the learning achievement of Development Disability Learners, are discussed. Randomly selected 50 students among 142 special needs students who attended the same school were divided into five groups of ten students, with each group using different courseware with different numbers of colors used. The results show that learners achieve better with courseware developed with more than 6 different colors than those of utilizing 2 or 4 colors. Interestingly, there are no significant differences between courseware(s) using more than 6 colors, and numbers of colors used in CAI courseware has keen relationships with learners' positive attitude and learning achievement.

Keywords: CAI courseware, Development Disability, Aesthetic aspect, Color

Introduction

The application of technology for special needs learners, assistive technology, prevails in many universities around world, with many of these approaches empower disabled learners to control environment, access technology, and overcome physical barriers. Moreover, providing educational resources such as CD-ROM titles or CAI courseware for learning enhancement have been tried through several institutions including Johns Hopkins University and Central Washington University [1].

Developmental disability indicates various handicaps in mental or physical functioning, and its common examples are autism, cerebral palsy, uncontrolled epilepsy, certain neuropathies, and mental retardation [2] with attention deficit hyperactivity disorder (ADHD). It is well known that children with ADHD often demonstrate significant educational [3] deficits. To enhance the potential for children dealing with ADHD, computers have been applied to the learning environment due to the possibility of individual learning with computers, and one of method to introducing computer to these learners is using well-designed Computer-Assisted Instruction (CAI) courseware.

Several aspects need to be considered for educationally effective CAI courseware and aesthetic aspects with color selection being one component. From the information processing theory of cognitive learning, a cognitive-based multimedia CAI courseware design method considers the number of colors and graphics as crucial points of the learner's cognition in order to foster attention [4].

Compared to normal learners, less research has been carried out regarding the development of disabled learners. Therefore, such technology as computers and the Internet were tested to determine the affect of adopted color numbers in courseware in relation to learners' achievement.

Little research has been done for the number of colors adapted to CAI courseware design; however, it is easy to agree that colorful courseware is more effective than a black and white version. However, if the colors are not effectively used to highlight teaching points, it is hard to expect desirable effects (such a statement is a prime spot for a citation). What may be extrapolated here is that color in courseware may contribute nicely and aid in visual impact, but more importantly be considered as readability using colors. Therefore, when developers create class aid material(s), color needs to be carefully selected to augment instructional impact.

Banaschewski, et. al. [5] reported that children with ADHD committed more errors on the Farnsworth–Munsell 100 Hue Test (FMT), particularly on discrimination of *colors* along the blue–yellow axis. As it is known that ADHD is associated with unexplained impairments on speed naming of colored stimuli, such observations imply that selecting colors and number of colors for CAI courseware for special needs learners are imperative.

Based on the Banaschewski's report this study was designed to ascertain the number of colors used for CAI courseware and their effect(s) to developmental disability learners, thus the focus on the number of colors was two, four, six, and eight colors.

1. Method

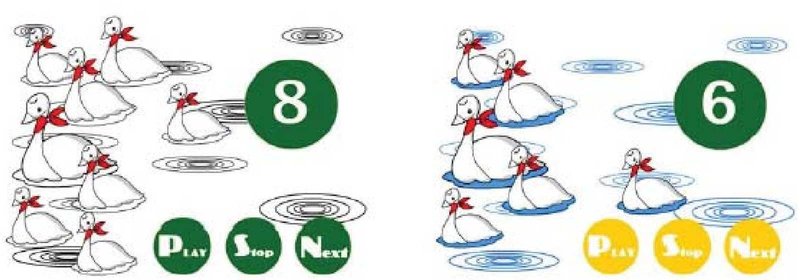
1.1 Subjects

Among 142 elementary school level mental retardation learners, 50 learners who were physically capable to operate a computer and with basic cognitive capabilities were randomly selected. The participated students for this experiment ranged from the second to sixth grade. Since the students' grades are different in each group, we have adjusted group participants to be almost age in average. The I.Q. range of each subject was 50 to 70.

1.2 Experimental Tasks

1.2.1 Courseware Design

The topic of the designed courseware consists of counting numbers from 1 to 10, and introducing counting the number of animals in each page as shown in the Figure 1.



(a) Two colors (b) Four colors

(c) Six colors (d) Eight colors

Figure1: Number of colors and drawings used in the courseware

The courseware utilizes buttons placed on the right side of each page containing learning objectives and three-step learning pages including a formative page. Additionally, buttons are placed on the bottom of each page, such as **Play**, **Stop**, and **Next**, to provide easier control of the courseware. Learning contents have 4 types: numbers with moving characters in the 1st stage, number narration with the same number of characters appearing in the 2nd stage, mouse dragging to check numbers after counting the Characters in the 3rd stage, and formative testing via typing numbers after counting characters in the last stage.

1.2.2 Conditions

The courseware has buttons placed on the right side of each page with learning objectives, and three step learning pages with a formative page. Buttons such as play, stop, and next placed on the bottom of each page provide easier control of the courseware. Learning contents have 4 types; Number with moving Characters in the 1st stage, Number narration with the same number of Characters appearances in the 2nd stage, Dragging mouse to check Number after counting the Characters in the 3rd stage, and formative test typing Numbers after counting Characters in the last stage.

1.2.3 Colors Applied in the Courseware

Ten colors from the Munsell color system, 5 basic colors (Red, Yellow, Green, Blue, and Purple) and 5 additional colors designed by adding basic color and neighboring complementary colors were used on 5 different test CAI courseware as shown in Table 1.

Table 1: Applied colors for five courseware

Courseware type	Applied Colors
Two colors	Red, Green
Four colors	Red, Yellow, Green, Blue
Six colors	Red, Yellow, Green, Blue, Purple, Yellow-Red
Eight colors	Red, Yellow, Green, Blue, Purple, Yellow-Red, Yellow-Green, Blue-Green
Ten colors	Red, Yellow, Green, Blue, Purple, Yellow-Red, Yellow-Green, Blue-Green, Purple-Blue, Red-Purple

1.3 Experimental Procedures

Pre-tests were carried out to check learners' differences in cognitive capabilities.' After there were no significant differences in the capabilities, 5 randomly selected groups were assigned different courseware using different color sets as depicted in Table 1.

Subsequently, the post-test and the achievement test were implemented after formal instruction. In addition, teachers who guided the learners' lessons were asked to give feedback regarding the students' learning aptitude tests in order to check learners' responses to the courseware.

2. Method

2.1 Pre-test and post-test

Table 2 shows the pre-test and post-test results of student group achievements.

Table 2: Pre- and post-test results of group average scores

Group	**Test**	**Average score**	**S.D.**	**t**	***p***
Group 1	Pre	48.50	25.28	0.95	0.926
	Post	49.00	30.53		
Group 2	Pre	49.50	26.81	0.000	1.000
	Post	49.50	24.20		
Group 3	Pre	49.00	27.86	2.631	0.027
	Post	64.50	31.74		
Group 4	Pre	48.00	31.90	4.375	0.001
	Post	65.00	32.48		
Group 5	Pre	48.00	31.55	2.283	0.048
	Post	64.50	43.03		

(p<0.05)

Figure 2 depicts each group average score in pre- and post-test according to the number of colors used in each coureseware.

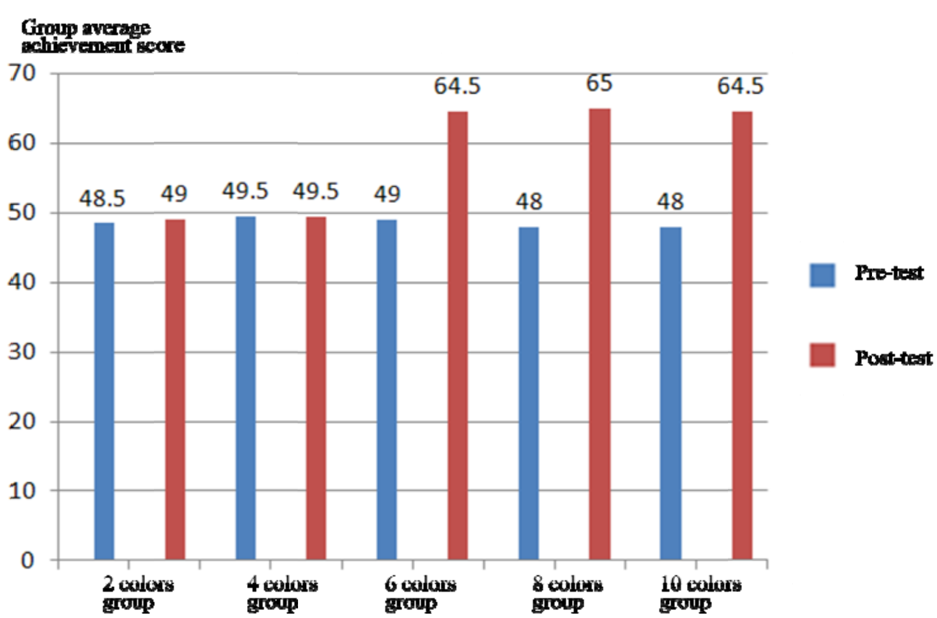


Figure 2: Group average scores in pre- and post-test

2.2 Teachers' report of students' aptitude of using CAI courseware

From the teachers' report of each group, classification ranging from positive attitude to negative attitude were created. Negative attitude marks indicate that teacher(s) reported students showing boredom or distraction while the students used the courseware. Teacher report results are depicted in Table 3. The teachers' subjective opinions were validated to clearly show the learners' attitude, however, some of the reports are excluded, and thus the sum percentile of positive and negative is not 100% in each group.

Table 3: Teachers' reports of students' attitude

Group	Positive Attitude (%)	Negative Attitude (%)
Group 1	9.9	16.6
Group 2	19.9	19.9
Group 3	36.6	6.6
Group 4	33.3	10.0
Group 5	43.3	6.6

3. Discussions

From Table 2 and Figure 2, comparing the pre-test and post-test results of student group achievements, it is clear that CAI courseware that use more than 6 colors are effective for mentally retarded learners in the second to sixth grades. However, there is no significant difference in achievement tests between courseware utilizing 6, 8, and 10 colors. Furthermore, we found that mentally retarded learners' better achievement is also related with positive attitudes toward CAI courseware, and it has been observed by the teachers as shown in Table 3. From Table 2 and Table 3, it is found that CAI courseware needs to implement at least 6 colors and that less than 4 colors using courseware is not beneficial for mentally retarded learners.

References

[1] New Horizons (2010). Inclusion of Students with Special Needs: Teaching and Learning, http://www.newhorizons.org/spneeds/inclusion/teaching/front_teaching.html, retrieved on May, 12, 2010.

[2] Training Media Dictionary (2010). http://www.nwlink.com/~donclark/hrd/media.html, Retrieved on May, 14, 2010.

[3] Lee, D. L. and Zentall, S. S. (2002). The Effects of Visual Stimulation on the *Mathematics* Performance of Children with Attention Deficit/Hyperactivity Disorder. *Behavioral Disorders*; May2002, Vol. 27 Issue 3, p272-288.

[4] Fourie, I (2001). The use of CAI for distance teaching in the formulation of search strategies, *Library Trends*, June 22, 2001.

[5] Banaschewski, T., et. al., (2008) *Color* perception in ADHD. *Journal of Child Psychology & Psychiatry*; Jun2006, Vol. 47 Issue 6, p568-572.

[6] Liu Shuguang, Li Pengfei, and Ba Lin (2010). "Design and Implementation of the Multimedia CAI Courseware Based on Cognitive Learning Theory," *Education Technology and Computer Science, International Workshop on*, vol. 2, pp. 803-807, 2010 Second International Workshop on Education Technology and Computer Science.

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Design of the Convergence Study Program based Educational-Robot

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Abstract: The purpose of this study is to develop the convergence study program through the educational robot to improve elementary students' problem solving ability and have more confidence about mathematics, science, engineering and computer programming. Nowadays, convergence is a global trend, also the world has been trying to educate the person who adapted well to the fusion circumstances. However, the great majority of curriculum does not reflect this turn that carried new pedagogical trend. Thus, in order to overcome this situation, by making use of convergence study program, students will be easily adapted to the converging circumstances. It is expected to include coverage of resources for teaching of convergence study program through robot - education for instructors who may wish to adapt this new trend of instruction.

Keywords: Convergence Study Program, Educational - Robot, Computer Programming, Problem Solving Ability.

Introduction

Fusion between knowledge is recognized as the keyword of the 21st century. The knowledge of the individual studies alone will be difficult to solve multi-layered problems of modern society. Therefore, a new study through the convergence that breaks the boundaries between disciplines has been receiving attention. Even the world's leading universities, such as Harvard, Stanford, Tokyo are focusing on high-value creation and concentrating on enhancing national competitiveness through converging between the studies seem not to become tied[1].

Natalie Rusk(2008)has presented that many young people become more engaged if they learn engineering concepts in the process of creating interdisciplinary project that combine art and engineering-for example, designing a painting machine, building a machine that can read and play music, or making a programmable water fountain[2]. In other words, people are able to be most creatively and productively when they are adapted well in complex environment.

Nowadays in many countries, the importance of convergence study program is being emphasized. But only a few countries are being used that program. In addition, related programs by using educational – robot are scarce.

When designing convergence study programs, we should consider below.

First, needs of the contents elevating the learner's problem solving ability and creativity.

Second, development of the convergence study program that leads out learner's real active participation. Third, considering the operational stage of elementary school students', it should be appropriate for them about the difficulty to use programming. Considering that presented above, this study is to propose the convergence study program to have student have positive attitudes in robot-education & programming, especially students are naturally willing to attend the program with interests about various subjects with the standpoint of convergence.

1. Theoretical Contemplation of Convergence Study

1.1 The definition of the Convergence Study

Convergence is the approach toward a definite value, a definite point, a common view or opinion, or toward a fixed or equilibrium state[3]. It's similar with fusion, syncretism. And also it is a convergence study that variety of subjects are converging into a new study[4]. Sung-Ho Kwon(2009)has presented that convergence study is a new study provided by converged two of more areas of knowledge and study[5]. To sum up the above definition, convergence study is the convergence between heterogeneous areas and study to increase flexibility, adaptability, productivity and efficiency with crossing boundaries between individual studies as needed, if the resolution is difficult with individual study alone.

2. Educational-Robot

2.1 Robotics in School

Robots are becoming available as consumer products and walking robot. But these stereotypical images can be misleading. Robotics includes all types of programmable machines that perform actions based on inputs from sensors[6].
In recent years, robotics have become popular as an educational activity internationally. A growing number of schools and other educational organizations are offering opportunities for the elementary school students to build their own computer-programmed robots, using kits such as LEGO Mind storms, Pico-Cricket.

2.2 Features of Pico-Cricket

Pico-Cricket is used in this study and designed for more artistic and expressive projects. The Pico-Cricket can control not only motors but also multi-colored lights and music-synthesis devices, so children can use Pico-Cricket to build their own musical instruments and light sculptures. The Pico-Cricket is also much smaller than other Educational-Robot, such as Mind-storms, so they are well-suited for projects that need to be small and mobile, such as electronic jewelry[2]. Below figures show the sample of programming blocks and Pico-Cricket device made by an elementary school student.

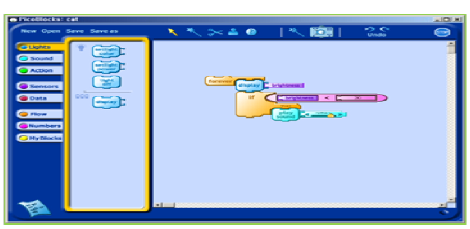	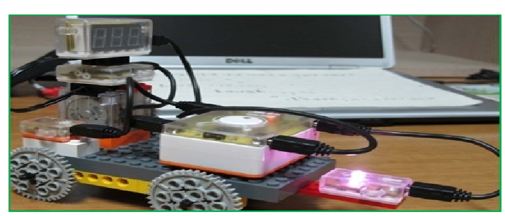
Figure 1 : Programming Blocks	Figure 2 : Pico-Cricket Device

2. 3 Components of Pico-Cricket

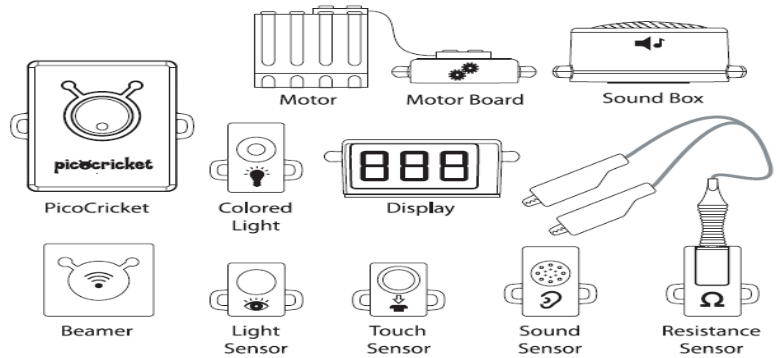

Figure 3 : Components of Pico-Cricket

The Pico-Cricket includes the upper following parts. That is a tiny computer that can control things and has four parts where we can plug in other devices, such as sensors, motors, and lights[7].

3. Methodology of the Convergence Study Program

3.1 Contents of Convergence Study Program

[Table 1] Topics of Convergence Study Program by using Educational-Robot

Topic	Brief Explanation of Topic	Related Subjects
1. A shower booth with auto control lights.	When touching or no sound, light will be off to save Energy	▪E, C, A, M ▪Environments & Green Growth
2. Making green home to save energy.	When getting brighter outside, light will be off, otherwise on.	▪E, C, A, M ▪Environments & Green Growth
3. Making energy saving car which has auto brightness detection function.	When going through tunnel, light will be on automatically, otherwise off.	▪E, C, S, A, M ▪Environments & Green Growth
4. Making smart traffic signal	To save time and energy, it will show counting display when turn light in green.	▪E, C, S, M, A ▪Environments & Green Growth
5. Funny trash can	When putting trash in the trash can, make it sound.	▪E, C, S, M, A ▪Environments & Green Growth

* ▪Engineering=E, ▪Computer Programming=C, ▪Art=A, ▪Math=M, ▪Science=S

Considering the ability of using Pico-Cricket of students (4 grades – 6 grades) in elementary school, we have selected the contents that would be easily programmable and implemented by elementary school students.

3.2 Designing the Model for Teaching

[Table 2] Step of STEM - PBL(Grant, 2002)

Feature	Description
Introduction	Use an introduction that includes “The Big Ideas”
Task	Guiding question or driving question what will be accomplished and embeds the content to be studied.
Investigation	The process and investigation include scaffolding to complete the task and reinforcing participation.
Resources	Resources provide data to be used and can include hypertext link, computer, scientific probes, robot, eyewitness, and so on.
Scaffolding	Scaffoldings are needed at different levels for different students and may include resources help, student-teacher interactions, peer counseling, job aids, project templates.
Collaboration	Many projects include groups or teams, especially when resources are limited, but cooperative learning may be helpful.
Reflection	PBL offer an opportunity for closure, debriefing, assessment, or reflection.

[Table 2] is an extended inquiry into various aspects of a real-world topic that is of interest to students and judged worthy by teachers. Because of real-world appeal, students are motivated to investigate, record, and report their findings. The hallmark of project learning is greater independence of inquiry and “ownership” of the work on the part of students[8]. STEM-PBL has advantages that positive interaction between students and teachers and students and students to maintain a cooperative relationship. For this reason, it was used as the basis of the convergence study program including robot education. Model shown in [table3] is to be remodeled for convergence study program based educational-robot.
To apply the robot-based learning, need to consider real-life. So, we need to get around the idea, using a variety of background information and analysis to identify issues to be placed a greater emphasis. In addition to, if necessary more difficult programming in ‘Appointments with others’ step, providing additional support of the teachers to students. Additionally, it was designed to solve the problem through coordination with friends. The learning model dealt in terms of convergence study based on the theme of energy saving related to green growth to combine several topics rather than fragmented learning for the production of the robot itself. Through exhibits and presentations after checking as well as the competitive elements of robot-learning in the past. It was developed to be the foundation for effective learning and interest for the elementary school level, taking into account the real possibility.

[Table 3] Model of Convergence Study Program

Step (STEM-PBL)	Process of Learning	Description
Introduction	Searching for around real-life	Motivation, Idea drawn
Task& Investigation	Analysis of activity	Drawn & use the background knowledge
Resources Scaffolding	Appointment with others	Providing resources of teacher Additional programming explanation

Collaboration	Problem solving	Cooperative learning
Reflection	Exhibition & Evaluation	Sharing & Presentation

In this study, we developed the Convergence Study Program to improve problem solving ability about the areas that are related various subjects.

4. Overview of Experiment

4.1 Energy Saving Attitude Test

On a study, we tested Energy Saving Attitude Test to ensure homogeneity. (Comparing to two classes of the same elementary school)

It showed a similar average for Control group and Experimental group ; it didn't show a statistically meaningful difference between Control group and Experimental Group of the Pre-test.(p>0.5) Thus, they turned to be the homogeneity group. On the contrary, both group had an average increase. But the average of the experimental group was higher than the average of the control group. It showed a meaningful difference between Control group and Experimental group of the Pro- test(p<0.5) relate to the (t=3.829, p=.001). Consequently, convergence study program has been verified the higher impact on energy-saving attitude than a general lesson.

[Table 4] Result of pre-test & pro-test

Time	Group	M	SD	F	T	p
Pre-test	Control(n=16)	65.38	14.12	33	1.347	.187
	Experimental(n=19)	71.73	13.75.			
Pro-test	Control(n=16)	75.16	9.28	33	3.829	.001*
	Experimental(n=19)	88.05	10.47			

Pre-test *p<.05, pro-test *p<.05

5. Conclusion

We have presented the use of educational - robot to teach the convergence study program. We count on that the convergence study program suggested would improve elementary students' problem solving skills and have more confidence about mathematics, science, engineering and computer programming. And it was effective to improve students' participation and interests.

Finally, it was positive effects on learner's attitude about converging trend. Furthermore, the experience through the convergence study program would be helpful to be members of converging leader with creativity.

References

[1] Ri-Hyung Lee. (2009). Integration & Convergence between interdisciplinary. *Journal of Keon young*.

[2] Natalie Rusk., Mitchel Resnick., Robbie Berg., Margaret Pezalla-Granlund. (2008). New Pathways into Robotics: Strategies for Broadening Participation. *Journal of Science Education and Technology*.

[3] http://en.wikipedia.org/

[4] Kwang -Hyun Sim. (2009). Consilence or convergence of art and technology. *Technology &Future press*.

[5] Sung-Ho Kwan. (2008). Access as a process of convergence in general education. *Journal of general education, 2*(2), 7-24.

[6] Mitchel Resnick. (2008). Computer as Paint Brush: Technology, Play, and the Creative Society. *Oxford University Press.*

[7] http://www.picocricket.com

[8] Robert M. Capraro., Scott W Slough. (2008). Project-Based Learning. *Rotterdam: Sense Publishers.*

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education

A Framework of User-Driven Data Analytics in the Cloud for Course Management

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Abstract: In this paper, we describe our goal of an effective course management system for assisting course managers to make informed decisions about what materials should be most appropriate to be presented to students (learners) and what learning strategies or methods should be used for the students. The system is supported by our design of a novel framework for user-driven data analytics in the cloud. Different modules of the framework will be illustrated in detail in the context of course management.

Keywords: Course Management, E-Learning, Data Analytics, Cloud Computing

Introduction

Modern technologies have the potential of transforming traditional ways of learning. Instead of gaining most of knowledge from classes, they can now learn knowledge from many resources scattered on Internet. In Singapore, in 2008 the government has invested in a 4-year Future School project to create a futuristic engaging learning environment with the help of Infocomm Technology. Many e-learning systems have also been implemented for online education purposes [10], e.g. Blackborad deployed by Nanyang Technological University. A crucial element for these systems is effective course management. Course managers (i.e. lecturers, course coordinators, and designers of e-learning systems) need to make informed decisions about what materials should be the most appropriate to be presented to students (learners) and what learning strategies or methods should be used for the students [2]. Most existing commercial course management systems, e.g. Blackboard, provide only basic information about student access statistics to the e-learning system. To achieve this, students' learning behaviors need to be modeled by taking into account different factors from distributed information sources and multiple domains: students' performance records from university databases, relevant policies from education authorities, student models from another country or university, general educational trends in a country, and rich secondary data (such as students' social networking patterns). The heterogeneity of these secondary data demands both robust data fusion and intuitive summarization or visualization to make possible interpretation and interaction by course managers. A robust user-driven framework is thus needed to integrate these different aspects involved.

In this paper, we describe our goal of an effective course management system that is supported by our proposal of a novel framework for user-driven data analytics in the cloud. This framework provides course managers with various data analytics services, including an intelligent crawler to find relevant data, a meta miner to recommend the best workflow together with the transfer learning for producing different models (such as student models and course material/learning object models) possibly across different domains, the cloud compute service to support computation and storage in heterogeneous and distributed environment, and the visual analytics service to allow course managers to interact with our system to find extra relevant data and refine produced models in order to perform more effective course management. We also describe in detail the different modules and components of our proposed framework in the targeted context of course management to clearly illustrate its supported procedures/functionalities towards an effective course management system.

1. Course Management

Our course management system will help course managers to determine which learning materials should be selected for students. Students' usage of the e-learning system kept in the log data will be used for usage mining to predict the students' performance. One important factor for prediction is the seasonality (i.e. access period) to represent student learning behavior in time series. Based on the prediction results, course managers need to personalize the materials that will be presented to the individual students who will likely have different grade levels. Relevant materials will be crawled from the cloud, such as Wikipedia, online discussion forums, various e-learning systems, digital libraries and so on. Data from other domains (i.e. IT service domain) will also provide additional indication for students who are studying in IT area about the demanding IT knowledge and skills they should have in order to be well-prepared for future career. These data will then be used to produce data models for managers to make decisions on which materials will be the most appropriate and relevant for which students. Along this process, the course managers may possibly refine the data analytics workflow, for example, to use different machine learning algorithms and to use a different data mining process through interactive visual analytics.
Our course management system will also help course managers to determine appropriate and effective methods to be used for students to learn. The social relationships among students can be analyzed for peer learning or group learning to enable students to get help from each other and promote interactive and collaborative learning, based on the relevant data from social networking sites in the cloud, such as Facebook and Twitter. Information about different mobile devices preferred by students will also be elicited through student survey. This information can be used to enable proactive pushing learning materials to students so that they can learn from anywhere and at anytime. Our vision of the effective course management system is supported by the design of a user-driven data analytics framework in the cloud, which will be illustrated in the next section.

2. Design of the User-Driven Data Analytics Framework

Figure 1 shows the high-level view of the proposed user-driven data analytics framework. The framework comprises two main modules: Data Analytics, which is responsible for the data analytics operations; and Data Infrastructure, which is responsible for the management of distributed compute and storage resources. The following briefly describes the Data Analytics module's components and their purposes:

- Intelligent crawler: gathers relevant information and services available in the cloud;
- Transfer learner: adapts analytics models from one relevant domain to another;
- Meta miner: recommends to users optimum data analytics workflows;
- Visual analytics: provides visualization and interaction features for users to refine data analytics workflows and output;
- Usage miner: mines collective patterns of usage by users for reusability and collaborative analysis.

The Data Infrastructure module includes the Hadoop framework for distributed computation, a distributed data storage management system, and the Data Broker Service. Hadoop framework ensures the efficiency and resiliency of computation in the cloud. It is also responsible for optimum Hadoop execution scheduling. Data storage management system provides cloud-based storage solutions by for example leveraging the existing cloud-based technologies such as Google File System, which can provide performance, scalability, reliability, and availability to our service. The Data Broker Service component utilizes the usage patterns to optimize the compute and storage needs. We now illustrate the use of the proposed framework in the context of course management.

Course management analytics seeding question is formalized: The course management analytics is seeded by a question concerning the effectiveness of a course design. Without the loss of generality, an example question that is used as our illustration throughout this section is “does providing customized course materials to students in different profile-groups help to improve the overall class grade?” To formalize this question, the proposed system requires three key elements: initial dataset, initial analytics workflow, and Predictive Modeling Markup Language (PMML) conversion of these two elements [5]. Good initial datasets in this context would be abstracted course characteristics (i.e. with abstract features like: learning curve and mathematical skill required), student profiles, and historical records of students’ performances. The corresponding analytics workflow can be clustering of students based on their profiles and association rule mining to find strong associations between good student-group performances and course characteristics. These datasets and the workflows are converted into standardized PMML descriptions as queries to the proposed system.

Course management-related resources are gathered and compiled: Using the seeding question provided by course managers (formatted in PMML), the primary goal of this stage is to expand the question by finding relevant datasets, analytics software, knowledge base, and services (e.g. storage and compute resources) in the cloud. Referring to the illustrative question described above the student profiles can be enriched by mining patterns of their social networking, more descriptive clustering algorithm (with PMML descriptions) can be downloaded, known associations between courses and student performances reported in education journal abstracts can be extracted. The intelligent crawler of the proposed system, a component responsible for this expansion, crawls the cloud databases and the Web to gather the resources. The intelligent crawler compiles these resources by converting them into PMML formats. For unstructured data (e.g. journal abstracts), information extraction based on the fields used in the PMML descriptions of the seeding question is performed to extract relevant entities from the data [3]. For semi-structured and structured data (e.g. formatted algorithm descriptions), synchronization with the seeding question is performed by data fusion techniques [1]. To achieve integration with available cloud resources, the compilation of resources conforms to SOA protocols. The output of this stage is the synchronized form of information and services relevant to the seeding questions from the cloud.

Analytics workflow is optimized through human-system collaboration to predict effectiveness of course materials and delivery methods: Taking into account factors enriching resources from the cloud, the initial analytics workflow defined by course managers need to be adjusted for more optimal prediction of course effectiveness. The proposed system is equipped with a meta-mining component, which based on the PMML descriptions of the seeding questions and the relevant resources, proposes to course managers more optimized analytics workflow [9]. Some examples of meta-mining proposals in our context are: 1) with the student profiles enriched by social networking information, a clustering algorithm is more optimized for networked data such as MCL [4] is suggested; 2) making use of Hadoop, a faster parallel version of MCL is deployed; 3) based on the existing publications on some known course-student performances associations, the support and confidence levels of the association rule miner are fine-tuned. Course managers monitor and refine proposals from the meta-miner through the visual analytics interface of the proposed system. The visual analytics screen shows in real time the graph representation of the student clusters [8], through which course managers can adjust for example the granularity levels of student clusters (i.e. smaller or bigger groups of students are more practical). The mining of associations between courses and student performances is also visualized using tools such as FpVAT [7], which enables course managers to handpick unexpected association rules missed out by the system.

Course management analytics is made reusable for future and collaborative analyses: To support institution-wide use of the proposed system, current analytics activities and usage patterns (e.g. the workflow and the workflow design process) are stored as resources. Other course managers in the future can benefit from collective rules generated by the usage miner component, such as “80% of course managers managing a course attended by more than 300 students prefer student clusters with higher granularity”. Aside from the usage miner component, the proposed system also deploys a transfer learning component for reusability [6]. Transfer learning performs adaptation of datasets and analytics workflows from one domain to another (e.g. from clustering of science students adapted to clustering of business students). Relevant analyses from past and cross-domain (e.g. from science to business) course management analytics can be taken into account to enhance the accuracy of current analysis.

Cloud compute system is activated to support course-management analytics: Behind the scenes, a cloud compute system, supported by the Hadoop framework and cloud-storage, serves as the engine of the large-scale and distributed analytics activities involved in the course management analytics. The computation also benefits from the mining of usage patterns that allows optimal allocation of resources, e.g. “Crawling of relevant information for business courses on average requires 10% more storage than engineering courses”. With this cloud compute system, course managers are not limited to the processors and storage of their personal computers.

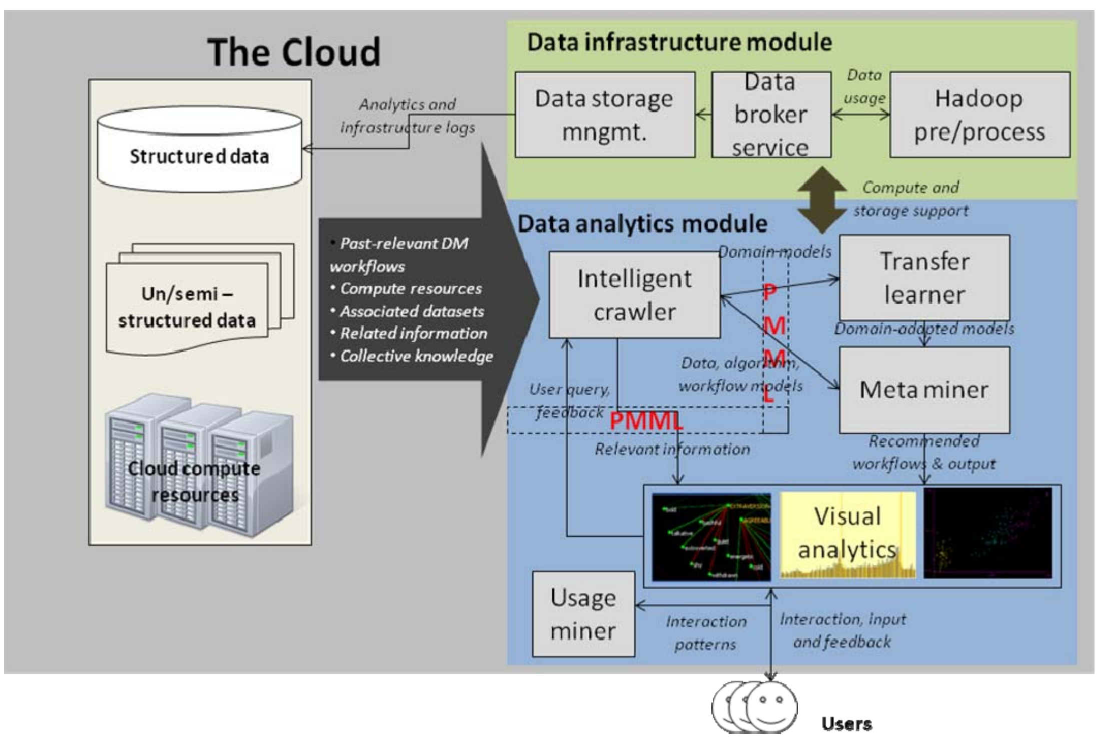

Figure 1. The Proposed Framework for User-Driven Data Analytics in the Cloud

In summary, a package of user-driven data analytics services is offered by our proposed framework to provide the following functionalities of the effective course management system: a) discovering new learning materials through crawling in the cloud (i.e. the web, learning object repositories, and e-learning systems); b) discovering global patterns in students records and profiles to improve existing course materials and learning objects, and optimize learning objects repositories and e-learning systems performance; c) discovering local patterns in the histories of students, by learning models of individual student's knowledge, learning style, motivation level, and social network; d) in combination with other domains, discovery of new important skills and knowledge that need to be learned, to constantly update the teaching goals and keep the skills of the students in sink with the market demands; e) discovering gradually patterns of successful personalization or learning sequences and learning methods based on successful learning sequences and methods for groups of students or classes of students (i.e. collaborative filtering); f) visualizing recommended analytics workflows and learned models or rules of students, learning materials and learning methods to allow course managers to interact with the data analytics results, in order to for example refine the course management analytics workflows, speed up the learning process, or adjust the learned results.

3. Conclusion and Future Work

In this paper, to support our goal of an effective course management system that is crucial for better e-learning, we designed a framework for user-driven data analytics in the cloud. It is a new scalable distributed data analytics framework that complements users of analytics by retrieval, integration and summarization/visualization of relevant heterogeneous information from external sources and facilitates user interpretation, interaction and collaboration to achieve domain-specific solutions.

Our next step is to implement the course management system based on the framework design. Then, we will evaluate the performance of this system. Students and course managers of e-learning systems will be involved. By employing our course management system, it is expected that students’ learning will be improved and better feedback will be provided to course managers.

References

[1] Bleiholder J. & Naumann F. (2008) Data fusion. *ACM Comput. Surv., 41*(1):1–41.

[2] Champaign, J. & Cohen, R. (2010). A Model for Content Sequencing in Intelligent Tutoring Systems Based on the Ecological Approach and Its Validation Through Simulated Students. *Proceedings of the Ninth Florida Artificial Intelligence Research Symposium (FLAIRS)*. Daytona Beach, Florida.

[3] Chang C.H., Kayed M., Girgis M.R., & Shaalan K. (2006) A Survey of Web Information Extraction Systems. *IEEE Trans. on Knowledge and Data Engineering,* 0475-1104.R3

[4] Enright A.J., Van Dongen S., & Ouzounis C.A. (2002) An Efficient Algorithm for Large-scale Detection of Protein Families. *Nucleic Acids Research, 30*(7):1575-1584

[5] Guazzelli, A., & Stathatos, K., & Zeller, M. (2009) Efficient Deployment of Predictive Analytics through Open Standards and Cloud Computing. *SIGKDD Explor. Newsl., 11*(1):32–38.

[6] Gupta, A., & Ratinov, L. (2008) Text Categorization with Knowledge Transfer from Heterogeneous Data Sources. *Proceedings of National Conference on Artificial Intelligence (AAAI).*

[7] Leung C.K. & Carmichael C.L. (2009) FpVAT: A Visual Analytic Tool for Supporting Frequent Pattern Mining. *SIGKDD Explorations, 11*(2), 39-48.

[8] Shen, Z., & Ma, K., & Eliassi-Rad, T. (2006) Visual Analysis of Large Heterogeneous Social Networks by Semantic and Structural Abstraction. *IEEE Trans on Visualization & Computer Graphics, 12,* 1427-1439.

[9] Smith-Miles, K. A. (2008) Cross-disciplinary Perspectives on Meta-learning for Algorithm Selection. *ACM Comput. Surv., 41*(1):1–25.

[10] Vassileva, J. (2009). Towards Social Learning Environments, *IEEE Transactions on Learning Technologies, 1*(4), 199-214.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Opinions on Future Research Themes for Technology-Enhanced Learning: A Delphi Study.

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Abstract: In this paper we present first results of a Delphi study on technology-enhanced learning (TEL). The study is carried out as part of the European Network of Excellence STELLAR (Sustaining Technology Enhanced Learning Large-scale multidisciplinary Research). In the 1st Delphi round an expert survey was conducted to identify future trends in TEL research: Forty-one European TEL researchers answered open-ended questions concerning future key societal demands and technological developments, and concerning research themes that could respond to these demands and developments. Answers were coded and categorized using a qualitative approach. To conclude this article we give an outlook on the next steps of the STELLAR Delphi study.

Keywords: Delphi study, technology-enhanced learning, STELLAR, future research trends

Introduction

As the prevalence and the capabilities of digital devices in educational settings increase rapidly, the research community's interest in the potential of information and communication technologies (ICTs) for learning is growing. Researchers in the field of technology-enhanced learning (TEL) are exploring how ICTs can be used to support learning in various educational settings [1]. In the past few years there have been a number of attempts to identify future trends in learning and technology such as the annual Horizon Report by the New Media Consortium [2]. The aim of the present study was to identify trends and challenges in TEL by gathering experts' predictions of emerging research themes, relevant societal challenges, and future technological developments. To do so, we used the Delphi method. In general, Delphi studies aim at identifying emerging trends and future developments in a given field [3]. They involve several rounds of consecutive surveys among experts. The results of each round are analyzed and transferred into materials to be processed and evaluated by the survey participants in the subsequent round. For example, the Japanese National Institute of Science and Technology Policy (NISTEP) [4] carried out a prominent large-scale Delphi study on scientific and technological developments.

The Delphi study that we present in this paper is carried out as part of the European Network of Excellence STELLAR (Sustaining Technology Enhanced Learning Large-scale multidisciplinary Research) [5]. One of the final goals of the work of STELLAR in general and the Delphi study in particular is a catalogue of recommendations for TEL research on the European level and beyond. The Delphi method allows us to involve a large number of international researchers and experts from various disciplines in the iterative process of co-constructing visions for future research in the field of TEL.

The focus of this paper is on the 1st Delphi round, which constitutes the starting point of the 5-round process of the STELLAR Delphi study. In the 1st Delphi round, we encouraged all researchers within the whole STELLAR network to provide their opinions on future TEL research. The STELLAR experts' input is discussed and extended in consecutive Delphi rounds, employing a larger international panel of experts. The 1st Delphi round was completed at the end of 2009; the subsequent rounds are already under way.

1. Methodology

1.1 Sample of Experts

The sample of the 1st STELLAR Delphi round consisted of 41 researchers working in the field of TEL from nine European countries. All participants of this round were members of the STELLAR program. The experts' professional background was almost equally distributed between educational technology/computer sciences (N = 23) and social/educational sciences (N = 18).

1.2 Questionnaire Design

In answering an online questionnaire, the experts stated predictions concerning the future of TEL and made recommendations for a future research program (see Figure 1). The questions were open-ended, that is, they allowed for written answers in text fields. The findings that we present in this paper refer mainly to the question asking for experts' forecast of future research themes (Figure 1; question 1); we do, however, also make connections to two other forecasting questions concerning technological developments and societal challenges (Figure 1; question 2 & 3).

Imagine a large international TEL research program to be carried out from 2014 till 2020 is planned:

1. What should be 2-3 central research themes and questions to be covered by this program?
2. What future key technical developments (e.g. increasing use of mobile devices) should be accounted for in the research program? (Please name 2-3)
3. What future key societal demands and challenges (e.g. aging society) should the research program live up to? (Please name 2-3)

Figure 1: Questionnaire 1st Delphi round – Forecasting Questions.

1.3 Data Analysis

The goal of the data analysis was to create thematic clusters for each of the three forecasting questions from the experts' textual input. Our analysis approach was twofold consisting of an open coding process [6] and a categorization of the experts' answers: Coding segments were chosen based on units of meaning. Categories were developed from the experts' answers in a bottom-up approach suitable for the explorative nature of the 1st Delphi round. In a second step, topics and subtopics were developed from these codes. Two independent coders developed their own hierarchical systems, which were then combined in one final version. Table 1 shows an extract from the resulting coding system for the question on future societal challenges that TEL research should live up to (Figure 1; question 3).

Table 1: Example for the category system developed for the open-ended answers on future societal challenges.

Topic	Subtopics	Sample expert quotations
Social justice	TEL for the inclusion of diverse groups of people	"ICT inclusion for elder people and ICT marginalized people"; „technology must not longer exclude certain classes of population"; …
	Reducing the digital divide	"danger of increased digital divide. "; …

2. Results – Future Trends in TEL Research

Table 2 lists the most important topics and subtopics that were mentioned for each of the three forecasting questions (future research themes, future technological developments, and future societal challenges; see Figure 1) along with the frequencies of each topic. Our discussion of these results in the following will focus on the experts' predictions of future research themes, but also connects them to the future technological developments and future societal challenges identified by the experts.

Overall, the experts named *ubiquitous and contextualized learning and technology* as the most important focus of future TEL research. The importance of this research theme has to be seen in the light of the demands that the modern knowledge society poses on formal education (societal demand: *knowledge society and its demands for education*). Ubiquitous technology satisfies the need for permanent access to the latest information in a time where knowledge is the most valuable resource and where knowledge is changing quickly and dynamically. Ubiquitous technology provides the possibility to access information and tools on the fly. The combination of mobile and location-based learning offers the possibility to instantly equip learners with context-related information; for instance, a learner could inquire the name of the architect of the cathedral he/she is just looking at. Furthermore, mobile devices bear the potential to improve formal learning by bridging across informal learning settings (e.g. a visit to the zoo) and formal learning settings (e.g. a biology class). Another field of application for *ubiquitous and contextualized learning and technology* can be seen in mastering the societal challenge of *lifelong and workplace learning*, which is especially important for an aging society. Learning on the job opens new horizons for continuing education in organizations and thereby contributes to the higher goal of organizational learning. Due to contextualized learning designs learning events can be embedded in the daily working routine.

The second most often mentioned topic for future TEL research was to *improve formal education*. A large cluster of expert statements focused on improving educational practices and education systems. For example, an expert statement illustrating the subtopic *teaching of TEL-skills* was:

> "Teaching of TEL-skills, e.g. computer-literacy, collaboration skills, learning skills, reading skills, information evaluation skills...: What skills are needed, how do they influence each other? How can they best be taught?"

Within the goal of *improving formal education* a key societal challenge is to adapt formal education to the changing demands caused by the *knowledge society*. According to the experts, this may include teaching media literacy and information literacy as well as adapting to new generations of students, i.e. digital natives who grew up with ICTs as part of their daily life. To meet these challenges successfully TEL tools need to be integrated in formal education, as suggested in this research question by one expert:

> "How to best integrate computer-based/computer-supported learning activities with regular face-to-face, teacher-to-students learning arrangements, in school and universities settings, but also in adult learning settings (e.g. vocational education, training on the job)?"

This statement also points out that future educational challenges may not only be met by adapting formal education as we know it, such as school systems and universities, but that the connection between formal education and *informal learning* as well as *lifelong and workplace learning* will need to be redefined.

Table 2: Most important topics and corresponding subtopics of the Forecasting Questions.

Topic (Subtopics)	**n**
Future Research Themes (coded units of meaning: n = 131; experts: n_e = 41)	
Ubiquitous and contextualized learning and technology (Contextualized learning and location-based learning/context-aware applications; Ubiquitous technology/learning; Mobile technology/learning)	19
Improve formal education (Improve formal education practice and formal education systems; Integrating technology into formal education; Teacher training; Teaching of “TEL-skills)	18
Characteristics of the research program [This topic contains statements concerning the research program itself rather than research questions or themes] (Theoretical frameworks and objectives ; Methodology; Connecting researchers)	15
Instructional methods and frameworks (Instructional objectives and frameworks; Instructional methods and applications)	11
Collaborative learning (Analysis of cognitive processes on group level; Collaborative learning; Collective intelligence/wisdom of the crowds)	9
Informal learning (Connection between formal and informal learning; Informal learning)	8
Personalization/individualization (Personalization/individualization; Personal Learning Environments)	7
Social justice (Addressing the needs of all learners; Addressing the digital divide; Have third world countries benefit from TEL)	7
Future Technological Developments (coded units of meaning: n = 102; experts: n_e = 38)	
Ubiquitous & contextualized learning and technology (Mobile devices & ubiquitous computing; Contextualization, location-awareness and context-aware applications; Ubiquitous mobile connectivity; Mobile learning)	29
New ways of human-computer interaction & ambient computing (Ambient intelligence/computing & sensor technology; “Intelligent” objects/furniture; New, more intuitive Interfaces)	18
Future Societal Challenges (coded units of meaning: n = 102; experts: n_e = 40)	
Social justice (TEL for the inclusion of diverse groups of people; (Reducing the) digital divide)	16
Knowledge society and its demands for education (Adapt to new generations of students; Adjust education to the “knowledge society”; Teach media/information literacy; Quick/dynamic changes of knowledge; Information society)	15
Demographic developments (Aging society; Job market changes; Gap between young and old people)	14
Improve formal education (Adapt education to individual needs; Teacher Training)	12
Lifelong learning & workplace learning (Lifelong learning; Connection between learning and working; Learning on demand)	11

Another important topic that was mentioned as a future research theme by several experts was also the most frequently mentioned future societal challenge: *social justice*. This topic reflects the idea that all learners (i.e. learners from different cultural and socio-economical backgrounds) should benefit from TEL. A related key future societal challenge for TEL mentioned by many experts is *reducing the digital divide* (subtopic of *social justice*) between people who have access to ICTs and know how to make use of ICTs and people who do not. The digital divide also refers to the divide between media-literate and non-media-literate people in industrial countries, which may increase due to the *aging society* (subtopic of *demographic developments*). The experts suggest that TEL research may help to reduce this latter divide by developing easy-to-use TEL tools for elderly people:

> „Handling of technological devices has to become easier, performance more reliable, and purchase cheaper to allow young children and old adults […] to really profit from TEL"

According to the experts, social justice also includes addressing the technological and educational divide between industrial and developing nations, as mentioned in this statement:

> "Social justice with a particular focus on countries in Sub-Saharan Africa -- Questions to include: How do we ensure access to technical resources is supported by access to human resources?"

3. Summary and Outlook

Our findings illustrate that the future of TEL and TEL research will be shaped by an interplay of technological developments, societal challenges and pedagogical advances. The experts who took part in our Delphi study did not only point out promising technological trends but also societal challenges that educational systems will need to meet. A trend towards interdisciplinary future research agendas that address multiple aspects of TEL is evident.

The 2nd STELLAR Delphi round was carried out from February to late April 2010 with the participation of 230 international TEL experts. This 2nd round aimed to further evaluate trends and developments that were identified in the first Delphi round. Results from the 2nd STELLAR Delphi round will be presented at the conference.

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References

[1] Law, N., Pelgrum, W., and Plomp, T. (2008). *Pedagogy and ICT use in schools around the world: Findings from the IEA SITES 2006 study*: Springer Verlag.

[2] New Media Consortium. (2010). *The Horizon Report. 2010 Edition.* Austin, TX: The New Media Consortium.

[3] Linstone, H. A., and Turoff, M. (Eds.) (1975). *The Delphi method: techniques and applications*. Reading, UK: Addison-Wesley.

[4] NISTEP (2005). *Science and Technology Foresight Study. Delphi Analysis*. Retrieved November 10, 2009 from: http://www.nistep.go.jp/achiev/ftx/eng/rep097e/idx097e.html

[5] STELLAR (2009). *Program of Work.* Retrieved, November, 19, 2009, from http://www.stellarnet.eu/program/

[6] Strauss, A. and Corbin, J. (Eds.). (1997). *Grounded Theory in Practice*. London: Sage

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A Study of the POS Keyword Caption Effect on Listening Comprehension

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Abstract: Listening comprehension is the most important part of English communication. Watching English films helps getting both audio and visual messages which can improve the learners' listening comprehension. In this study, we examined the full text captions films and the keyword captions with nouns and verbs to help understand the different effects of listening comprehension. One hundred English majored high school students participated in this experiment. This research indicated that with only nouns in the keyword captions the participants' listening comprehension was greatly assisted and reduced both the audio and visual senses from information overloading. On the other hand, with only verbs in the keyword captions, the participants' listening comprehension was excessively low. Moreover, the effects of listening comprehension for different types of films which include natural science and cultural history films were discussed. Natural science films provided more information without a necessary of a great deal of background knowledge; therefore it was easier for the participants to understand. However, it was difficult to comprehend cultural history films without having a certain level of knowledge of the background information. From the results, due to the participants' positive attitude towards the system satisfaction and learning approach, the participants had more self-confidence and higher motivation to operate the system and interface afterwards.

Keywords: Keyword Captions; Listening Comprehension; Part-of-Speech (POS) Tagger; Information Processing; Computer-Assisted Language Learning.

1. Introduction

Listening skill is the essential element in English learning [1] [2]. We can learn from many materials; especially video-based language learning is a good method to promote listening comprehension. This method integrates both the visual and audio messages which can help improve listening skills. Pavio [3] brought up the dual-coding theory which pointed out that while accepting the outside messages, human brains would make information encoding logogens and imagens. The information from both systems would produce correspondence and relation to help stimulate the strengthening of the memory. However, during the message processing, human brains tend to neglect the audio messages when there are too many visual messages to decode [4]. The learning theory revealed that too much noise would destroy the assisted learning effects [5]. Therefore, it is better to use the dual-coding method to help assist to decode messages for listening comprehension and prevent information overflowing. During the limited time of film watching, plenty of visual and audio messages would likely interfere with message decoding.
Most foreign films are being played with full text captions. Now we want to know how much content people understand while watching films with fewer texts or without any texts. The amount of captions will influence the level of listening comprehension while watching films. Schlesinger [6] pointed out that 2.5 to 3 chucking (the numbers of words that appear on the screen as captions each time) is a suitable quantity for assisting reading comprehension and also good for listening comprehension. Some researchers mention that

partial captions such as keyword captions are good for assisting listening comprehension and can help reduce information overload [7][8]. To this end, this study focuses on the effect of part-of-speech of keyword captions while watching films.

For English learning, Markham [9] indicated that people could improve listening and reading comprehensions through watching foreign films with captions. Reese [10] pointed out that text captions would only interfere in decoding the message and dispersing the learning effect with news that was rich in information as pictures and voices. Garza [11] evaluated whether the text captions could assist people to understand film contents. Participants were English native speakers learning Russian via films watching to compare the learning difference within the full text captions and non-text captions. The result showed a positive correlation between listening comprehension and full text captions.

This study focused on the different types of captions and effects on listening comprehension. There were three kinds of captions, nouns with the keyword captions, verbs with the keyword captions, and full text captions. We also examined the usages of different captions for different types of films for assisting listening comprehension.

2. System Implementation

The system is divided into three areas: User Interface Area, POS Tagging Area, and Fetch Area. The User Interface Area has two interfaces that are for film processing and operator interfacing. The second area, The POS Tagging Area, is part-of-speech tagger and subtitles processor. This POS tagger rule is based on Brill's tagger [12]. After being processed in the part-of-speech tagger, the text captions are filtered to retain noun and verb to assist in text captions, and allow stop words to filter noise message. Then, POS keyword captions are processed to be the final transcripts. The third area is "Fetch Area" that POS KW Films Database combines the final transcripts, film database, and test models.

This system is called "Film-Based Computer-assisted English Listening comprehension system". There are three interfaces in this system. The System Interface includes Login in Interface, Demo Interface, and Test Interface. The operations of the system process are as follows: Part1. Login Interface: This provides participants to login into the system. Part2. DEMO Interface: this is the same as System Interface to allow familiarity of interface operation. Part3. Test Interface: When participants enter a film catalogue, they would have to watch one film and take an exam in fifteen minutes.

3. Experiment Design

There are eighty-four girls and eighteen participants who are English majored high school students. The first experimental group used nouns with the keyword captions while the second experimental group used only verbs with the keyword captions. The control group used full text captions. Two types of films: natural science and cultural history, and six films in each category respectively. Every film endures for about five minutes.

The dependent variable is the preference of film content test which was called comprehension of the film contents. All test questions are from the content of films. There were three experts to co-edit the test questions. There were 25 questions from the natural science films and 27 questions from the cultural history films. The scale (7-point Likert's scale) shows the two questionnaires of English learning attitudes (the explanatory power is 76.37% & reliability is .913) and satisfaction (the explanatory power is 76.96%, reliability is .912) with the system. The five dimensions in the questionnaires are Confidence Dimension,

English Learning Attitudes scale, System Usability, Quality of provided Information, Interface Quality of System Satisfaction scale.
We processed the experiment for three weeks. TOEIC listening test was done in the first week and Film content-focused and understanding test for the second and third week. Participants had to write the TOEIC listening test and we then divided them into different level groups according to the result of the test. We arranged the different levels groups to our three caption groups and used the three caption groups as the same English listening test to process our experiment. The three groups were experimental groups: nouns with the keyword captions group (N) and verbs with the keyword captions (V) group. Both groups were attended by thirty-three participants. Thirty-four participants were in the control group with the full text captions group (F). In this experiment, experimental and control groups had to watch six subjects from the natural and science films and six subjects from the human and history films under the same conditions. Each film was played for approximately five minutes. In order to understand the learning results, we immediately performed the Film content-focused and understanding test after watching the films. Participants had to fill in the questionnaire of English learning attitudes after the completion of first stage. The questionnaire of system satisfaction was done after the second stage of the experiment.

4. Results

4.1 Results of Content-focused Understanding Test

The results of content-focused understanding test in films shows that using the three kinds of captions to enhance listening comprehension were significantly different (F_M=34.06, F_SD=5.371; V_M=30.94, V_SD=3.061; N_M=32.58, N_SD=3.734), with ANOVA test of association F=4.657*, p=.012<.05. With Post hoc tests of mean score different=3.119*, p=.012<.05 for full text captions group and verbs with the keyword captions group. But, it was not significantly different, with Post hoc tests of mean score different=1.483, p=.353>.05 for full text captions group and nouns with the keyword captions group. This result showed that the effect for listening comprehension was almost the same while learners watched the films with full text captions or with only nouns in the keyword captions. But the effects for listening comprehension were different between full text captions group and with only verbs in the keyword captions group. The listening comprehension from watching films with only verbs in the keyword captions was less effecting than with only nouns in the keyword captions.

4.2 Results of Listening Comprehension on the Different Type of Films

The analysis result of keyword captions help improve listening comprehension on the different type of films: Natural science films were significantly different (F_M=16.12, F_SD=3.436; V_M=14.21, V_SD=2.205; N_M=15.00, N_SD=2.487), with ANOVA test of association F=4.015*, p=.021<.05, and the cultural history film was not significantly different (F_M=17.94, F_SD=2.628; V_M=16.73, V_SD=2.066; N_M=17.58, N_SD=2.319), with ANOVA test of association F=2.339, p=.102>.05. This result indicates that the effect to enhance listening comprehension while watching natural science films was different with all three types of captions. ANOVA test was not significantly different for improving listening comprehension while watching cultural history films with the three different kinds of captions. Hence, no matter what kind of captions the learners selected, it did not affect any listening comprehension while watching cultural history films. On the other hand, there were the differences of the effect for helping listening comprehension with three different types of captions while watching natural science films. With Post hoc tests of mean score different=1.906*, p=.022<.05 for full text captions group vs. verbs with the keyword captions group. But there was not much difference shown with Post hoc tests of mean score different=1.118, p=.260>.05 for full text captions group vs. nouns with the keyword captions group. These results showed that there was a different effect for listening comprehension while watching natural science films but the effect was to be equal when learners watch films with full text captions or with only nouns in the keyword captions.

4.3 Results of Investigations on the Questionnaire of English Learning Attitudes and System Satisfaction

There are five dimensions in the questionnaire, including confidence, English learning motivation, system usability, information quality and interface quality. The results of these five dimensions on full text captions group, only nouns with the keyword captions group and only verbs with the keyword captions group were analyzed.
Table1 shows that confidence dimension was significantly differently, with ANOVA test of association F=7.465**, p=.001 <.05. This result shows that these three types of keyword captions groups represent the different level of confidence in English learning. We compare the mean score of these three types of keyword captions groups on confidence dimension, the mean score with full text captions group was 5.64, the mean score with only nouns with the keyword captions group was 5.01 and the mean score with only verbs with the keyword captions group was 4.74. The mean score of the confidence dimension on full text captions group was higher than only nouns with the keyword captions group, and the mean score of only verbs with the keyword captions group was the lowest in these three groups. In addition, we compared the scores of confidence for these three types of keyword caption groups and uses Sheffe post hoc tests to test. Table1 displays the result of the score of confidence between full text captions group and only verbs with the keyword captions group. Post hoc tests of association p=.001<.05, and the score of confidence between full text captions group and only nouns with the keyword captions group was significantly different, with post hoc tests of association p=.036<.05. When we look at the differences of the average score between full text captions group and only verbs with the keyword captions group was more different than the average score between full text captions group and only nouns with the keyword captions group. This result shows that participants have more confidence while watching films in full text captions, but they have less confidence while watching films with only verb with keyword captions.

Table 1. The result of investigation on caption groups

Group(N)	**Confidence**	**Eng-Learning motivation**	**System Usability**	**Information Quality**	**Interface Quality**
F (34)	5.64	5.47	6.16	5.90	6.07
V (33)	4.74	4.95	5.92	5.76	5.60
N (33)	5.01	5.04	6.16	5.90	6.06
F test	7.465	2.014	.954	.229	2.631
P-value	.001**	.139	.389	.796	.077
Confidence Post Hoc Test Mean Difference (P-value)			F-V	F-N	V-N
			3.619 (.001**)	2.529 (.036*)	1.091 (.533)

In addition, Table 1 shows the different results for English learning motivation dimension (F=2.014, p=.139>.05), system usability dimension (F=0.954, P=.389>.05), information quality dimension (F=0.229, p=.796>.05) and interface quality dimension (F=2.631, p=.077>.05). According to Table 1, the mean score of English learning motivation

dimension, system usability dimension, information quality dimension and interface quality dimension were higher than the medium value of scale (M=3.5).
These results indicate that using the three types of captions groups gives the participants a positive learning attitude and satisfaction in English learning motivation dimension, system usability dimension, information quality dimension and interface quality dimension.

5. Conclusions

This study showed that the participants in full text caption groups pay more attention to read the text captions. Over saturation of the visual sense channel at all times makes the participants have difficulty decoding audio information. Hence, the full text caption group usually neglects listening and focuses more on reading. Kintsch [13] explained films with captions could help viewers to understand the content, but the listening stimulation would be reduced. In this study, using only nouns in the keyword captions in films is more helpful for listening comprehension than full text captions and only verbs in the keyword captions. Moreover, these two kinds of films with different kinds of captions influence listening comprehension differently. Also, gaining knowledge from the film's content is difficult for the participants who do not know enough vocabulary. From the results, the cultural history films are difficult to watch without having enough background knowledge. Even if there is vocabulary to help the viewers understand the film content, the result on understanding the content is still limited. With nature science films in our study, it is easy for the participants to catch the main points and also to understand the content. Therefore, the captions have a different effect on understanding film content. In future study, the focus on learners' different backgrounds and increasing other types of film materials to classify film contents to understand participants' listening ability are recommended.

References

[1] Decker, M. A. (2004). Incorporating guided self-study listening into the language curriculum. *The Language Teacher, 28*(6), 5-9.
[2] Verdugo, D. R., & Belmonte, I. A. (2007). Using digital stories to improve listening comprehension with Spanish young learners of English. *Language Learning and Technology, 11*(1), 87-101.
[3] Paivio, A. (1971). *Imagery and verbal processes*. New York: Holt, Rinehart and Winston.
[4] Seo, K. (2002). Research note: The effect of visuals on listening comprehension: A study of Japanese learners. *International Journal of Listenin*g, *16*, 57-81.
[5] Mayer, R. E., & Anderson, R. B. (1992). The instructive animation: Helping students build connections between words and pictures in multimedia learning. *Journal of Educational Psychology, 84*(4), 444-452.
[6] Schlesinger, I. M. (1968). Sentence structure and the reading process. Mouton, The Hague.
[7] Guillory, H. G. (1998). The effects of keyword captions to authentic French video on learner comprehension. *CALICO Journal, 15*, 89-108.
[8] Jones, L. C., & Plass, J. L. (2002). Supporting listening comprehension and vocabulary acquisition in French with multimedia annotations. *Modern Language Journal, 86*(4)., 546-561.
[9] Markham, P. (1999). Captioned videotapes and second-language listening word recognition. *Foreign Language Annals, 32*(3), 321-328.
[10] Reese, S. D. (1983). Improving audience learning from television news through between-channel redundancy. Presented at the Annual Meeting of the Association for Education in Journalism and Mass Communication (66th, Corvalis).
[11] Garza, T. J. (1991). Evaluating the use of captioned video materials in advanced foreign language learning. *Foreign Language Annals, 24*(3), 239-258.
[12] Brill, E. (1995). Transformation-based error-driven learning and natural language processing: A case study in part-of-speech tagging. *Computational Linguistics, 21*(4), 543-565.
[13] Kintsch, W. (1988). The role of knowledge in discourse comprehension: A construction- integration model. *Psychological Review, 95*(2), 163-182.

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The Effect of the Preceding Graphic Organizer on Learning Attitude to Programming and Problem Solving Ability of Middle School Students

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Abstract: Middle school students often feel hard to understand computer algorithms and programming concepts due to their abstract nature. The purpose of this study is to verify the effects of the Preceding Graphic Organizer (PGO) embedded in middle school students' Educational Programming Language (EPL) classes on learning attitude and problem solving ability. For this goal, we developed new programming teaching-learning materials called the PGO based on visualization method. For assessment, we experimented with these materials in middle school programming classes and measured their effects statistically. As a result, through before-and-after t-test verifications performed on the experimental group and the control group respectively, there were statistically significant differences between these two groups and the effectiveness of our materials was proved in students' programming learning attitude and problem solving ability.

Keywords: Preceding Graphic Organizer, Middle School Programming, Learning Attitude, Problem Solving Ability

Introduction

The computer programming education has become a core field for understanding the basic concepts of computer science and furthermore building up problem-solving skills in a variety of situations which are required for the modern information-oriented society.
Keeping pace with these changes in Korea, the subject of '*the method and procedure of problem-solving*' which includes programming education was newly established in the contents of the curriculum of ICT education amended and notified in 2007 [1, 2]. Especially, the guide book of the curriculum of ICT education published in 2008 suggested the usage of educational programming languages (EPL) for educational purposes [3].

In this regard, we developed EPL teaching-learning materials using Osborne's generative learning model [4] from the constructivist point of view. They are visual materials for the revitalization of the learners' empirical knowledge and preceding graphic organizer such as action sentence tables reflecting the characteristics of the structure of EPL programming, and we applied them to actual classes for measuring their effectiveness.

1. Theoretical Backgrounds

1.1 . The Preceding Graphic Organizer

The Preceding Graphic Organizer, i.e., the visualization of preceding organizers, is defined by several researchers as shown in <Table 1> [5].

Table 1 The Definitions of the Graphic Organizer

Year	Researcher	The Concept of the Graphic Organizer
2001	Sun-Shine Yang	A visual system that presents organized concepts, knowledge and information, combined with text and figures, especially for elements of important concepts in the text and their details to be organized with figures. Useful when teaching important concepts and terms.
2003	Yeo-Kyung Moon	A visual tool that presents a thought process and knowledge structure used when learners read text. Used for learners during learning process.
2008	Ok-Lee Kang	A form of effective organizer designed for learners to enhance background knowledge

The *preceding* graphic organizer is to structuralize the contents of text into diagrams with important concepts and terms. To apply this to programming learning process, appropriate materials should be devised for learners to enhance background knowledge with respect to the preceding algorithm and to develop a graphic organizer related to it.

1.2 The Osborne's Generative Learning Model

The Osborne's model is a representative teaching model which considered constructivist principles of learning. <Table 2> shows the phases and procedures of the Osborne's generative learning model of instruction [4].

Table 2 The Phases and Procedures of the Osborn's Generative Learning Model

Phase		Learning Procedure
1st phase	Preliminary	A teacher prepares for the next phase of teaching activity.
2nd phase	Focus	A teacher draws the learners' ideas concerning a certain subject
3rd phase	Challenge	A teacher asks questions as to the contents of the presentations made by learners and lead them to challenge.
4th phase	Application	Learners solve problems using the concepts they learned or apply them to new situations.

We regard above model as the instruction model suitable for teaching EPL programming in that this model of instruction draws the learners' ideas and empirical knowledge and makes them challenge of their own initiative when new subjects were given. Further, the learners can apply easily the concepts they learned to new situations of their daily life.

2. Teaching Plan

2.1 The Selection of Programming Contents and Class Hours

Referring to the 7th revised ICT education curriculum which is activated in 2010 and the programming contents in the guide book of middle school computer education course, the contents of EPL programming were selected. <Table 3> shows the selection of programming topics with their class hours and contents respectively.

Table 3 The Selection of Programming Contents and Class Hours

Topic selection	Contents
Introduction to Alice (2 learning hours)	Alice Concepts, Scenarios and Storyboards, Built-in Functions and Expressions
Object-Oriented and Event-Driven	Class, Objects, Methods, Parameters, Events and Event

Programming Concepts (2 learning hours)	Handling
Functions and Control Statements (6 learning hours)	Functions, If/Else, Repetition: Definite and Indefinite and Repetition: Recursion

2.2 The Teaching Draft

A teaching draft of the Alice EPL class for our study was planned according to the phases of the Osborne's generative learning model of instruction. <Table 4> summarizes and shows the draft of teaching the Alice programming by use of the preceding graphic organizers. Further, <Figure 1> and <Figure 2> shows the example of a preceding graphic organizer in the preliminary and focus phases respectively as to the 'limited loop' statements among repeat statements.

Table 4 An Example of the Teaching Draft of the Loop Statement

Phases		Learning Procedure
The 1st phase	Preliminary	-Show the visual aids such as pictures and videos related to the programming elements of this hour. -Bring out common elements from the Venn diagrams of the pictures. -Conduct the mind-storming to remind the learners of various empirical knowledge related to common elements.
The 2nd phase	Focus	-Indicate the problems related to programming elements with the scene pictures of the Alice EPL -Let students draw up 'phased order table'.
The 3rd phase	Challenge	-Provide new challenges that can be solved by use of Alice. -Make students express the process that the problem is solved by picture story boards. -Re-express the contents of the story boards on 'phased order table' and do coding by use of Alice.
The 4th phase	Application	-Let students make a new situation or a story including this hour algorithm by themselves, do coding and correct it in person. -Make them compare the results with other classmates' and evaluate each other.

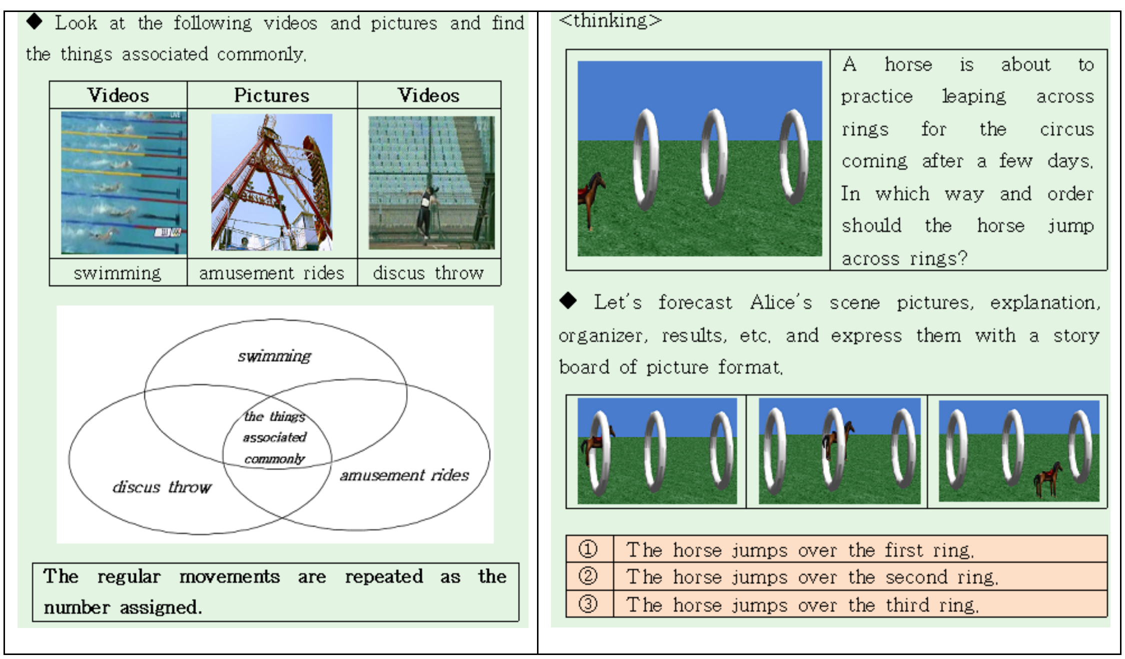

Figure 1 The Preparation in the Preliminary Phase

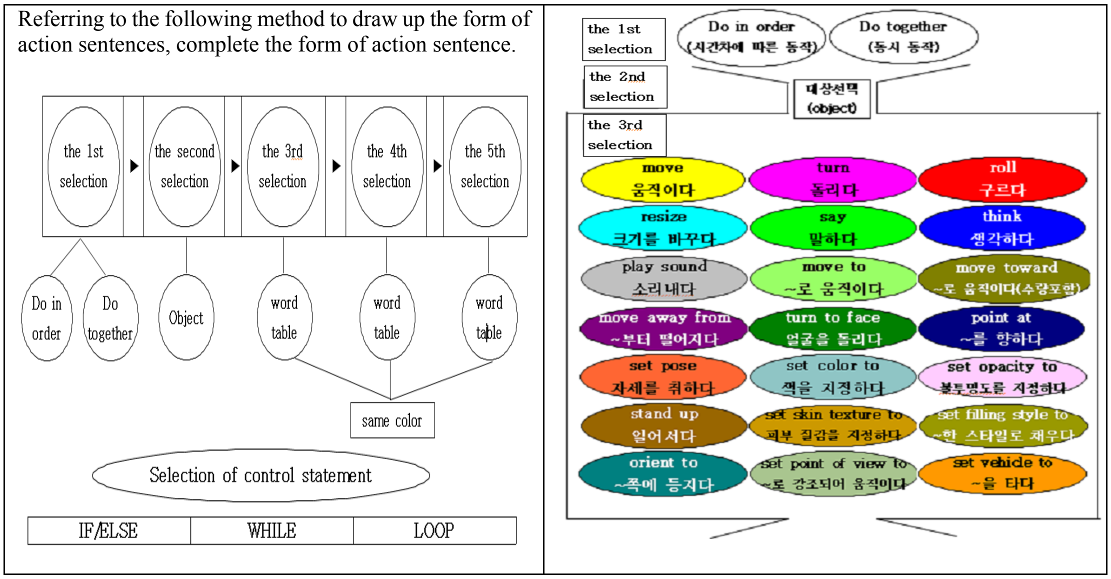

Figure 2-1 The Five Phases Order Statement Table for the Focus Phase

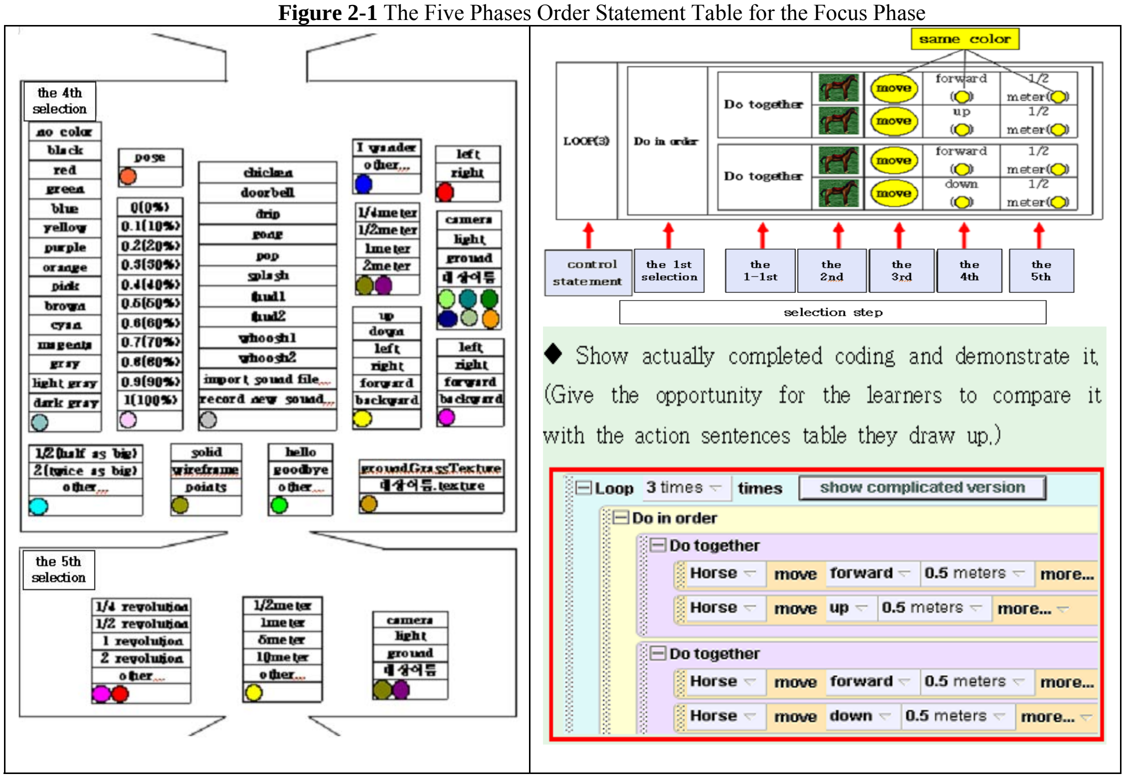

Figure 2-2 The Five Phases Order Statement Table for the Focus Phase

3. Assessment

3.1 Programming Classes Assessment Plan

For this study, two groups of 33 students who are the 2nd graders of a middle school located in the Seongnam city were selected respectively. The first group of 33 students was selected as an ‘experimental group’ to which the Preceding Graphic Organizer was applied and the second group of 33 students was selected as a ‘comparative group’ to which a traditional instruction of programming was applied. <Table 5> shows the experimental plan.

Table 5 Experimental Assessment Plan

G1	O1	X1	O2
G2	O3	X2	O4

G1	: an experimental group
G2	: a comparative group
O1 O3	: preliminary examinations (preliminary independent samples t-test)
O2 O4	: post examinations(post independent samples t-test)
X1	: programming instructions using visualization method
X2	: traditional programming classes

4. Results and Discussion

Regarding the preliminary test, as the result of independent sample t-test, two groups were proved to be homogenous. In the result of post independent sample t-test, the significance level shows significant difference. <Table 6> shows the results of our examination.

Table 6 Results of Examination

<Preliminary test results of learning attitude and problem-solving ability respectively>

group	N	M	SD	t	p
experimental group	33	89.45	12.359	-1.15	.908
comparative group	33	87.79	11.064		

group	N	M	SD	t	p
experimental group	33	89.73	8.435	-1.135	.261
comparative group	33	92.15	8.913		

<Post test results of learning attitude and problem-solving ability respectively>

group	N	M	SD	t	p
experimental group	33	97.30	9.472	2.303	.025
comparative group	33	91.39	11.279		

group	N	M	SD	t	p
experimental group	33	101.00	10.627	2.267	.027
comparative group	33	95.18	10.221		

5. Conclusions

The EPLs are recommended as a good method to make programming education easy and interesting in middle schools. In this study, a new teaching method was designed and experimented for programming using the preceding graphic organizer based on Osborne's generative learning model. The results of our research indicate the significant effect in the aspects of learning attitude and problem-solving ability. These results imply that our preceding graphic organizers which reflect the characteristics and coding rules of the EPL decrease the load of cognition which actually occurs in class and increase the desire to solve one's own problems by oneself with affirmative attitude.

Acknowledgements

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References

[1] Ministry of Education, Science and Technology (2007). Optional curriculum in discretionary activities for middle school - Information. 2007-79.

[2] Ministry of Education, Science and Technology (2007). The Technology & Home curriculum – Information.

[3] Korea Institute for Curriculum and Evaluation (2007). Discretionary activities based on the middle school I (Chinese Character, Information, Environment), The Explanation of Curriculum.

[4] Osborne, R.J., & Cosgrove, M. (1983). Electrical circuits-teachers guide. Hamilton, NZ: S.E.R.U., The University of Waikoto.

[5] Kim, Jong Han (2010). Design of Algorithm Diary Using Graphic Organizer for Elementary School Student. *The Proceedings of Korea Association of Computer Education,* 14(1), 61-65.

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A Model for Social Presence in an Online Classroom

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Abstract: In order to better facilitate the social presence in an online classroom, this study attempted to build a model for measuring social presence and its relationships with other factors in online learning based on the social cognitive theory. A total of 535 valid samples were collected and analyzed from three schools in Taiwan. The results show that user interface and mediated communication have significant influences on social presence. User interface also has positive impact on mediated communication. Moreover, this study provided evidence that social presence has significant effects on interaction performance, and then interaction performance has significant effects on learning performance.

Keywords: Online learning, online classroom, social presence, learner interaction, social cognitive theory

Introduction

From the viewpoint of social cognitive theory, social presence is an essential element to promote learner interaction, especially in the context of online learning [9]. Learner interaction refers to a dynamic sequence of social and learning actions between individuals or groups who adjust their actions and thoughts through their interactions with others [5]. Social cognitive theory considers that people learn not only through their own experiences, but also by observation, imitation, and modeling of others. It focuses on the learning that occurs within a social context. Cognitive and other personal factors, environmental events, and behavior are the three major factors which continually interact with each other [1]. Interaction encourages deep learning processes which take place when learners translate new information into engraved concepts and relate it to their life experiences. Learner interaction is also one of the main factors which affect the effectiveness of the learning process [10].

In an online classroom, learners can conduct their interaction via Internet with the help of multiple devices engaging different sensory channels, such as keyboards, mice, headsets, and webcams, for asynchronous and synchronous communication with other participants [12]. These devices allow for creation of a real atmosphere similar to a physical classroom while still retaining the flexibility and convenience of online learning. With these kinds of learning technologies, the interaction among instructors and learners can be greatly improved [7].

The perceived social presence among learners is not the same for everyone. In order to better facilitate the learner interaction in an online classroom, this study aimed to explore what factors would affect social presence based on the perspective of social cognitive theory. Thereafter, the relationships among social presence, interaction performance, and learning performance were also measured and verified. Finally, the implications of the findings were discussed for further research directions and practical applications.

1. Research Methods

The research framework of this study is shown in Figure 1. In the proposed research framework, there are two important environmental factors, user interface and mediated communication, which would affect personal perception of social presence. A high degree of perceived social presence should have profound effects on learners' interaction behaviors [11]. In this study, the viewpoints of co-presence and psychological involvement were adopted to define social presence in an online learning environment. The second-order construct of social presence is composed of three first-order constructs, co-presence, intimacy, and immediacy [2]. A high degree of perceived social presence can help learners engage in interaction. Besides, learning performance is a major consideration in online learning. In this study, learner satisfaction and goal achievement were considered as two important factors for learning performance measurement.

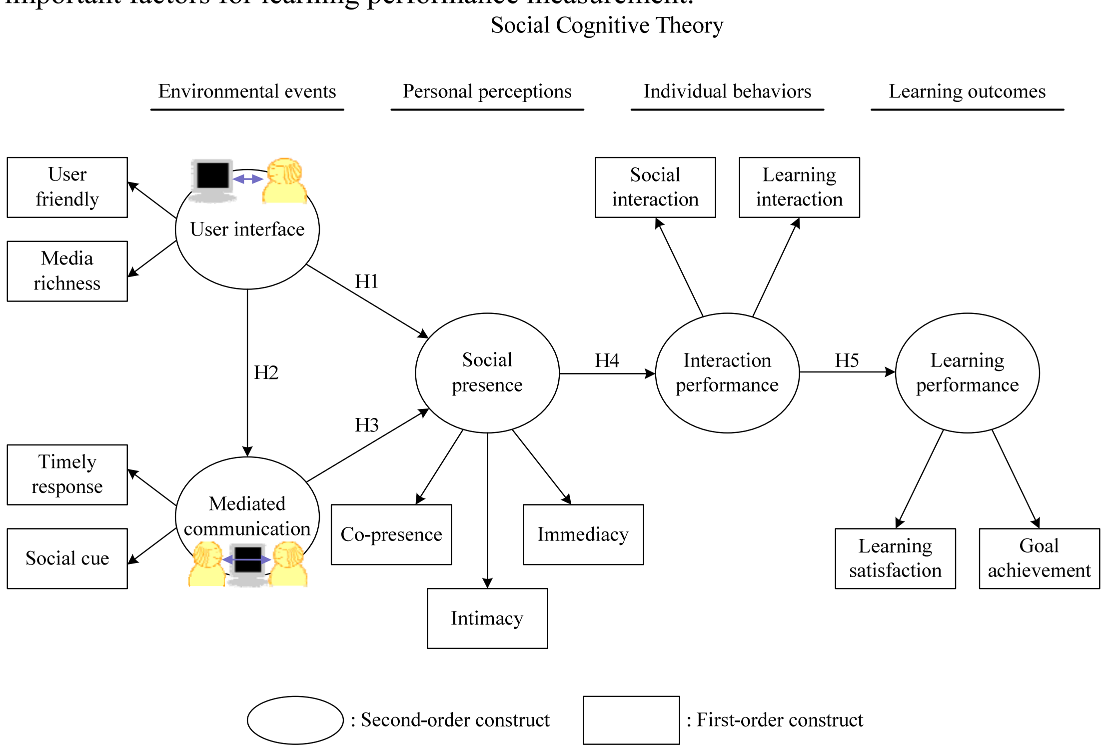


Figure 1. Research framework

Based on the proposed research framework, there are five hypotheses which are to be verified in this study. The theoretical inference and hypothesis statements are described as follows.

H1: User interface has a positive effect on learners' perceived social presence in an online classroom.

H2: User interface has a positive effect on learners' perceived mediated communication in an online classroom.

H3: Mediated communication has a positive effect on learners' perceived social presence in an online classroom.

H4: Perceived social presence has a positive effect on learners' interaction performance in an online classroom.

H5: Interaction performance has a positive effect on learners' learning performance in an online classroom.

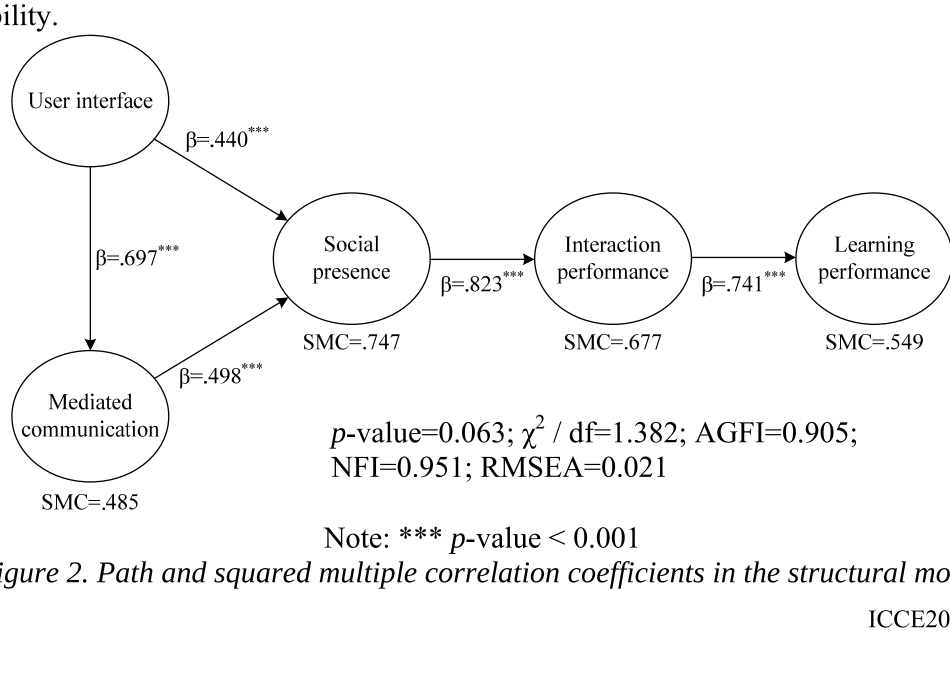
Three institutions, Sansin School of the Future, the Department of Information and Learning Technology of National University of Tainan, and the Department of Information Management of National Sun Yat-sen University, in Taiwan were chosen to participate in this study. These three institutions have been offering online learning courses for several years with good reputations.

An instrument with reliability and validity was developed for measuring the constructs. An initial questionnaire was developed to measure the constructs based on the operational definitions and was then evaluated by 10 domain experts in two rounds in order to establish content validity. After items had been carefully revised based on the domain experts' suggestions, the questionnaire was used in the pilot study to collect demographic information with a nominal scale (7 items) and to measure the degree of learners' perception (44 items) with a five-point Likert-type scale ranging from strongly disagree (1 point) to strongly agree (5 points).

The formal study was carried out with a paper-based questionnaire in one of the participants' classes. The total number of the participants who participated in the formal study was 627. Because 92 learners did not complete the questionnaire, the valid samples remained as 535 (85.53%). The number of females (50.65%) was found slightly more than males (49.35%). In terms of experience of online learning, the highest percentage (46.17%) was of those who took just one online course, followed by those who took two online courses (20.75%) and at least five online courses (20.37). The results show that there were more than 50% of the participants who took at least two online courses. There were 174 participants (32.52%) who had the experience of online synchronous learning with audio and video devices.

2. Results

Structural equation modeling (SEM) was the major method used for data analysis. The reliability of second-order constructs was assessed by composite reliability. The composite reliability must be above .70 for each construct, then, it can be considered as an acceptable internal consistency [8]. All the composite reliability coefficients are ranging from .842 to .907. The results indicate that the second-order constructs has a good composite reliability.



Note: *** p-value < 0.001

Figure 2. Path and squared multiple correlation coefficients in the structural model

Both convergence and discriminability were also examined for second-order constructs. All the factor loadings were higher than the criterion of .70. Moreover, the AVEs of all constructs exceeded the recommended level of .50 ranging from .727 to .817. The results indicate that the second-order constructs has good convergent validity. Discriminant validity was also assessed by the AVE method. The diagonal element for a given construct is larger than any of the correlation coefficients in the same column or row. The results indicate that the second-order constructs has good discriminant validity.

Path coefficients were estimated by maximum likelihood as shown in Figure 2. It can be seen that every path coefficient reaches the significance level of .001. The results show that the proposed framework is suitable to demonstrate the role of social presence and its relationships with related constructs in an online classroom. All hypotheses were supported.

3. Discussion

From the psychological viewpoint, this study provided evidence that social presence can be composed of co-presence, intimacy, and immediacy with adequate reliability and validity examined by SEM. It is a contribution to further research that the questionnaire developed by this study can be directly adopted to measure the perceived social presence in online learning. In an online classroom, learning technologies are necessary to support interaction and learning behaviors. When a learning environment has a friendly user interface and rich media, learners can easily share social cues with each other. Verbal and non-verbal cues are very important resources for perceived social presence. In a physical face-to-face learning environment, learners can receive immediate feedback from interactive people. Actually, both synchronous and asynchronous communications have been recognized as important factors affecting interpersonal communication [6]. In online classrooms, what communication functions should be adopted for learning activities actually depend on learners' demands. When further research attempts to explore the role of social presence in online learning, the factors of user interface and mediated communication should be considered as important predictors.

From the viewpoint of social cognitive theory, learner interaction in an online classroom can encourage deep learning processes. Social interaction helps learners to develop social relationships with a supportive atmosphere. Learning interaction is directly related to the learning processes, contents, and tasks. This study provided evidence that social presence has a high positive impact on interaction performance and learning performance with total effects of .823 and .610 respectively. It indicates that social presence is an important factor in online learning. Besides, interaction performance has a high effect of .741 on learning performance. The results conform to the findings of past studies that learner interaction is a critical factor for learning performance [4]. The relationships among proposed factors in the research framework were examined by rigorous statistical methods. Therefore, this study can be regarded as an important reference for further research.

It is important that online learners become familiar with the online learning environment in the initial learning sessions [3]. Instructors can encourage learners to prepare the equipments, such as headsets, webcams, keyboards, and mice, for transmitting social cues before an online course starts and guide them how to set up and use these equipments. Of course, instructors have to introduce the functions of an online classroom and make learners familiar with these functions. When learners understand how to use the functions, they would feel that the system is easy to use and very friendly. If the learners have ability to handle the equipments and functions to transmit cues, it will be helpful in increasing the social presence.

4. Conclusion

Summing up the prior studies about social presence, the factors affecting social presence can be sorted by human side and media side. This study reviewed the literature to find the factors which may influence social presence. These independent constructs include user friendly, media richness, timely response, and social cue. They were classified into two second-order constructs, user interface and mediated communication, to emphasize the salient features of the constructs. Social presence can be composed of three subjective perception, co-presence, intimacy, and immediacy. Both social interaction and learning interaction were employed to provide evidence regarding the importance of social presence in online learning. These two kinds of interaction have positive impact on learning performance which includes two first-order constructs, learner satisfaction and goal achievement. Social presence has positive influences on interaction performance.

In order to enhance the degree of generalization in the research results, researchers can collaborate with other institutions which engage in online learning to enlarge sample size and increase the variety of samples. Moreover, the time and frequency factors could also be considered as important factors. Researchers can carefully design an experiment to find out the variation of the perceived social presence of learners in various phases.

Acknowledgements

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References

[1] Bandura, A. (1977). *Social learning theory*. New York: General Learning Press.
[2] Biocca, F., Harms, C., & Burgoon, J. K. (2003). Toward a more robust theory and measure of social presence: Review and suggested criteria. *Presence: Teleoperators & Virtual Environments, 12*(5), 456-480.
[3] Chen, N. S., Kinshuk, Wei, C. W., & Yang, S. J. H. (2008). Designing a self-contained group area network for ubiquitous learning. *Educational Technology & Society, 11*(2), 16-26.
[4] Chen, N. S., Wei, C. W., Wu, K. T., & Uden, L. (2009). Effects of high level prompts and peer assessment on online learners' reflection levels. *Computers & Education, 52*(2), 283-291.
[5] Chou, C. E., Peng, H. Y., Chang, C. Y. (2010). The technical framework of interactive functions for course-management systems: Students' perceptions, uses, and evaluations. *Computers & Education, 55*(3), 1004-1017.
[6] Dennis, A. R., Fuller, R. M., & Valacich, J. S. (2008). Media, tasks, and communication processes: A theory of media synchronicity. *Mis Quarterly, 32*(3), 575-600.
[7] Garrison, D. R., Cleveland-Innes, M., & Fung, T. S. (2010). Exploring causal relationships among teaching, cognitive and social presence: Student perceptions of the community of inquiry framework. *Internet and Higher Education, 13*(1-2), 31-36.
[8] Hair, J. F., Black, W. C., Babin, B., Anderson, R., & Tatham, R. (2006). *Multivariate data analysis* (6 ed.). Upper Saddle River, NJ: Prentice Hall.
[9] Ke, F. F. (2010). Examining online teaching, cognitive, and social presence for adult students. *Computers & Education, 55*(2), 808-820.
[10] Offir, B., Lev, Y., & Bezalel, R. (2008). Surface and deep learning processes in distance education: Synchronous versus asynchronous systems. *Computers & Education, 51*(3), 1172-1183.
[11] Short, J., Williams, E., & Christie, B. (1976). *The social psychology of telecommunications*. London: John Wiley & Sons.
[12] Uden, L., Chen, N. S., Wei, C. W., & Fan, J. C. (2009). Online synchronous English learning from activity theory perspectives. *International Journal of Information Communication Technologies and Human Development, 1*(3), 1-25.

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The Effects of Scaffolding-Based Courseware for The Scratch Programming Learning on Student Problem Solving Skill

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Abstract: Programming learning is of use for the improvement of complicated problem-solving skills that modern society calls for. Yet it puts heavy strain on learners, and the careful selection of a good program tool and the improvement of learning methods are required to relieve learners of the burden. Scratch is an educational programming language that has an affluent multimedia programming setting and is easy and interesting to learn. So that is appropriate for programming beginners, and the use of a scaffolding-based courseware has a superb effect on the development of problem-solving skills in association with programming that is difficult to do. The purpose of this study was to develop a scaffolding- based courseware geared toward facilitating scratch programming learning and to examine the effects of it on problem-solving skills. As a result of utilizing a scaffolding-based courseware developed in this study, that turned out to have a significant effect on boosting the problem-solving skills of the learners who learned by using the courseware.

Keywords: Scaffolding, Scratch, Courseware, Problem Solving, Programming

Introduction

What matters in knowledge-based society is converting information into internalized knowledge, applying the knowledge to problem situations and solving the given problems. Problem-solving skills could be said to refer to solving new problems and learning new knowledge by applying existing knowledge. Indeed, problem-solving skills are one of primary mechanisms that affect the way of thinking, work and even life styles. A wide variety of studies are under way in various academic communities such as psychology, computer science and education to enhance problem-solving skills[3][4]. In cognitive science and intelligence theories, the skills are discussed from a theoretical and general perspective, and industries and the education sector put stress on more practical, down-to-earth problem-solving skills. Engineering researchers and educators view contextuality or contextual complexity as one of the primary conditions for the enhancement of problem-solving skills and provide opportunities for learners to go through situations similar to reality to bolster their problem-solving skills[7].
A computer programming process is a process of modeling or automating an abstract thinking process through computing equipment in pursuit of problem solving, and the experience of the computer programming process could lead to more reinforced abstract thinking[2][1]. That is, the programming process requires automation skills to automate abstract skills or abstract concepts to choose and organize the best abstract concepts for the purpose of problem solving[5]. Such a cognitive ability is different from problem-solving or reasoning skills stressed in other academic fields in that the former could provide the best solution by producing strategic knowledge applicable to general problem-solving situations and by creating and automating a problem-solving process through computing equipment[2]. Accordingly, the development of authentic and complex problem-solving

skills needs programming education, and research efforts should be put into selecting efficient teaching-learning tools, what to teach and the best teaching-learning methods to ensure successful programming education.

Scratch is one of teaching-learning tools that can back up programming education successfully and has a lot of benefits. That is an educational programming language jointly developed by the U.S. MIT Media Lab and UCLA researchers, and that is a graphic building-block programming language that piles up blocks whose commands are all different according to color and form on objects called sprites and programs the sprites. Learners and teachers take a dim view of existing programming education that is very time-consuming, and that educational programming language is easier to understand and learn irrespective of age and can make intuitive programming possible. Furthermore, that gives support to various kinds of multimedia and different languages. Thus, the programming language is very splendid and has a lot of benefits.

Scaffolding refers to providing temporary help for learners to learn successfully in teaching-learning process, which was introduced by Wood, et. al., who tried to apply Vygotsky's theory as one of the major elements of individualized teaching. Scaffolding denotes what more competent peers, teachers or parents give an appropriate introduction or help to learners and consequently serve as a scaffold to step up their cognitive development. In other words, that is a backup system that serves to boost the task performance or cognitive process of learners by offering visual clues, modeling or feedback without altering the given task itself and lets them determine for themselves how much help they need to perform the task on their own based on the degree of task performance.

This study intended to find out the impact of a scaffolding-based courseware on scratch programming learning by investigating whether there would be any gaps in problem-solving skills between one group that utilized the scaffolding-based courseware and the other that didn't.

1. Background

Understanding of Scratch and The Meaning of Scaffolding

Scratch is an educational language that was developed by the Lifelong Kindergarten Research Team of MIT Media Lab. That is object-oriented and based on visual graphic under the influence of Logo, SmallTalk, HyperCard, StarLogo, AgentSheets, Etoys and Tweak.

Scaffolding was introduced by Wood, Brunner and Ross[6] who tried to identify the major components of effective individualized teaching by applying Vygotsky's zone of proximal development theory. They defined it as help that adults or experts provide for children or beginners to solve the given problems, perform the given tasks and achieve their goal on their own..

2. Method

Hypothesis

The following hypothesis was formulated:

A scaffolding-based courseware designed to facilitate scratch programming learning might have an impact on problem-solving skills.

Subject

The subjects in this study were 60 students who were in their sixth grade in an elementary school located in Gangwon Province, Korea. An experimental group and a control group were made up of 30 students respectively.

Instrumentation

The scaffolding-based courseware used in this study was designed to be implemented in eight sessions. And we teach 4 weeks(2 hours per week).

The Structure of the courseware

Table 1. The Structure of the Courseware

Period	Theme
1	Deal with motion blocks
2	Deal with observational blocks
3	Deal with variable blocks
4	Deal with operation blocks
5	Deal with control blocks
6	Deal with blocks of form
7	Deal with sound blocks
8	Deal with pen blocks

Two Learning Modes of the Courseware

There are two different modes in which students can study with this courseware. One is a demonstration/repetition mode, and the other mode is doing alone. Appropriate scaffolding is provided while students study with the courseware.

Demonstration / Repetition

In this mode, the computer gives a demonstration on how to do, and then learners do the same. An error message is given whenever they make any programming mistake, and they are helped to do it again.

The Characteristics of Scaffolding

In this mode, learners perform the given task for themselves. If they make a programming error, a cue is provided(scaffolding) to help them do it again.

Evaluation Instrumentation

We use the PISA 2003 problem-solving items that were modified to be appropriate at school children's level.

Research Design and Procedure

The experimental design and procedure of the study are as below:

Table 2. The experimental design and procedure of the study

Group	Pretest	Experiment	Posttest
The Experimental Group	O1	X1	O2
The Control Group	O3	X2	O4

A pretest was conducted to evaluate the problem-solving skills of the two groups to see whether they were equivalent or not. And then the experimental group took lessons by applying the scaffolding-based courseware, and the control group took typical lessons. The experiment was implemented during a four-week period of time, and they were given tasks immediately after the experiment to find out the effects of the experiment.

3. Result

Pretest Result

A independent-samples t-test was carried out before the experiment, and there were no significant intergroup gaps at the .05 level of significance($p>.05$). So the two groups were considered to be equivalent in terms of problem-solving skills.

Table 3. Pretest Result

Classification	N	M	SD	DF	t	p
The Experimental Group	30	9.546	3.50	65	-.667	-.507
The Control Group	30	10.088	3.16			

Posttest Result

A posttest was conducted after the experiment, and the collective average of the experimental group was larger than that of the control group. As for the intergroup gaps in mean scores, the value of t was 2.375, and the probability of significance was .021, which showed that there was a significant difference between the two in problem-solving skills in the .05 level of significance. So the scaffolding-based courseware applied to the experimental group exerted a great influence on the improvement of problem-solving skills.

Table 4. Posttest Result

Classification	N	M	SD	DF	t	p
The Experimental Group	30	13.3636	3.55	65	2.375	.021
The Control Group	30	11.5	2.84			

The Result of Pretest and Posttest in Each Group

A paired-samples t-test was carried out to find out the pretest and posttest scores of each group. As seen on the table, the pretest scores of the experimental group were significantly different from the posttest scores of that group at the .05 level of significance, and the probability of significance was .000. It indicated that the students who studied with the scaffolding-based courseware made progress in problem-solving skills.
When the pretest and posttest scores of the control group were compared, there was a significant gap at the .05 level of significance, and the probability of significance was .001. So the students who studied in the typical way showed improvement in problem-solving skills as well.

Table 5. The Result of Pretest and Posttest in Each Group

Group		Pretest-Posttest				
		M	SD	DF	t	p
The Experimental Group	Pretest	9.5455	3.55	32	4.264	.000
	Posttest	13.3636	3.5			
The Control Group	Pretest	10.0882	3.16	33	3.783	.001
	Posttest	11.5	2.84			

Conclusion

The objects of programming education that aims at improving problem-solving skills are not only to acquire the use of the programming tool itself but to gain actual experiences in problem solving through the programming process. The programming process that designs a problem-solving process and configures it as a computer program is a complicated problem-solving process itself, in which learners are able to integrate a variety of knowledge and knowhow and acquire strategic knowledge to flexibly cope with problem situations. Yet the problem is that programming is difficult and time-consuming to learn. Therefore it's needed to show how to approach programming education easily, and one of the best ways is the use of scratch and the supply of scaffolding.

The findings of the study were as follows:

First, programming learning turned out to be effective. Both of the experimental and control groups showed a significant improvement in problem-solving skills, and it could be interpreted that programming learning has a positive impact on problem-solving skills irrespective of teaching methods.

Second, the scaffolding-based software turned out to be effective. Both of the experimental and control groups used the scratch when they engaged in programming learning, but the experimental group that was provided with scaffolding made a better significant progress in that regard.

References

[1] Eunkyung, Lee. Youngjun, Lee. (2008). The Effects of Programming Ability and Immersion Level for Middle School Student on Programming Education using The Scratch, The Middle School Education Research. 56(2). pp. 359-382.

[2] Eunkyung, Lee. (2009). Robot Programming Teaching and Learning Model to Enhance Computational Thinking Ability. Doctoral Thesis. Korea National University of Education.

[3] Jitgarun, K. (2002). The Development of Computer-Based Simulation Laboratory for e-Learning : A case Study of Non-Electrical Engineering Background at KMUTT in Thaillad. World Conference on E-Learning in Corp., Govt., Health., & Higher Ed. 2002(1), pp. 1669-1672

[4] Najjar, L. J. (1996). Multimediainformation and Learning. Journal of Educational Multimedia and Hypermedia, g, pp. 129-150

[5] Wing, J. M. (2006). Computational Thinking. Communications of the ACM, 49(3), 33-35.

[6] Wood, D., Bruner, J. S. & Ross, G. (1976), The role of tutoring in problem solving. Journal of Child Psychiatry and Psychology, 17(2), 89-100.

[7] Youngmin, Lee. (2005). The Effects of Simulation Delivery Instruction on Students's Problem Solvng Performance and Motivation. KACE. 8(5), pp. 43-50.

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Computer Ethics Education based on ARCS Strategy for Students with Mild Intellectual Disabilities

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Abstract: Because of dysfunction of information-oriented society such as hacking, cyber violence, Internet addiction, and online game addiction, Korean Government is emphasizing computer ethics education for students. However, students with mild intellectual disabilities in integration education have difficulties at understanding and learning due to their cognitive abilities. So, It is necessary to special computer ethics education considering their characteristics. For successful computer ethics education to students with mild intellectual disabilities, students' motivation is needed. Therefore, the purpose of this paper is to develop the instructional strategy using Keller's 10 steps in ARCS motivational design process.

Keywords: Computer Ethic, Intellectual disabilities, ARCS model

Introduction

Students with intellectual disabilities have low mental age than general students but, along with increase of chronological age, they have same emotions and needs like general students [1]. Thus they are using Internet that is concern of friends even if it is hard something to use computer perfectly. In this process, the wrong actions, such as abuses on the internet board and online game addiction are often generated and to control the time of a using computer is very difficult. So, parent and teachers raise the necessity of computer ethics education.
However, students with intellectual disabilities have difficulties at understanding and learning because of their general characteristics from low intelligence. Also they have difficulties to motivate and maintain. Therefore, we have to consider their low abilities and try to make strategies that can motivate the education constantly and interest them in the education from the first time. If we do so, we will be able to educate computer ethics for them effectively.
In this paper, we are using ARCS strategies for computer ethics education for students with intellectual disabilities.

1. Literature Review

1.1 ARCS Model

Keller [2] argued that there was a close link between the effect of instruction and learner motivation. He claimed that it's needed to take a systematic and specific approach toward learning motivation to maximize the effect of instruction, and he presented an ARCS model that involved four factors (Table 1).

Table 1: ARCS Model Categories, Definitions

Attention	Capturing the interest of learners; stimulating the curiosity to learn
Relevance	Meeting the personal needs/goals of the learner to effect a positive attitude
Confidence	Helping the learners believe/feel that they will succeed and control their success
Satisfaction	Reinforcing accomplishment with rewards(internal and external)

Each of the four categories also has subcategories based on the major motivational variables subsumed by the categories. The subcategories are useful in diagnosing learners' motivational profiles and in creating motivational tactics that are appropriate for the specific problems that are identified.

1.2 Motivation of Students with intellectual disabilities and Possibility of ARCS Model

Switzky [3] mentions that the attitude or motivation affects the detective reason of the result of education more than the physical flaw or intelligent lethargy affects. Moreover, Zigler [4] emphasizes that whether proper and successful motivation in the process of teaching can generate the most important reason why two groups, such as general students and students with intellectual disabilities, have gaps between them. Moreover, he mentions that the basic condition for the students who actually are possible to have education is motivation. Therefore, we need the educational strategy in the class for them that we choose the subject that they realize they can experience not failure but success with a little bit of their effort.
After all, in terms of computer ethics education for them, the main idea is that we have to lead educational motivation so that the learners themselves can understand the seriousness of problem and organize internet culture and its values.

1.3 Computer ethics(CE)

The CE can be defined as a yardstick that can be used to handle ethical issues in information-oriented societies; It defines the basic moral standards-right and wrong, good and evil, and moral and immoral-to attain the most desirable behavior while living in and information-oriented society as well as handling computer and communication devices [5]. The scope and contents of the computer ethics education is classified into four categories. These are the fundamental principles we need to consider when making ethical decisions in an abstract and complex information society [6].

Table 2: Four basic principles of the CE and the corresponding technical definitions

Principles	Fundamental concept
Moderation	Considering current situation, properly control one's behavior based on the decision criteria – what's right and wrong, and what's good and bad.
Respect	Value and admire others as well as oneself; regard others as human beings with dignity by caring for their identity and cherishing their self-esteem.
Responsibility	Predict the outcome of one's behavior onto others and be liable for possible loss and/or sanctions from it.
Participation	As an independent information user, offer help to others while abiding by the responsibility and eager participation. Also create / present valuable information and vigorously contribute to various cyber activities.

Moderation indicates controlling something to an appropriate level. For example, it's about managing the degree of addiction to online gaming, chatting, shopping, and obscene and aggressive media. Also, one can specifically set up his / her own rules in the usage of the Internet and try to stick to them.
Respect has two aspects, self-respect and respect for others. Overly immersing oneself into the Internet and thereby failing to care for one's health is violating the self-respect. Also, admitting other's privacy, thoughts, and identity is an example of the latter. In other words, respect is to treat yourself and others as the same and precious human being.
Responsibility is to carefully consider one's role as both information provider and user before taking any action. For example, should someone suffer from or experience loss as a result of one's behavior, one should take all the blame for that and also need to offer corresponding reward / apology.
Participation is to contribute to various cyber activities in a positive and energetic manner such as producing useful information, earnestly answering questions from others, complimenting others for their good works, etc.

2. Methodology

2.1 Computer Ethics Education using ARCS Model

We used Keller's 10 steps in ARCS motivational design processs [2] as shown Table 3 for instructional design in order to consider the characteristics of students with intellectual disabilities.

Table 3: Steps in the ARCS Motivational Design Process

	Steps
Define	1. Obtain course information
	2. Obtain audience information
	3. Analyze audience motivation
	4. Analyze existing materials and conditions
Design	5. List objectives and assessments
	6. List potential tactics
	7. Select and design tactics
	8. Integrate with instruction
Develop	9. Select and develop materials
Pilot	10. Evaluate and revise

Step 1. Obtain course Information : The selection and development of motivational tactics that are appropriate for a given course depend on many factors that include, but are not limited to, characteristics of the learners and their goals. To ensure that the tactics are appropriate for the situation, it is necessary to collect background information about the course that is to be offered and about the audience.
Step 2. Obtain audience information : The information in this step, together with the preceding one, provides the foundation for the audience analysis to be conducted in Step 3. This step focuses on several factors that have a strong bearing on the initial motivation of students and how they are likely to respond to the content and instructional strategies of the course.

Step 3. Analyze Audience : The purpose of this step is to estimate what the motivational profile is for the whole class or for selected subgroups or individuals in the class. One of the challenges in solving motivational problems is that the initial motivation of the learners can be too high as well as too low. By analyzing the audience to determine specifically what types of motivational problems exist, it is possible to select tactics that solve these specific problems.
Step 4. Analyze existing materials and conditions : The purpose of this step is for you to analyze your current instructional material, which could be a unit, a module, an entire course, or whatever segment of instruction you with to motivationally enhance, to identify their motivational strengths and deficiencies.
Step 5. List objectives and assessments : In this step, we write motivational design objectives and assessments. In objectives, describe the motivational behaviors that you wish to observe in the learners.
Step 6. List potential tactics : This step is a preliminary selection phase in which you prepare a list of possible motivational tactics, or solutions, that pertain to the specific objectives and to the general situation as described in the worksheets for Steps1 through 5.
Through such 6 stpes process, we chose final strategy.

3. Results

Proper motivation is the most important to increase educational effect when teaching computer ethics education to students with mild intellectual disabilities. Therefore, we have developed instructional strategy using Keller's 10 steps in ARCS motivational design process. “Select and design tactics” as final strategy in step 7 are as follows Table 4.
The next step is to integrate motivational tactics into the instructional lesson plan. After this process, we can expect to modify some of tactics so they are smoothly combined with the learning activities.

Table 4: Worksheet 7 Final Design: Computer Ethics Education

Computer Ethics Education: Worksheet 7:

Final Design

Throughout

- Provide learning contents in various ways. (A)
- Exchange glances with students and observe their facial expressions. (C, S)
- Compliment that gives positive influence on self-respect when students achieved assignment successfully. (C, S)
- Sympathize with even if students say wrong answer and encourage closer to answer. (C, S)
- Use individual language to feel in talking personally. (R, S)

Beginning

- Use examples from everyday life, like news articles. (A, R)
- Inform students of what they can do after this instruction. (R, C, S)
- Explain the importance of learning content to students. (R)
- Show examples of previous instruction. (C, S)
- Supplement if students misunderstand. (C)
- Tell with positive and ardent words that students are able to achieve the objectives of lesson. (C, S)
- Offer positive words and behaviors when students try to settle problems. (C, S)

- Tell students several times gently about subjects discuss in the lesson that it is not difficult. (C)

During

- Provide opportunities to query about learning contents. (A, R, C)
- Offer problems about real life issues and provide challenges as per individual ability. (R, C, S)
- Cause the spirit of inquiry through concrete problems. (A, R)
- Compliment for giving positive influence on self-respect if students achieved assignment successfully. (C, S)
- Provide consistent feedback about satisfactory response of students. (C, S)
- Provide opportunities to set learning goal according to individual ability of students. (C, S)

End

- Have some kind of presentation and special event, such as a "fair" to allow students to demonstrate their work and see what the others have done. Make it fun, not evaluative or competitive. (S)
- Provide a summary of objectives the learner accomplished during the training course. (C, S)
- Provide positive feedback for course completion. (S)

Later, this study will be applied to students with intellectual disabilities in the special class of high school, and will verify the result with statistical verification and observation of actual action.

References

[1] Taylor, R. L., Richards, S. B. & Bready, M. P. (2009). Mental Retardation : Historical Perspectives, Current Practices, and Future Directions. Pearson Education, Inc.

[2] Keller, J. M. (2009). Motivational design for learning and performance: The arcs model approach. NY: Springer.

[3] Switzky, H. (1997). Mental retardation and the neglected construct of motivation. Education and Training in Mental Retardation, 32, 194-196

[4] Zigler, E. (1999). The Individual with mental retardation as a whole person. In E. Zigler & D. Bennett-Gates (Eds.), *Personality development in individuals with mental retardation* (pp. 1-16). Cambridge, UK: Cambridge University Press.

[5] KERIS (2000). A Guidebook for teaching Information Communication Ethics. Seoul : Korea Education and Research Information Service (KERIS). CR 2000-2.

[6] Cho, S.H. & Kim, S.S. (2008). The Delphi Analysis to measure the Information Communication Ethics Consciousness Level of young people. Korea Association of Information Education (KAIE) 12(4), 449-457

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Recognition and Interaction Analysis of IIBS aided Distance Computing Teaching-Learning Model

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Abstract: Recently, IIBS(Individual Internet Broadcasting System) service has become a new instruction medium and it also can do Distance Education. Here, IIBS aided Distance Teaching-Learning can provide active real-time participation of teacher and student in class. Students have very strong motivation and it helps students have very powerful interaction with teacher, experts group and parents. In Korea, IIBS-aided education has been studied and that model can help teaching-learning to be more progressive and friendlier than traditional education. However, we need to examine the recognition and the interaction on the educational use of the IIBS aided Distance Computer Teaching-Learning in distance education. Therefore, we surveyed about the recognition and the interaction of that model between teachers and students in class. In this study, we could find that they have a positive perception of the use of the IIBS aided Distance Computer Teaching-Learning Model in class. Also, we identified what functionalities are required for the educational use of the IIBS aided Distance Computer Teaching-Learning Model in Korea.

Keywords: Distance Education, IIBS, Instruction

Introduction

With increasing Video Streaming Technology and use of high speed broadband, there is new thing to consider about. IIBS(Individual Internet Broadcasting System) is a new broadcast medium that designed for Web-Broadcasting. Those IIBS Technology aided Distance Computing Teaching-Learning model leading to a change in the educational environment, due to the advent of internet(broadband speed-up and the development of streaming technology), is becoming a new educational medium that is suitable for the future Distance Teaching-learning environment in Korea.

The IIBS Distance Computing Teaching-Learning Model provides educational services that meet the learner's requests(including secret questions, students use a whispering function of IIBS chatting program), anytime in class. Two results of related studies(ByoungChan Gwak, YuongJun Lee in 2008) have shown that IIBS-aided Computing education is effective in enhancing learners' motivation and academic achievement. [1][2]

Purpose and Methods

The purpose of this study is to examine learner's perception of the educational use of IIBS aided Distance Computing Teaching-Learning Model in class and to suggest proper functionalities as a new distance educational medium in regular class. To achieve these objectives, we surveyed the recognition and also checked interactions of related teacher to students and student to students of the educational use of IIBS aided Distance Computing Teaching-Learning Model

Background

First, ARCS theory of Keller(1984). The ARCS model is a problem solving approach to designing the motivational aspects of learning environments to stimulate and sustain students' motivation to learn. IIBS learning environment as a new medium surly can provide strong motivation to students and appropriate for them.[3]
Second, Teacher' and Student' Activities can save at AVI file and Text file in IIBS. It shows that students learn more effectively when they develop artifacts of the Class, concerned PBL theory. Students ask the question each other and teacher and then it makes the teacher use drawings, web site, computer-programs and so on. It supports students in developing understanding associated with the learning goal of the lesson. [4]
Third, this model is not saved VOD class but REAL-TIME class Activity. It means that students, teachers, and community members(parent group, expert group and so on) engage in collaborative activities to solve the problem and these activities are in Social-Interaction in learning(Social interactions based on PBL theory). The best learning results form a particular kind of social interaction: when teachers, students, and community members work together. It means IIBS aided real-time instruction support a powerful interaction.[4]

Participants and Methods

We surveyed university students using IIBS aided Distance Computing Teaching-Learning Model at KNUE(Korea National University of Education).
First, a total of 31 students of two classes in 2009-2010 year answered questions. The teacher checked the reactions of interaction quantity and interaction type(both teacher to student and student to student , those also have two kind of special feature(open interactions, whispering interactions)) at first semester 'Instruction method using Computer' class in 2009-2010 year.
Second, data from the answers and reactions were analyzed regarding the recognition and interaction for IIBS aided Distance Computing Teaching-Learning Model functionalities through percentage analysis.
Third, describes the impact on educational achievement and motivation in learning of IIBS aided Distance Computing Teaching-Learning Model.

IIBS Distance Computing Teaching-Learning Model

IIBS Computing Distance Teaching-Learning Model normally consists of a teacher, students, a microphone, educational website, each educational computers connected internet network and IIBS server/client software. The next Figure 1 express IIBS Distance Computing Teaching-Learning Model and it shows the construction of online lessons. And also the IIBS Software has chatting and whispering functions.

a. Teacher broadcast today's lesson using IIBS sever-program and students join that channel. Teacher and student can talk each other and check attendance.
b. Students prepare today's lesson and concentrate teacher's lecture.
c. Student can do Additional Activities(after school activities) on Educational WBI site)
d. The lecture can save as AVI file and students show that on WBI web site after school.
e. Experts group or parents group can join this class and help the lesson.(option)
f. IIBS Distance model consists of IIBS-Server/Client Software and do not demand special hardware equipments and additional budget than traditional Distance-Model. It means if someone want to use that model in one's class, it is very easy.

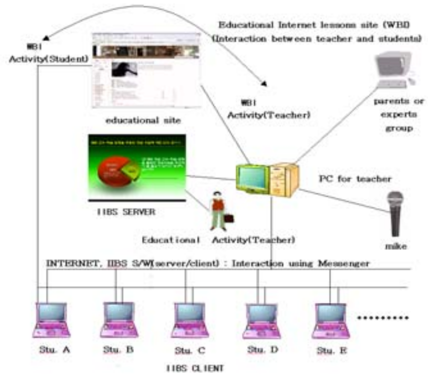

Figure 1: IIBS Distance Computing Teaching-Learning Model

Survey Questions

The questionnaire was divided into three Questions. The first question was to investigate 'Is necessary the IIBS Distance Computing Teaching-Learning Model in class?' and next we surveyed opinions about whatever IIBS-aided Distance Computing Teaching-Learning Model is suitable for computer lessons. The last was 'How often IIBS-aided Distance Computing Teaching-Learning Model teach? (x weeks / 15 weeks, x = student's opinion)'

Table 1: Needs Question in the Survey about IIBS Computing Teaching-Learning Model

Survey Questions 1		Answer	
Perceptions and Needs	Do you think that the IIBS Distance Computing Teaching-Learning Model can perform effectively?(Is necessary The IIBS Computing Teaching-Learning Model in class?)	Yes (54.84%) *R : 17*	No (25.81%) *R : 8*

R: the number of Response Students. (6 students say 'I do not know well') Total 31 Students.

This result showed that students agree with using the IIBS Distance Computing Teaching-Learning Model in class.(54.84%) On the other hands, 25.81% of students have a negative perception about using IIBS Distance Model in class. The reasons is that 12 students say 'yes' because it was so interesting and exciting, 3 students say 'yes' because I do not go to classroom and also it has very friendly atmosphere. In case of 'No', 5 students say 'The broadband sometimes has a bad buffering and so he cannot listen to teacher's lecture. 3 students say because the place is not classroom, so do not concentrate the lecture.

Table 2: Recognition Question in the Survey about IIBS DCTL Model
(DCTL : Distance Computing Teaching-Learning)

Survey Questions 2		Answer			
Perceptions and Needs	Do you think that the IIBS-aided Distance Computing Teaching-Learning Model is suitable for computer lessons?	Very Suitable (16.13%) *R : 5*	Suitable (38.71%) *R : 12*	Normal (9.67%) *R : 3*	No (35.48%) *R : 11*

R: the number of Response Students. Total 31 students.

This result showed that most students agree with using IIBS Distance Computing Teaching-Learning Model in class (54.84%, plus very Suitable 16.13% and Suitable 38.71% at table 2). In this case, we can see that students have the positive perceptions about IIBS-aided Distance Computing Teaching-Learning Model in computing lessons.

Table 3: Question about 'How often IIBS-aided DCTL Model teach?'

Survey Questions 3		Answer (x weeks/15weeks)						
Perceptions and Needs	How often IIBS-aided Distance Computing Teaching-Learning Model teach?	1W (0%) *R:0*	2W (6.45%) *R:2*	3W (16.13%) *R:5*	4W (3.23%) *R:1*	5W (54.84%) *R:17*	More than 5W (16.13%) *R:5*	Not necessary (3.23%) *R:1*

R: the number of Response Students
W: weeks, x = student's opinion Total 31 Students.

This result showed that most student think '5weeks/15weeks' is suitable for IIBS aided Distance Computing Teaching-Learning Model and this means that students consider that the IIBS Distance model have educational effect(learner's good recognition and interaction concerning the educational use of IIBS in class) and the model support educational practices.

Interaction Activities check Table

Table 4 explains educational interaction of CIM education class at the first semester 4-7 weeks at KNUE in 2009 and 2010 year.
At the 4-5 weeks, we did not use IIBS Distance Model and at the 6-7 weeks apply the IIBS Distance Computing Teaching-Learning Model. Now you can see the total interactions for 4 weeks. At table 4, the traditional class in 2009 year, the numbers of interactions are Teacher 7(4+3), Student 4(2+2). In 2010 year, the numbers of interactions are 11(5+6), Student 4(3+1). Therefore, total interactions of traditional instructions are 26.
By the way, at table 4 the numbers of total Interactions of IIBS aided Distance Instructions are 130. These results prove the effectiveness of Interactions of IIBS aided Distance Model. And also the table explains for improving interactions between teacher and student (Here, we except lots of non-educational questions).
In all lessons using IIBS-Distance model, students said that it was very interesting and free so I assert that is the reason to improve the Interaction.

Table 4: Interaction of CIM class at the first semester in 2009-2010
(CIM : Computing Instruction Method)

	Interaction of CIM class at the first semester in 2009 and 2010			
	CIM class in 2009		**CIM class in 2010**	
4h week	Traditional Instruction		Traditional Instruction	
	Teacher	Student	Teacher	Student
	4/impossible	2	5/impossible	3
5th week	Traditional Instruction		Traditional Instruction	

	Teacher	Student	Teacher	Student
	3/impossible	2	6/impossible	1
6th week	IIBS aided Distance Instruction		IIBS aided Distance Instruction	
	Teacher	Student	Teacher	Student
	11 / 7	9	8 / 11	18
7th week	IIBS aided Distance Instruction		IIBS aided Distance Instruction	
	Teacher	Student	Teacher	Student
	9 / 11	11	7 / 21	7

* Teacher : Interaction with Student to Teacher.
* Student : Interaction with Student to Student.
* x / y : open chatting Question(normal question) / whispering Question.

Acknowledgements

To suggest optimal functionalities of the IIBS Distance Model, we surveyed what is students' recognition and reactions of functionalities to support educational practices in regular class. Also, we investigated interactions of between teacher and student, students' activities throughout class. Finally, we identified that student have a positive perception about the use of IIBS aided Distance Computing Teaching-Learning Model, and also it is more effective to improve interaction in class than traditional education method.

And also the result showed that the interaction between teacher and students improved that used IIBS Distance Computing Teaching-Learning Model than traditional instruction model in class. The Needs for Educational Functionalities of IIBS aided Distance Teaching-Learning model will be stronger and bigger.

However, there are two things to worry about this Instrument-Model. Those are the speed of broadband and the stability of network connection. If those thins do not warrant, this model will not progress.

We believe that the results of this study can be helpful in developing the optimal functionalities of the IIBS-aided distance education and maximizing its usability and educational effectiveness in schools. In the future, all of us maybe perform IIBS-aided distance education in regular class and closely analyze the reactions and the satisfaction levels of IIBS-aided distance education.

References

[1] ByoungChan Gwak & YoungJun Lee(2008). *Informatics Teaching-Learning Model using Individual Internet Broadcasting System*. KNUE in Korea: Korean Association of Computer Education Press

[2] ByoungChan Gwak & YoungJun Lee(2008). *Leaner's Recognition Analysis one Study Using IIBS Computer Instruction-Learning Model*. KNUE in Korea: Korean Association of Computer Education Press.

[3] Keller, J. M (1984). The use of the ARCS model of motivation in teacher training. In K. Shaw & A. J. Trott (Eds.), *Aspects of Educational Technology Volume XVII: staff Development and Career Updating*. London: Kogan Page.

[4] Joseph S. Krajcik and Phyllis C. Blumenfeld. *Project-based Learning*. The Cambridge Handbook of The Learning Sciences, chapter 19, page 319, 327.

[5] Markus(M.Lynne). *Toward a critical Mass, Theory of Interactive Media: universal Access, Interdependance and Diffusion.* Communication Research, Vol.No.5, Oct.1987.

[6] Jinhyun Tak, Sehun Lee(2000), *Distance Education System Based on WMT Internet Broadcasting Technology*. Korean Association of Korea Schoolnet,

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Analyzing the Effects of Peer Review Activities in the EFL Writings

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Abstract: In this paper, we propose a new method to analyze the effect of peer review activities in the English-as-a-Foreign-Language (EFL) writing classes. Although a number of studies on peer review activities have been conducted in the last two decades, no method that can objectively analyze the effects of the approach has been proposed thus far. We surmised the degree of difference of the essays by focusing on the estimation of similarity of the documents using the normalized compression distance (NCD), a compression-based classification algorithm. We have applied the NCD measures to the student reports in the college EFL writing courses. The proposed method was found to be beneficial in evaluating the writings of the pre and post peer review activities.

Keywords: peer review activity, collaborative learning, normalized compression distance

Introduction

Peer review activities are one of the collaborative learning approaches, which will help develop logical thinking skills and insight into their own writings. The method using peer review activities, also known as peer response or peer feedback, was originally proposed and introduced by P. Elbow in the 1970s as a promising process approach for writing without teachers in the first language compositions [1]. It was then applied to the second language education and recognized as a beneficial way to polish the writings. In the late 1980s the researches on the peer review activities in the English as a second language (ESL) writings attracted considerable attention in the United States and then in some Asian countries such as China, Singapore, and Taiwan. Numerous studies on the implementation of peer review have been conducted and verified its effects [2]~[9]. On the contrary, some studies suggest that students with certain cultural backgrounds tend to feel reluctant to comment on peers' writings and prefer teacher comments, because they either have a lack of confidence in their language ability or wish to stay in harmony with their peers [10][11]. Although an increasing number of teachers of the Japanese language employ peer review activities, the approach has not been widely used among the teachers of English in Japan.

This paper presents a new method based on the Kolmogorov complexity to objectively analyze the effects of peer review activities on the English as a foreign language (EFL) writings. The proposed method estimates the degree of similarity of the documents by use of the normalized compression distance (NCD), a compression-based classification algorithm to cluster any similar objects, which was first formulated by Cilibrasi and Vitányi [12] on the basis of the normalized information distance (NID) proposed by Li et al [13]. In order to lighten a burden of correcting students' essays, which is a time-consuming task for any language teachers, we have applied the NCD measures to the student essays to surmise the degree of difference between the first and the revised drafts by focusing on the estimation of similarity of the documents.

The remainder of this paper is organized as follows. Section 1 shows our method of the experiment, the results using the holistic scores and the NCD measure are presented in Section 2, and the whole experiment is concluded in Section 3.

1. Method of the Experiment

1.1 Subjects

The present experiment was conducted at a pharmaceutical university in Tokyo, Japan. A total of 35 fourth-year Japanese students, who are enrolled in the six-year course which is compulsory to become a pharmacist, participated in the experiment. They had been educated and received at least nine years of instruction in English. The number of male and female subjects was 10 and 25 respectively. The original data included 37 students, but 2 of them were eliminated from this analysis because they did not attend the anonymous peer review activity. The participants have experienced at least one of the three identifiable peer review activities prior to this experiment.

1.2 Procedures

1.2.1 Essay Writing

On the very class of the experiment, the participants were provided with a written assignment and asked to write an opinionative essay about *kampo* medicines and the health insurance systems. The participants were instructed to write a logical essay with approximately two hundred words. The provided time for the essay writing was forty-five minutes. They were permitted to use dictionaries. After the completion of the first draft, all essays were collected and typed in a word form to make them unidentifiable.

1.2.2 Anonymous Peer Review Activities

After one week of the essay writing, the participants underwent the peer review activities. The anonymous essays were distributed to the participants and twenty-five minutes were provided for the activity in Japanese. The reviewers were told to underline any ambiguous sentences in the peer's essay while reading and were allowed to make any changes or suggestions they could make.

The following written instructions were given before the activity: point out any spelling, grammatical, and syntax errors; discover any omission of background information and inconsistency of logical structure; make any suggestions to improve the peer's essay; and state overall impressions. More specific instructions were also provided orally prior to the activity in order to help students understand how to make comments (e.g. pay attention to the third person singular present form, the sequence of tenses, and examine the adequacy of the reasons to support the writer's final statement).

Upon receiving the comments from the peer, all essays with the reviewer's comments were collected again and returned to each author by the instructor. Then, another twenty minutes was provided to revise the essays.

1.2.3 Analysis Using Holistic Scoring

The first and the revised essays were assessed by the instructors based on the adequacy and organization of the content, the cohesion and logicality of the scripts, and the overall quality. The holistic scoring used for the evaluation is shown in Table 1.

Table 1 A Rubric for Holistic Scoring

Score	Description
5	Sufficient background information and reasons for the claimed statement; good presentation of coherent logical development
4	Some but insufficient background information and reasons for the claimed statement; good presentation of coherent logical development
3	Sufficient background information and reasons for the claimed statement; either incoherent or illogical development
2	Insufficient background information or reasons for the claimed statements; either incoherent or illogical development; less than 80% of the designated length
1	*(Not acceptable)* Little or no background information and reasons for the claimed statement; incoherent and illogical development

1.2.4 The Normalized Compression Distance (NCD)

The normalized compression distance (NCD) is an outcome of the mathematical theoretical development based on the incomputable notion of algorithmic complexity developed by Kolmogorov in the late 1960s. In 2004 the formula called the Normalized Information Distance (NID) was proposed by Li et al. [11], and the next year Cilibrasi and Vitányi [10] designed the NCD on the basis of the NID. The NCD is applicable to clustering objects of any kind, such as music, texts, or gene sequences.

If x and y are the two objects concerned, and c(x) is the compressed size of x using compressor c, then the

$$\mathrm{NCD}(x,y) = \frac{c(x \cdot y) - \min\{c(x), c(y)\}}{\max\{c(x), c(y)\}}$$

where c(y) is the compressed size of y using compressor c and c(x·y) is the compressed size of concatenated objects x and y. The NCD is supposed to be between 0 and 1.

The closer the NCD(x,y) is to zero, the more similar x and y are. In this study, we set c(x) is the compressed size of the first draft, c(y) is the compressed size of the revised draft, and c(x·y) is the compressed size of the concatenation of the first and the revised essays.

2. Results

2.1 Holistic Scores of the Essays and Surface-Level Errors

Seventeen out of the thirty-five essays (48.6%) received higher scores, fifteen (42.9%) received the same scores, and three (8.5%) received lower scores than the first drafts, as shown in Table 3. The shadowed sections are the scores of the essays whose contents were scarcely changed even after the revision. Four reviewers (11.4%) could not point out any spelling, grammatical, or syntax errors even though some obvious mistakes were found in the texts. These four reviewers were below the English proficiency level and their essays were indeed indicated five to fifteen such errors. The scores with an asterisk were the essays with many surface-level errors (more than ten grammatical and/or spelling errors).

Table 2 Evaluations of the Essays

Essay#	Score of the first draft	Score of the revised draft	Essay#	Score of the first draft	Score of the revised draft
1	3*	4	20	4	5
2	3*	5	21	4	4
3	2	2	22	4	4
4	2	1	23	2	3
5	1*	2	24	2	3
6	2	2	25	3	3
7	4	5	26	4	4
8	3	3	27	3	1
9	4	4	28	3	4
10	3	3	29	3*	4
11	3	5	30	5	5
12	3*	4	31	3	4
13	3	4	32	3*	4
14	3	3	34	4	5
15	4*	4*	35	4	2
16	1*	2	36	4	5
17	2	4	37	4	4
18	5	5			

Regrettably, the scores of the three revised essays (essay #4, 27, and 35) were lower than the first drafts. It was revealed from the comments submitted along with the revised essays that those writers were uncertain of the way to incorporate the peer comments into their writings.

2.2 The NCD Results of the Essays

The normalized compression distance ranged from .11 to .44 as shown in Table 3.

Table 3 Compressed Size and the NCD Results of the Essays

Essay#	c(x)	c(y)	c(x·y)	NCD	Essay#	c(x)	c(y)	c(x·y)	NCD
17	417	558	662	.44	24	452	493	573	.25
27	519	361	640	.34	20	585	621	736	.24
35	620	498	778	.32	29	539	556	671	.24
34	619	676	832	.32	12	550	523	673	.24
5	407	424	534	.30	14	521	558	651	.23
23	536	554	701	.30	9	487	549	614	.23
11	553	560	719	.30	22	564	582	695	.23
2	649	671	847	.30	26	566	559	686	.21
13	505	540	664	.29	6	430	448	525	.21
32	605	653	797	.29	3	382	395	465	.21
16	506	469	642	.29	30	561	573	674	.20
7	553	615	731	.29	18	654	661	776	.18
1	485	500	620	.27	21	609	548	709	.18
4	430	419	541	.26	25	591	591	697	.18
10	449	445	566	.26	8	560	574	661	.18
36	552	549	692	.26	15	687	681	788	.15
31	485	500	620	.25	37	546	549	605	.11
28	660	645	821	.25					

The shadowed sections were the same as in Table 2 except the essay #10, whose content in the revised draft was scarcely changed from the first draft. The revised version of this essay contained some rephrased sentences, which resulted in a higher NCD value.

2.3 Holistic Scores and the NCD Results of the Essays

The holistic scores of the essays with the NCD value below .23 were unchanged. The changes made in those essays were the only minor surface-level ones that were pointed out by the peer. The contents of the essays were unchanged as the NCD measure indicated the similarities of the documents pre and post peer review activities. From the experiment, the NCD measure was found useful in properly evaluating some of the essays.
The results of the evaluation using the holistic scores are easily comprehensible for the English language teachers. It is, however, a time-consuming task to score while reading each essay. On the other hand, the NCD measure is an effective means for finding the essays that contain noticeable changes in the content, although the quality of the changes made cannot be determined by the NCD results. In the present case, the revised essays with the NCD of .23 or lower contained few changes in the content as well as in the structure.

3. Conclusions

In this paper we presented a new method based on the Kolmogorov complexity to objectively analyze the effects of peer review activities on the English as a foreign language writings. The proposed method estimated the degree of similarity of the documents by use of the normalized compression distance. Within the present experiment, it was found quite beneficial in preestimating and evaluating the degree of difference in the contents of the writings before and after the peer review activities. This study provided the ground that supports the use of the new method as a potentially valuable aid for the language teachers in reducing the time-consuming task. However, further analyses will be necessary to establish the objective measurement and beneficial prior instructions for more effective peer review approach. For further research, we plan to make qualitative analyses of the students' production, determine what factor to be utilized as an indicator, and establish an objective measurement that would reduce the burden of the language teachers.

References

[1] Elbow, P. (1998). *Writing Without Teachers, 2nd ed.* New York, NY: Oxford University Press.
[2] Chaudron, C. (1984). The effects of feedback on students' composition revisions. *RELC Journal 15*(2): 1-14.
[3] Mittan, R. (1989). The peer review process: Harnessing students' communicative power." In D. Johnson and D. Roen (eds.), *Richness in Writing: Empowering ESL Students:* 207- 19, New York: Longman.
[4] Nelson, G. & Murphy, J. (1993). Peer response groups: Do L2 writers use peer comments in revising their drafts? *TESOL Quarterly 27*(1): 135-142.
[5] Connor, U. & Asenavage, K. (1994). Peer response groups in ESL writing classes: How much impact on revision? *Journal of Second Language Writing 3* (3): 257-276.
[6] Mendonça, C. & Johnson, K. E. (1994). Peer review negotiations: Revision activities in ESL writing instruction. *TESOL Quarterly 28* (4): 745-769.
[7] Tsui, A. B. M. & Ng, M. (2000). Do secondary L2 writers benefit from peer comments? *Journal of Second Language Writing 9*(2): 147-170.
[8] Liu, J. & Hansen, J. G. (2002). *Peer Response in Second Language Writing Classrooms*. Ann Arbor, MI: The University of Michigan Press.
[9] Rollinson, P. (2005). Using peer feedback in the ESL writing class. *ELT Journal 59*(1): 23-30.
[10] Zhang, S. (1995). Re-examining the affective advantage of peer feedback in the ESL writing class. *Journal of Second Language Writing 4*(3): 209-222.
[11] Carlson, J.G. & Nelson, G.L. (1996). Chinese students' perceptions of ESL peer response group interaction. *Journal of Second Language Writing 5*(1): 1-19.
[12] Cilibrasi, R. & Vitányi, P. (2005). Clustering by compression. *IEEE Transactions on Information Theory 51*(4): 1523-1545.
[13] Li, M., Chen, X., Li, X., Ma, B. & Vitányi, P. (2004). The similarity metric. *IEEE Transactions on Information Theory 50* (12): 3250-3264.

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The Effectiveness of Inductive Discovery Learning in 1: 1 Mathematics Classroom

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Abstract: This study proposes inductive discovery learning supported with computers to facilitate mathematics learning in Taiwan's elementary education. It is hypothesized that students can learn mathematics concepts better when they are engaged in the induction process, including observing some instances of a concept, searching and testing the pattern behind those instances, and generalizing their findings with proper written words. With supports of the one-to-one technology, students can devote their thinking efforts in such an individual learning task and discover on their own. To investigate the effectiveness of inductive discovery learning, three third-grade classes were involved in the experiment. The result suggests that students have better concept retention, especially for the high and medium performance students through the learning material of inductive discovery.
Keywords: discovery learning, inductive learning, inductive discovery learning, elementary mathematics, 1: 1 classroom

1. Introduction

It is important that students active engage in math learning activity to develop better understanding of the knowledge. Unfortunately, today many mathematics teachers still adopt teach-than-solve method which disadvantages the learning opportunities of students [14]. However, passive attitude and mechanical memory lead to quickly forget [13]. One-on-one digital classroom environment were developed to solve this important issues [7], involving every student in an active learning process [5]. But besides the learning environment, effective pedagogic strategies also play a crucial role.

Discovery learning is one of the pedagogic strategies which reduce teachers' direct instruction and have students construct knowledge on their own. Advocates of discovery learning hypothesize the human learn better and deeper when they are required to discover and construct essential information for themselves [3] to look for patterns and underlying principles [13]. Worthen [15] found that comparing with expository method, discovery learning leads students perform superior on retention and transfer of heuristics in the mathematics tasks. Olander and Robertson [11] implied that students learning under the discovery approach could benefit more in concept understanding.

However, pure discovery environment lack of structure, guidance, and minimal feedback would get into trial and error, lost and frustrated situations [16]. Guided discovery are superior to pure discovery in helping students learning and transferring [9]. Moreno [10] noted that students learn more deeply from strongly guided learning than from discovery. Kirschner [8] also argued that learning via direct instruction have great amount of examples guidance were relatively greater quality of learning compare to discovery. All of them emphasized the importance of guidance and examples, otherwise false starts cause inefficient result [1] and misconceptions [4]. Nevertheless, if discovery guide too much would similar to direct instruction, and lose the advantage of it.

In current study, we implemented a computer supported inductive discovery learning approach in a third-grade elementary mathematics classroom to solve those problems above. Inductive discovery [6] means students learn the key concept by observing a series carefully designed instances reflecting the target concept, discerning the pattern behind those instances while interacting with computers, and then making conclusion of what is discovered. Specifically, the key feature of inductive discovery is providing instances which reflect the same concept to have students discover the underlying principle during interacting with computers—no direct instruction is involved.

2. Inductive Discovery Learning: Design and Consideration

2.1 Define critical attributes of a concept, and focus on one attribute at a time

Every concept has four elements: a name, examples, attributes, and value of attribute [2]. To have students see what is expected to be seen, the critical attributes have to be identified and singled out [8]. Take the meaning of denominator as an example, critical attributes include the number of parts and whole, and each part is equal. Separating critical attribute of a concept and only presenting one at a time make students learning material easier.

2.2 Make the critical attribute obvious

Once the target critical attribute is decided, it has to be obvious to be noticed. Lo, Pong, and Chik [8] pointed out that people tend to aware something when (1) the thing keeps change while other things remain the same; and (2) the thing remains the same while other things keep change. For the first situation, if the target attribute of denominator is the number of parts into which one whole is divided, similar examples can be given. For example, the pie graph share the same representation, which only the numbers of parts are different so that the meaning of denominator can be discerned. Or, for the second situation, examples of different representations can be given while the fraction number keeps the same.

3. Design structure and ideas of learning material

Before design learning material, we had to analyze and identify the structure of each conception in detail. The content design must focus upon each unit of the phenomenon [8], so one page only taught one critical feature to avoid students misunderstanding what we expected. Students must follow learning steps to discover the critical feature relevance. Each step based on simplifies scientific reasoning steps—modeling: stating the hypothesis; discovery: testing the hypothesis, collecting and analyzing data; and induction: making conclusions and possible revisions about the robustness of the original hypotheses [12].

3.1 Modeling

Computer performs two examples constituted by the same critical feature of new concepts. Students observed and exploited from examples without additional instruction. They compared examples and questions to infer the essential procedures and internalize them [16]. This step in scientific discovery process is stating an initial hypothesis, and then applied the hypothesis to the following new questions.

3.2 Discovery

Students discover the hidden critical feature and rule by doing questions with only critical part(s) missing. Instead of presenting the whole questions to students from the onset, we provide a simplified question to identify and examine important information. To force students carefully observe the given examples and think what the missing parts are, they have to try their answers until correct. Next question appear as this question be answered correct. If students answer incorrect, they have to observe two examples again. This is the discovery process. Students keep on testing their hypothesis by completing the critical feature in questions, collecting and analyzing the possible result.

3.3 Induction

Induction part enables students to reflect the concept structure of different questions to summarize their finding. Students check their hypothesis repeatedly. If students can't induct and externalize the critical feature by themselves, the text description or algebra as the symbolic representation would help scaffolding induction. Students should choose appropriate items fit the statement of critical feature to make their conclusion, see Figure 1.

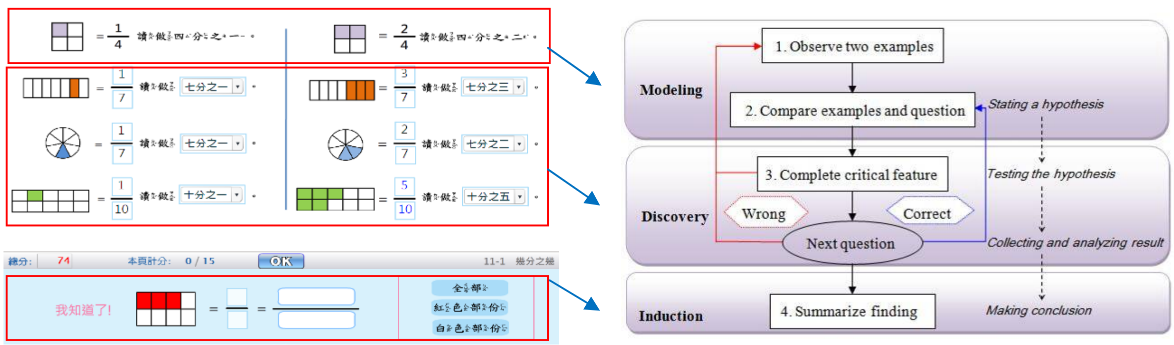

Figure 1 Mathematics content interface and corresponding steps in inductive discovery learning

4. Method

To investigate the effectiveness of inductive discovery learning in 1: 1 mathematics class, this study involved three 3-grade elementary classes in Taiwan. We would like to see if there is any different learning effect between three classes, and also examine the learning effeteness of different instructions to high, medium, and low levels according to their learning performance in their own classes.

4.1 Subjects

This study included three groups. One was experiment group (EG; n = 27), which used inductive discovery learning approach supported with one to one device to learn mathematics. The other two control groups were CG1 (n = 29) and CG2 (n = 29). Both of them used traditional direct instruction approach to explain the concepts and procedures.

4.2 Procedure

This study held on the formal mathematics classes during one semester. Each week had third times, and each time used 40 minutes. The EG had this mathematics fraction experiment was one part of all units. The fraction experiment was close to the final exams, so we adopted the final exams as our comparing reference. We used ANOVA to test their average grades of final examination. There were no significant differences. After one month winter vocation and two weeks in second semester, all the groups did the delay test to reflect their learning retention. The difficulty of the delay test was about 0.5.

5. Findings

We would illustrate the overall situation of the delay test, and then focus on comparing the performance of three levels in each group. The EG means (standard deviations) of delay test was 57.63 (22.24), CG1 was 46.41 (19.65), and CG2 was 47.79 (20.31). As you can see in Figure 2, the standard deviation of three groups was large. The students of EG around 60~80 points were more than control groups. But the highest scores in EG was 90 points which lower than 92 points of CG1 and 94 points of CG2. The EG had almost equal people in 20~39 with CG1 and CG2. But no one behind 20 points in EG, which the lowest scores were 22 points, differed from the 16 points of CG1 and 14 points of CG2. The students of EG concentrated on 30~80 points, however, CG1 and CG2 concentrated on 20~60 points. EG and CG2, CG2 all have very different distribution. The degree of dispersion in EG seemed more obvious. In sum, the mean of EG in the delay test higher than CG1 and CG2 about ten points, so the learning retention in EG longer than CG1 and CG2.

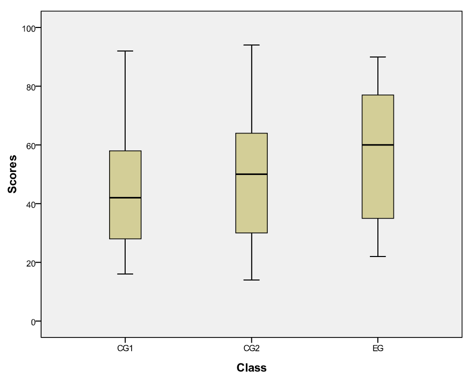

Fig 2 Box plot of three groups scores

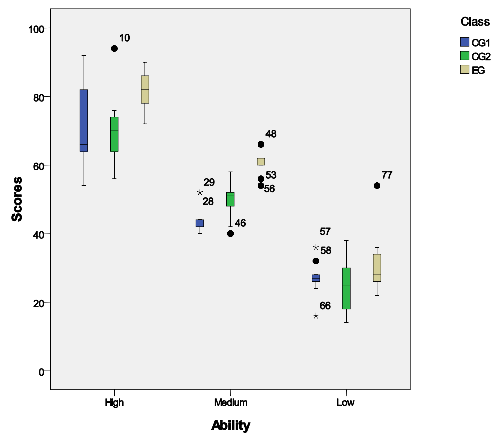

Fig 3 Box plot of three performance levels in three groups

Regarding the achievement of different level students in three groups, we used ANOVA to test the group difference, but no significant was found in low performance level, $F(2, 28) = 1.19$, $MSE = 62.90$, $p > .05$. However, significant group differences were found in medium and high performance levels. In medium performance level, the group means (standard deviations) of EG was 60.22 (3.53), CG1 was 44.00 (4.42), and CG2 was 49.60 (5.40), $F(2, 28) = 30.81$, $MSE = 62.90$, $p < .01$. The scores of EG was obviously higher than control groups about ten points. In high performance level, the group means (standard deviations) of EG was 81.78 (5.61), CG1 was 70.67 (12.61), and CG2 was 70.67 (10.58), $F(2, 26) = 3.67$, $MSE = 100.82$, $p < .05$. Unlike the CG2 have the highest scores 94 points as an outlier, yet the second high scores down to 76 points. Even though the highest scores 90 points in EG was lower than control groups, but scores in EG were more concentrate on 80~90. Similar to the medium performance level, the means of high performance level in EG was higher than the other two control groups about ten points. Therefore, our inductive discovery learning content seems more benefit to the students in medium and high performance level, but for the low performance was less use.

6. Conclusion

This study provided a basic mathematics learning framework based on inductive discovery learning in 1:1 mathematics classroom. Computer presents content, provide immediate feedback and summary of word explanations as scaffolding to facilitate students' mathematics learning. Our experiment showed that comparison with direct instruction, inductive discovery approach is feasible in the 3-grade mathematics classroom, not only learn better but also retention longer, particular for medium and high performance students. Our finding showed similar initial learning effects but better engagement effects, and students have capabilities to induct from observation, doing questions, discover critical feature of concepts, and further deepen their mathematics concepts. In the future, we will try to deepen the understanding of learning with suitable scaffolding in this learning method.

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References

[1] Brown, A. & Campione, J. (1994). Guided discovery in a community of learners. In K. McGilly (Ed), Classroom Lessons: Integrating Cognitive Theory and Classroom Practice, (pp. 229-270). Cambridge, MA: MIT Press.

[2] Bruner, J. S., Goodnow, J. J., & Austin, G. A. (1956). *A study of thinking.* New York: Wiley.

[3] Bruner, J.S. (1961). The act of discovery. *Harvard Education Review, 31*(1), 21-32.

[4] Carlson, R.A., Lundy, D.H. & Schneider, W. (1992) Strategy guidance and memory aiding in learning a problem-solving skill. *Human Factors, 34*,129–145.

[5] Chan, T.W., Roschelle J., His, S., Kinshuk, Sharples, M., Brown, T., Patton, C., Cherniavsky, J., Pea, R., Norris, C., Soloway, E., Balacheff, N., Scardamalia, M., Dillenbourg, P., Looi, C.K., Milrad, M. & Hoope, U. (2006). One-to-one technology enhanced learning: an opportunity for global research collaboration. *Research and Practice in Technology Enhanced Learning, 1*(1), 3–29.

[6] Ching, E., Chang, T., & Chan. T. W. (2009, October). *Learning Elementary Mathematical Concepts with Computer-Supported Inductive Discovery*. Paper presented at The Technology Enhanced Learning Conference 2009 (TELearn 2009), Tainan, Taiwan.

[7] Liang, J., Liu, T., Wang, H., Chang, B., Deng, Y., Yang, J., Chou, C., Ko, W., Yang, S., & Chan, T. (2005). A few design perspectives on one-on-one digital classroom environment. *Journal of Computer Assisted Learning, 21*(3), 181–189.

[8] Lo, M. L., Pong, W. Y. & Chik, P. M. P. (2005). *For each and everyone: catering for individual differences through Learning Studies*. Hong Kong University Press.

[9] Mayer, R. E. (2004). Should There Be a Three-Strikes Rule Against Pure Discovery Learning? *American Psychologist, 59*(1), 14-19.

[10] Moreno, R. (2004). Decreasing cognitive load for novice students: Effects of explanatory versus corrective feedback in discovery-based multimedia. *Instructional Science, 32*, 99-113.

[11] Olander, H. T. & Robertson, H.T. (1973). The effectiveness of discovery and expository methods in the teaching of fourth grade mathematics. *Journal for Research in Mathematics Education, 4*(1), 33-44.

[12] Rieber, L. P. (2002). Supporting Discovery-Based Learning within Simulations. Available online: [http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.83.1369&rep=rep1&type=pdf[retrieved on 5/20/2010].

[13] Sawyer, R. K. (Ed.). (2006). *Cambridge handbook of the learning sciences*. New York: Cambridge University Press.

[14] Van de Walle, J. (2004). Elementary and middle school mathematics: Teaching developmentally. New York: Addison Wesley Longman.

[15] Worthen, B. R. (1968). Discovery and expository task presentation in elementary mathematics. *Journal of educational psychology monograph supplement, 59* (1), 1-13.

[16] Zhu, X., & Simon, H. (1987). Learning mathematics from examples and by doing. *Cognition and Instruction, 4*,137-166.

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Mechanism Design on Coursework Grading to Create Incentives for Student Learning

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Abstract: In this paper, we discuss some issues of extrinsic motivation in learning and argue that mechanism design can be applied on coursework grading to create incentives for student learning. We present an exploratory study using non-graded coursework in two fourth year university classes. Based on the study results, we discuss and suggest some important factors that influence students' learning motives and that need to be taken into consideration for designing a proper coursework grading mechanism.

Keywords: Computer Aided Education, Mechanism Design, Incentives for Learning

Introduction

Learning can be made more engaging and gratifying through games. Games provide a combination of challenge, achievement and reward, which motivate intrinsically the players by allowing them to hone their skills. Games provide also extrinsic/social incentives, through engaging the players in competition with others and allowing them to build reputation. Finally, game performance may be related to some real world rewards, if translated into currency or grades. We argue that coursework can be regarded as an educational game, which involves challenges (assignments, projects, essays that the students need to do), and the corresponding rewards for overcoming these challenges (grades and relative importance/weight of each challenge).

In our experience, university students are strongly motivated to achieve high grades in their classes. They play the game, i.e. do the coursework, in order to learn, and also to earn the rewards. Teachers define the challenges and the corresponding rewards (grades), so that they can engage students in meaningful learning experiences through the term and thus prepare them for the exams. Designing both a good game and good coursework for a class requires careful design of the challenges and rewards provided. Certainly following educational principles and knowledge of the domain is necessary in the selection of the challenges. For example, the challenges have to be adjusted to the gradually increasing skill level of the player/learner.

In the current practice of designing university class coursework, teachers select rewards for overcoming each challenge (e.g. assignment, project or participation) in an ad-hoc manner, following some general university guidelines. For example, the weight of the final exam cannot be more than 50%, or the majority of the final grade should be earned in coursework during the term. A typical course grading scheme at our department, for example looks as follows (in this case taken from the Social Computing Class course outline): 2 assignments (worth 10% of the final grade each), Course project (worth 25% of the final grade), Class participation (worth 5 % of the final grade) and - Final exam (worth 50% of the final grade). One can easily imagine an alternative grading scheme, for example: Preparing 2 class presentations on selected topics (worth 15% each), In-depth review paper on a selected topic (worth 30%), Course project (worth 35%), Participation in class discussion (worth 5%)

While the second grading scheme seems more typical of graduate-level classes, it may be suited well to some undergraduate students. Providing alternative activities within the coursework that students can choose to take allows for multiple possible alternative paths towards the goal and opens the possibility for personalization in traditional, classroom environment.

When designing such coursework grading schemes, a crucial decision is the reward (or grade percentage) offered for each activity/challenge. If we assume that students are economically motivated and with limited resources (time, shared between the courses they are taking), they focus most of their energy on the challenges that offer the greatest rewards. It is important therefore, that the activities/challenges that would provide the biggest learning benefits, are assigned the highest rewards.

However, students may not be entirely driven by grades, and (hopefully), there are always some students driven by intrinsic motives, like desire to learn, wish to impress (the teacher or peers), or wish to help others learn. Activities that provide additional rewards of this kind involve some kind of public space and collaboration, e.g. participation in online discussion forums or in class discussion, in wikis, and doing team-projects. These activities may be intrinsically rewarding and may not need to provide high rewards in terms of marks. Course designers may wish to keep high grade weight as reward for unattractive and hard challenges, which have a high learning value. A course designer may look for inspiration into economics and game theory. The area of mechanism design deals specifically with the question of how to set the rewards for particular actions/challenges, to ensure a “fair” game and individual player behavior that satisfy certain goals of the designer (e.g. putting more effort in certain activities than others).

1. Mechanism design

Mechanism Design is the branch of economics that is concerned with designing the rules of interaction (game) that achieves a specific outcome even when the participants are self-interested. This is done by setting up a structure in which each player has an incentive to behave as the designer intends. The game is then said to implement the desired outcome. There are many applications of mechanism design: the design of auctions, matching algorithms, such as the one used to pair medical school graduates with internships, the provision of public goods and the optimal design of taxation schemes by governments. The task of designing a mechanism in learning/educational setting needs to consider the utility or the personal goals of learners. Students are clearly motivated by extrinsic factors - getting a credit, certification, or just a higher grade in class. Yet, they are also motivated by intrinsic factors - wish to learn, self-efficacy [1]. Apart from these two main motivations, students may be motivated by social factors - a wish for peer- or teacher-recognition, or earning high reputation in the group (socially motivated). They may be driven by a goal to help others, e.g. to learn knowledge so that they can explain it to their friends, to reciprocate or to build new relationships through collaboration with others.

In our previous work, we have explored the use of incentive mechanism design that rewards students’ contributions in a shared class resource repository and participation in a discussion forum (considered beneficial for learning) with reputation, status in the group, and immediate pleasing effect that emphasizes the individual contribution to the community [5]. While not providing differential marks for participation in these activities, we have observed significant increase in participation (nearly 100%).

Designing an incentive mechanism involves two important parts: 1) defining the payoff matrix which rewards for particular actions/challenges, and 2) communicating the results of the game to the players on an ongoing basis. The rewards have to be aligned with the individual learner’s goals, but also with the teaching goals of the instructor and certain social/community goals (e.g. to ensure fairness). For example, rewards in terms of points for contributing posts to a discussion forum align with the learner's goal to earn recognition among his or her peers, but also with a teaching goal to stimulate discussion on a topic and a social goal – to ensure a certain level of participation in the forum so that it is attractive to the learners and they come back to check it regularly. Communicating the performance results back to the players/students rewards and motivates them and allows them to correct their behavior so that they can achieve their goals. For example, publishing the reputation ranking in a discussion forum or the assignment marks rewards students who are motivated by personal achievement, those motivated by reputation, (i.e. those who want to impress their fellow students and the teacher). However, it may intimidate students who didn't do well, and those who do not want to be seen as too eager to impress.

Game design involves also for "maintenance" activities that need to be completed but do not carry particular rewards. These activities may be needed to prepare to perform well on other, highly reward activities (e.g. the final exam). In some sense all of the coursework activities listed in the two examples given earlier could have been considered "maintenance" activities that prepare the students to perform well on the final exam. In fact, many European Universities do not assign graded coursework to students during the term, the final exam is worth 100% of the class grade (or there are two exams, worth 50% each). The students are expected to find ways practice their skills and prepare for the final exam on their own and receive no rewards for this in terms of grades. It is somewhat unusual, however, in a North American university context to think of assigning coursework, which does not bring rewards towards the final course grade. In the next section we describe a small experiment that we carried out in two classes taught at the University of Saskatchewan in the fall of 2008 to explore if the two parts of a mechanism design listed above are important in the design of coursework.

2. Mechanism Design in Grading Coursework

The classes were Mobile and Ubiquitous Computing (MobUbi) taught by one of the co-authors and on Social Computing (SocComp), taught by another co-author. Both were 4th year undergraduate Computer Science classes, with 11 and 10 students, respectively. In both classes the instructors considered writing of a half-page summary of the material covered each week to be a valuable learning experience. Both classes had no textbooks; a large amount of material was covered; and it was challenging for students to select the most important information to remember for the final exam. The summaries could be useful in preparing for the final exam, since otherwise the amount of material and details would be overwhelming. So the instructors decided to add "weekly summaries" to the list of activities in the coursework and decided to experiment if the students will complete the summaries if there was no direct reward in terms of percentage of the final grade for doing the summaries. To create an indirect incentive for doing this activity, the students were allowed to take the summaries in the final exam (i.e. the exam became a semi-open book). The mechanism of the activity of submitting the summaries in the two classes was different, as explained below.

In the MobUbi class, each student had to submit an individual summary by the end of the week. In the final examination, each student received a printed copy of all of their own summaries. In this way there was an incentive for students to do their best when writing the summary. After the strict weekly submission deadline, everyone could see all submitted summaries, and compare their own summary with those of others. In this way, students had access to other viewpoints of what was most important, and could prepare better for the exam. Also since the exam was the highest rewarded activity, the expectation was that the students will invest effort in doing good summaries so that they can bring in the exam a good "cheat-sheet".

In the Social Computing class, where some of the class topics covered public goods, the tragedy of commons, collaborative knowledge production in Wikipedia and online communities, the instructor decided to involve a collaborative style of writing the summaries, using a wiki. To illustrate the concept of "tragedy of commons" in practice, and to eliminate other social motivators (attempts to earn reputation or impress the instructor), the instructor set the wiki so that it did not require login and there was no way for the instructor or the other students to know who had contributed and if they had - to which part of the summary. In the final exam everyone would receive a printed copy of each weekly summary (generated collaboratively). The expectation was that even though there was no direct personal benefit from participation and no public knowledge of one's involvement, the students would contribute and collaborate for the common good and will produce summaries that are better than individual summaries, reflecting a multitude of viewpoints. In this way they will all have a good starting point in the exam.

Table 1. Weekly contributions in two fourth year undergraduate classes at the Computer Science Department, University of Saskatchewan, fall 2008/2009.

Week of the Class	**Social Computing Class (10 students)**	**Mobile & Ubiquitous Computing (11 students)**
Week 1	6 users (last 3 before the exam)	7
Week 2	6 users (last 3 before the exam)	4
Week 3	3 users (last 2 before the exam)	4
Week 4	2 users (last one before exam)	4
Week 5	3 users (last one before exam)	1
Week 6	2 users (last one before exam)	3
Week 7	2 users (last one before exam)	2
Week 8	2 users (both before exam)	2
Week 9	2 users (both before exam)	0
Week 10	2 users (both before exam)	0
Week 11	1 user (before exam)	0
Week 12	1 user (before exam)	5

The results showed that the indirect reward (increasing the chances of doing better on the final) was not strong enough to motivate students to do the extra activity. The declining time pattern of contributions was similar in both classes (see Table 1). The number of students submitting summaries in the MobUbi class dropped down to 0 and only in the last week of the class it went up again. In the SocComp class we saw much lower participation. Three students participated in the writing of the weekly wiki summaries in the first 3 weeks, and after that only one student remained active; he wrote all of the wiki summaries for the next 7 weeks. Only after the end of the term, just before the final exam, another couple of students participated to revise some of the summaries. Of these, one student did minor changes (word swapping) in all of the summaries. This student was the sole author of the last two summaries, which were plagiarized from the course notes (the entire text was copied, with no line breaks). Apparently, this act of gaming was a result of desperation by an unprepared student, who was hiding behind the anonymity of the wiki.

We repeated the experiment in the next year, 2009/2010 in the same classes, with comparable numbers of students in each class. This time students had to log into the Wiki used in the Social Computing class, so it was visible who participated in writing the collaborative summaries. Nevertheless, not a single summary was started for the entire term! Not even in the days immediately before the final exam. It is hard to explain the students' disinterest in helping themselves do better on the final. On the contrary, in the MobUbi class with the individual summaries, most students submitted summaries on time for each week.

3. Discussion and Future Work

While the results show that rewards in terms of marks are the most important incentive for students to do coursework activities; when no marks are awarded, students do not do the work. This is easy to explain [3]: students are very busy and focus their attention where they get immediate payoff. Even if they understand the long-term/postponed benefits of doing an activity, they may not do it, if there is no perceived threat (e.g. a looming deadline). Our hypothesis for the better success of the no-rewards activity in the MobUbi class is that students, who have so many demands on their time, grow increasingly deadline-driven. They would do the activity if they may lose the chance to do it later (as the deadline for submitting summaries in MobUbi was strict). Students in the SocialComp class procrastinated for too long and in the end of the term the task appeared too enormous to complete for any single individual, so no one attempted to work on it. Other factors that may have influenced the students' motivation are probably: 1) *Direct personal benefit* - in the MobUbi Class a student could benefit only from his/her own summary, while in the SocComp class the work of one student benefitted everyone. Apparently, working for the public good is a rare phenomenon when time is short. The student who contributed all wiki summaries was finishing his studies and this was his only class left to take. 2) *Social Transparency* - in the MobUbi class, it was clear who did not contribute (and the students possibly feared retaliation by the teacher), while in the SocialComp Class the anonymity facilitated the tragedy of commons effect, in the first experiment. These factors will need to be taken into consideration for designing a proper mechanism on coursework grading.

Mechanism design has also been widely applied in multi-agent systems. And, researchers have been developing multi-agent systems to deal with the challenges in educational environments [4]. However, none of them use mechanism design in multi-agent system based education. For future work, we will further explore the direction of mechanism design in a multi-agent based education environment where automated mechanism design [2] can be applied to elicit student learning, and where students can also be assisted by intelligent agents to make informed decisions about, for example, how much time should be spent on coursework in order to gain the maximum marks.

References

[1] Cheng, R., & Vassileva, J. (2006). Design and Evaluation of an Adaptive Incentive Mechanism for Sustained Educational Online Communities. *User Modelling and User-Adapted Interaction, 16*(2/3), 321-348.

[2] Conitzer, V., & Sandholm, T. (2003). Applications of Automated Mechanism Design. *Proceedings of the Conference on Uncertainty in Artificial Intelligence (UAI) Workshop on Bayesian Modeling Applications*. Acapulco, Mexico.

[3] Levitt, S., & Dubner, S. J. (2005). Freakonomics: A Rogue Economist Explores the Hidden Side of Everything. *William Morrow/HarperCollins. ISBN 0-06-073132-X*.

[4] Shi, H., & Shang, Y., & Chen, S. (2000). A Multi-agent System for Computer Science Education. *Proceedings of the Annual Conference on Innovation and Technology in Computer Science Education (ITiCSE), pp.1-4*. Helsinki, Finland.

[5] Vassileva, J. (2009). Towards Social Computing Environments, *IEEE Trans. Learning Technol. 1*(4), 199-214.

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Can E-mails as Reminder Enhance English Learning on the English Learning System?

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Abstract: In recent years, more and more online English learning sites have emerged. However, most language learners may be constantly busy or may lack external stimulation and reminders so that the learners in a lower on-line learning initiative cannot maintain a fixed long learning, and then affects their learning outcomes. This research, therefore, developed an English learning system with assistance of email to maintain learning activity. This system applied to college students and office workers, conducting a one-month experiment. The results revealed that the students' learning achievement with assistance of e-mail was significantly higher than those without it.

Keywords: Email, computer-assisted language learning, learning system

Introduction

In recent years, information technology has become a major turning point of English teaching (Cavus & Ibrahim, 2009). Currently, the asynchronous English teaching websites offers students/learners a diverse learning platform. However, the materials and courses offered by websites lack of supervision of teachers or other additional external reminders mechanism for long-term motivation. Therefore, learning English site need to take how to stimulate the motivation and attitudes of students into consideration to maintain users' long-term learning (Furner & Daigle, 2004).

In such an information age, more and more computer mediated communication (CMC) applies in education. More and more research focus how to integrate emails into the teaching activities (Hertel, 2003; Thornton & Houser , 2005; Yang & Chen, 2007). That's to say, if e-mail can be integrated effectively at the appropriate time for learners to learn in real time, and if e-mail can be used to remind the learner through the timely on-line access to learning system to make learning sustainable, such an email assisted English learning system will get learners motivated. This is also the motive of this research.

The aim of this research is to develop an online English learning system, and build a media of learning like an alarm clock to make e-mails become the timely provision of materials to remind learners of learning. To understand the application of such learning objects, in this study two groups including college students and office workers are selected to become this experiment subjects, discuss the discrepancy and effectiveness of language learning with the assisted reminders of email.

1. Related research about E-mail assisted language learning

With the advent of information technology and network, computer-assisted language learning system grows rapidly in recent years (Muir-Herzig, 2004). More and more studies declare that using e-mail an assist language learning (Hertel, 2003; Rau, Gao & Wu, 2008). Yang and Chen (2007) study shows that the experimental results of using e-mails to contact with pen pals as writing courses show that e-mail truly improve learners' motivation and effect of learning, Thornton and Houser (2005) e-mail students vocabularies and other materials to the phone for their learning English, and the results of it show that a better learning results in the teaching materials via e-mail sent to users than photocopying a piece of paper or on the web.
This study focused on the e-mail functions for sending messages, materials and test questions, providing users with online instant reply function, and reminding learners of using English on-line learning system.

2. Research Methods

The purpose of this study is to develop e-mail supporting the online English learning system, and conduct experiments and related assessment and analysis. The following is a brief account of these elements.

2.1 Experimental design

This experiment is designed to divide learners into two groups, including the experimental and control groups. The experimental group adopts e-mail to assist online English learning system. The control group uses the same online English learning system as the experimental group, but doesn't use e-mail to assist their learning. The experiment lasts for one month and imposes on pre-test questionnaire in English achievement tests before the experiment and post-test questionnaire in English achievement test after the experiment in order to understand the effect and differences of learning.

2.2 Subjects

The experimental subjects were office workers and college students, and these two groups were divided again into the control and experimental group, giving a total of four groups, each group in each of 30, total number of 120.

2.3 Experimental procedure

This experiment mainly explore the discrepancies of effect of learning between using the English learning system with the assistance of email system and using the English learning system alone, and learn further about the application of this learning object. Experimental procedure is described as below. First, the subjects in the experiment group conducted the pre-test questionnaire of the test of English Achievement Test which is the related learning materials in the English learning system the previous week before the experiment. Next, start the experiment after the pre-test. In the experimental group, the system pre-located to send materials by mail at least one time a day, and the times of sending emails a day to the user can be adjusted at this system and decided by the users. Thirdly, compare the learning effectiveness of subjects at the end of the experiment. Conduct the post-test questionnaire of the test of English Achievement Test after one month of the experiment in order to compare the effectiveness and discrepancies of the learners' English learning achievements before and after the experiment according to test scores.

2.4 Research tools

2.4.1 Use Email to strengthen English learning system

Users must first register before using the system and select the desired time, frequency and the difficulty and quantity of sending learning materials in the system. According to the information filled by learners, the above system send learning materials, test questions by e-mail at a fixed time to inform the learners to get on the system. After receiving the notification, the learners/users either select the link in the message/email to this learning system for testing and learning or answer online directly.

2.4.2 Analysis tool and the results of analysis

In this study, do the pre-test and post-test analysis of the English achievement test, and the related materials are out of the English learning system. Assessment of some experimental results to the experimental treatment (control group, experimental group) as independent variables, the pre-test scores before the English achievement for the questionnaire were variable, the post-test scores as the dependent variable, and do ANCOVA analysis to explore the learning model with the assistance of electronic e-mail for students and office workers, learn the impact and effectiveness of learning with the assistance of email.

3. Results

The one-way Analysis of Covariance (ANCOVA) was performed to test the difference among the achievements of the experiment and the control group. The pretest scores were used as the covariate in the analysis.
Tables 1 and 2 present the results of the statistical analyses of the study. The descriptive statistics for the ANCOVA analysis are depicted in Table 1, whereas Table 2 presents a summary result of the ANCOVA analysis on the overall post achievement test. For both the college students and the office workers, the ANCOVA results (college students: F=506.25*; office workers: F=628.10*) and the adjusted means in the experimental group (college students: M=35.77; office workers: M=36.50) are significantly higher than those in the control group (college students: M=21.47; office workers: M=22.11) indicate that the experimental group scored significantly higher than the control group on the overall achievement test.

Table 1. *Descriptive statistics of the achievement test scores*

Subjects	Groups	N	Pretest		Posttest		Adjusted Means
			Mean	SD	Mean	SD	
College students	Control	30	20.67	2.44	21.57	2.57	21.47
	Experimental	30	20.40	2.40	35.67	3.43	35.77
Office workers	Control	30	21.70	1.95	21.90	1.88	22.11
	Experimental	30	22.37	2.82	36.70	3.23	36.50
College students	Experimental	30	20.40	2.40	35.67	3.43	36.23
Office workers	Experimental	30	22.37	2.82	36.70	3.23	36.10

Table 2. *Summary results of the ANCOVA analysis on the overall achievement test score*

Subjects	Groups	Source	SS	df	Mean Square	F	p
College students	Experimental & Control	Between Groups	3057.00	1	3057.00	506.25	.00*
		Error	344.19	57	6.04		
Office workers	Experimental & Control	Between Groups	3046.96	1	3046.96	628.10	.00*
		Error	276.51	57	4.85		
College students & Office workers	Experimental	Between Groups	.33	1	.33	.04	.85
		Error	496.73	57	8.71		

*p < .05

And the results can be seen the learning English achievement test scores of college students and office workers in the experimental group are not significantly different (F=.04). That is, there is no significant difference between office workers and college students in experimental group with the complement of assisted learning system, using e-mail, after learning.

4. Conclusions and Recommendations

This study investigated the impact of learning outcome with the supporting system of the e-mail online English learning to support students and office workers. The experimental results and learning outcomes of the college students and office workers using e-mail assisted learning system are better than those simply using the online English learning system and there is no more bias towards the effectiveness of the learning with e-mail assisted learning system of learning English for college students and office workers.

In this study, the experiment lasted one month, and in the future it may develop more long-term experiments to explore the learning effects of the long-term users and users' learning behavior. In addition, the subjects of this study were office workers and students, and in the future we may take more different ethnic groups as the subjects in the experiments and compare their discrepancies more among them.

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References

Cavus, N., Ibrahim, D. (2009) m-Learning: An experiment in using SMS to support learning new English language words. *British Journal of Educational Technology, 40*(1), 78-91.

Furner, J. M., & Daigle, D. (2004). The educational software/website effectiveness survey. *International Journal of Instructional Media, 31*(1), 61-77.

Hertel, T. (2003). Using an e-mail exchange to promote cultural learning. *Foreign Language Annals, 36*(3), 386-396.

LeLoup, J. W. (1997). But I only have e-mail – what can I do? *Learning Languages*, *2*, 10–15.

Muir-Herzig, R. G. (2004). Technology and its impact in the classroom. *Computers & Education*, *42*(2), 111-131.

Rau, P. P., Gao, Q., & Wu, L. M. (2008). Using mobile communication technology in high school education: Motivation, pressure, and learning performance. *Computers & Education*, *50*(1), 1-22.

Thornton, P. & Houser, C. (2005). Using mobile phones in English education in Japan. *Journal of Computer Assisted Learning*, *21*, 217–228.

Yang, S. C., & Chen, Y. J. (2007). Technology-enhanced language learning: A case study. *Computers in Human Behavior*, *23*, 860-879.

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Teachers' Technology Professional Development: A Malaysia Perspective

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Abstract: This paper centers on the impact of laptop use on the professional development of teachers. Three hundred and eighty six secondary school teachers from 28 selected schools participated in the survey. These teachers were currently teaching Science and Mathematics, and were provided laptop as part of the Teaching and Learning of Science and Mathematics in English, or better known by its Malay acronym PPSMI programme. Teachers' professional development was measured in three dimensions: teaching-learning, administrative practice and use of resources. The analysis revealed that the use of laptop has a moderate impact on the overall teachers' professional development.

Keywords: laptop, teacher, professional development, impact

1. Introduction

The Malaysia Ministry of Education (MoE) has been exploring ways to harness technology into the education system. Malaysia embarked on the laptop initiative program beginning from the year 2003, initially as part of the teaching and learning of Science and Mathematics in English (better known by its Malay acronym PPSMI) program [2, 3, 4]. Taking into considerations from the education level where science-based courses rely heavily on English dependent reference materials [2, 3, 5], and the emergence of technology driven world that needs the nation to engage efficiently and competitively in English, contributes to the change in the policy [3]. The launching of the program started with the change of medium of instruction of Science and Mathematics subjects from Bahasa Melayu to English. As part of the program, laptops were deployed to every Science and Mathematics teachers as an initiative to facilitate and enrich the teaching of both subject areas in English [2, 3, 5, 6]. They were also equipped with self-instructional learning materials inclusive of grammar books, dictionaries and CD-ROM as a means for teachers to develop their own instructional toolkit and own resources for continuous professional development [2, 3]. Advocates and practitioners strongly believe that the integration of ICT in teaching-learning primarily through laptops is, for all intents and purposes, beneficial for the teachers and students.

2. Methodology

A survey was carried out among 386 secondary school teachers who were teaching Science and Mathematics subjects in school with the aid of laptops. A set of questionnaire with five-fold Likert categorization with a continuum of strongly agree (SA), agree (A), neutral (N), disagree (D), strongly disagree (SD); was designed by the researchers based on the review of related literature and previous studies [8, 9]. The Cronbach alpha coefficient value obtained was high [10, 11, 12], namely .925.

Results and Discussion

There were 79 males and 307 females participated in the survey. They reported spending an average of 4.55 hours (S.D. = 2.46) per day using the laptop. They have a range of less than a year to 32 years of teaching experience (M = 10.41; SD = 8.48). The impact of laptop use on teachers' professional development was measured in terms of three dimensions namely teaching-learning, administrative practice and use of resources.

2.1 Teaching-Learning

These findings outlined the impact of the initiative on the teaching-learning process. Three items were above the overall mean (3.80). Item number 1 had the highest mean score of 4.28 (S.D.=0.75), followed by item number 5 with a mean score of 4.06 (S.D.=0.87). The negative item (Item 3) had the third highest mean (M=3.92; S.D.=0.88). The item number 4 scored the lowest among all the items (M=3.05; S.D.=1.02).

Table 1

Percentages, Means and Standard Deviations for Items on Teaching-Learning

Items	**SD % (f)**	**D % (f)**	**N % (f)**	**A % (f)**	**SA % (f)**	**Mean**	**SD**
1. I feel using the laptop benefits my teaching.	0.5 (2)	3.1 (12)	5.4 (21)	49.7 (192)	41.2 (159)	4.28	0.75
2. The use of laptop in the teaching-learning process saves time.	1.8 (7)	17.1 (66)	14.8 (57)	40.9 (158)	25.4 (98)	3.71	1.08
3. * The presence of laptop in my classroom is disruptive to my teaching.	25.4 (98)	49.5 (191)	17.4 (67)	7.0 (27)	.8 (3)	3.92	.88
4. * I can teach better without the help of a laptop.	7.0 (27)	22.3 (86)	35.8 (138)	29.0 (112)	6.0 (23)	3.05	1.02
5. I can explain something more effectively to my students with the aid of a laptop used in conjunction with the LCD projector.	0.8 (3)	5.7 (22)	13.5 (52)	46.9 (181)	33.2 (128)	4.06	0.87

Mean of means=3.80

*negative item

2.2 Administrative Practices

This dimension deals with the impact of laptop use on the administrative practice of the teachers. Six items in Table 2 were above the overall mean (3.93). Item number 11 had the highest mean score 4.26 (S.D.=0.82), followed by item number 2 (M=4.21; S.D.=0.71). Item number 4 had the lowest mean score among all the items (M=3.55; S.D.=1.14) while the second lowest was from item 7, which was the negative item (M=3.56; S.D.=1.5).

Table 2
Percentages, Means and Standard Deviations for Items on Administrative Practices

Items	**SD % (f)**	**D % (f)**	**N % (f)**	**A % (f)**	**SA % (f)**	**Mean**	**SD**
1. I can complete my work in a shorter time because I can take work home in my laptop.	35.5 (137)	48.7 (188)	9.8 (38)	4.4 (17)	1.6 (6)	4.12	0.87
2. Having a laptop helps me to be better organized in my work.	34.2 (132)	55.7 (215)	7.3 (28)	2.6 (10)	1.6 (.3)	4.21	0.71
3. I key-in examination marks on spreadsheets using the laptop.	2.4 (9)	12.4 (48)	13.5 (52)	40.7 (157)	31.1 (120)	3.88	1.12
4. I calculate the examination marks on spreadsheets using the laptop.	3.9 (15)	18.7 (72)	18.1 (70)	37.0 (143)	22.3 (86)	3.55	1.14
5. I analyse the examination marks on spreadsheets using the laptop.	3.4 (13)	13.0 (50)	16.3 (63)	43.5 (168)	23.8 (92)	3.72	1.07
6. The quality of my work has improved since I received a laptop.	0.3 (1)	3.9 (15)	19.2 (74)	55.4 (214)	21.2 (82)	3.94	0.76
7. * Using the laptop has increased my workload.	4.1 (16)	12.7 (49)	23.1 (89)	42.7 (165)	17.4 (67)	3.56	1.05
8. Laptop is a vital tool for recording assessment data.	0.5 (2)	4.9 (19)	9.3 (136)	51.0 (197)	34.2 (132)	4.13	0.81
9. I use the laptop to store students' information.	0.5 (2)	6.5 (25)	11.4 (44)	49.7 (192)	31.9 (123)	4.06	0.86
10. Having a laptop has improved my efficiency in class management.	0.5 (2)	8.3 (32)	20.2 (78)	51.6 (199)	19.4 (75)	3.81	0.86
11. I use the laptop to create examination sheets or worksheets.	1.0 (4)	3.9 (15)	6.0 (23)	46.6 (180)	42.5 (164)	4.26	0.82

Mean of means=3.93
* negative item

2.3 Use of Resources

Table 3 shows the findings of the impact of laptop use on teachers' use of resources. Five items with scores above the mean (3.75). Item number 1 scored the highest among all (M=4.13; S.D.=0.80). The lowest mean score (M=3.41, S.D.=1.13) was from item 6 (S.D.=1.13). This may be due to the lack of Internet access at some of the teachers' residence, or teachers do not use their laptop with the Internet while at home.

Table 3
Percentages, Means and Standard Deviations for Items on Use of Resources

Items	**SD % (f)**	**D % (f)**	**N % (f)**	**A % (f)**	**SA % (f)**	**Mean**	**SD**
1. Having a laptop has helped me to obtain access to more up-to-date information.	0.80 (3)	3.9 (15)	10.1 (39)	51.8 (200)	33.4 (129)	4.13	0.80

2.	With the laptop, I have the freedom to access the Internet anywhere I like.	2.3 (9)	11.9 (46)	19.2 (74)	40.9 (158)	25.6 (99)	3.76	1.04
3.	Having a laptop enables me to surf websites to search for relevant information.	2.1 (8)	6.2 (24)	12.4 (48)	51.0 (197)	28.2 (109)	3.97	0.92
4.	I often use the Internet with the laptop to enhance my teaching.	1.0 (4)	17.1 (66)	29.0 (112)	40.2 (155)	12.7 (49)	3.46	0.95
5.	Having a laptop enables me to experiment with new software at home.	2.3 (9)	11.9 (46)	17.9 (69)	49.2 (190)	18.7 (72)	3.7	0.98
6.	I use my laptop to obtain access to the Internet at home.	4.7 (18)	20.7 (80)	21.2 (82)	36.0 (139)	17.4 (67)	3.41	1.13
7.	Having a laptop has given me the access to a greater range of teaching resources than ever before.	0.80 (3)	4.7 (18)	15.3 (59)	58.3 (225)	21.0 (81)	3.94	0.79
8.	I can download documents from the Internet now that I have a laptop.	1.3 (5)	10.4 (40)	16.3 (63)	46.4 (179)	25.6 (99)	3.85	0.96
9.	With a laptop, I intend to purchase educational electronic resources (e.g.: CD, VCD and DVD).	3.7 (14)	11.1 (43)	25.1 (97)	46.1 (178)	14.0 (54)	3.55	0.99

Mean of means=3.75

2.4 Levels of Laptop Impact on Teachers' Professional Development

Professional development was categorized into three levels: low, moderate and high; according to the 25th, 50th and 75th percentile. Cumulative scores that fall below the 25th percentile is categorized as having a low impact, between 25th and 75th percentile as moderate impact and above the 75th percentile as high impact. Table 4 portrays that the percentages of teachers who perceived that laptop has a moderate and high impact on their teaching-learning process was almost equal (35.2% and 34.7% each). Almost a majority of them (47.4%) indicate that the laptop impact on their administrative practices was moderate. In terms of resources, nearly half of the teachers (46.9%) confirmed the impact of the laptop was moderate on their use of resources.

Table 4
Levels of Laptop Impact on Teachers' Professional Development

Dimension	**Low % (f)**	**Moderate % (f)**	**High % (f)**	**Mean**	**SD**
Teaching-Learning	30.1 (116)	35.2 (136)	34.7 (134)	3.80	.67
Administrative Practices	25.6 (99)	47.4 (183)	26.9 (104)	3.93	.61
Use of Resources	27.5 (106)	46.9 (181)	25.6 (99)	3.75	.69
Overall Professional Development	**26.4 (102)**	**48.7 (188)**	**24.9 (96)**	**3.68**	**.47**

Mean of means=3.68

On the whole, almost half of the school teachers (48.7%) indicated that laptop has a moderate impact on their overall professional development. All three dimensions scored above the mean (3.68).

3. Conclusion

Teachers of this study were found to have experienced a positive, moderate impact of laptop on their professional growth. The use of laptop during teaching-learning has helped teachers improve their classroom instruction. Moreover, the portable technology was also actively used for other tasks such as administrative practices. Additionally, the laptop has helped improved teachers' quality of work and their efficiency in class management. Teachers regard laptop as a vital tool for recording students' record as it allows storage for large amounts of data such as the students' information and the assessment marks. Even though the findings reported a moderate level of laptop impact, it can be assumed that teachers are now beginning to accept and assimilate their daily practices with the help of laptops.

Reference

[1] Zhao, Y. (2007). Social studies teacher's perspectives of technology integration. *Journal of Technology and Teacher Education, 15*(3), 311-333. Chesapeake, VA: AACE.

[2] Choong, K. F. (2004). *English for the teaching of Mathematics and Science (ETeMS): From concept to implementation.* English Language Teacher Center Malaysia. pp. 1-11. Retrieve September 13, 2007 from www.eltcm.org

[3] Pillay,H. & Thomas,M. (2004). *A nation on the move: From chalkface to laptops.* Paper presented at MICELT. Retrieved October 16, 2008 from www.eltcm.org

[4] Microsoft's Partnership in Learning. (2007). *Learning to Lead Change: Building System Capacity*. Asia Elite Short Course, March 2007.

[5] Ucapan Bajet Tahun 2003 (2002). *Ucapan bajet tahun 2003 oleh YAB Dato' Seri Dr. Mahathir bin Mohamad Perdana Menteri dan Menteri Kewangan Malaysia.* Rang Undang-undang Perbekalan 2003. Dewan Rakyat.

[6] Noraini Idris, Loh, S.C., Norjoharuddeen Mohd. Nor, Ahmad Zabidi Abdul Razak & Rahimi Md. Saad. (2006). The professional preparation of Malaysia teachers in the implementation of teaching and learning of Mathematics and Science in English. *Eurasia Journal of Mathematics, Science & Technology Education, 3*(2), pp. 101-110.

[7] Bee, T. L. & Chia, H. S. (2008) Exploring the extent of ICT adoption among Secondary school teachers In Malaysia. International Journal of Computing and ICT Research, Vol. 2, No. 2, pp.19-36. Retrieved June 13, 2009 from http://www.ijcir.org/volume2-number2/article 3.pdf

[8] Cunningham, M., Kerr, K., McEune, R., Smith, P., & Harris, S. (2003). *Laptops for teachers: An evaluation of the first year of the initiative.* ICT in School Research and Evaluation Series No. 19. Becta/National Foundation for Educational Research (NfER).

[9] Silvernail,D.L. & Lane,D.M.M. (2004). *The impact of Maine one-to-one laptop programme on middle school teachers and students*. Maine Education Policy Research Institute University of Southern Maine Office, USA.

[10] DeVellis, R. F. (2003). *Scale development: Theory and application*. Thousand Oaks, California: Sage Publications, Inc.

[11] Hinton, P. R. (2004). *Statistics explained* (2nd ed.). New York: Routledge

[12] Pallant, J. (2005). *SPSS Survivor Manual: A step by step guide to data analysis using SPSS version 12.* New York: Open University Press.

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A Report on Investigation of Digital Literacies among Child, Teacher, University Student

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Abstract: This report is on basic research that tests an approach to information ethics education from the perspective of digital media. From a previous study on digital literacy, I composed a questionnaire on media usage behavior and awareness (involving such things that are seen as important), targeting junior high school students, in-service teachers and university students (student teachers), and analyzed the results. I will describe from the results, the approaches to information ethics education (the current educational approach, with diverse and extensive information, and an approach in which commonalities and perspectives are slightly altered), based on the commonalities and differences between the three parties.

Keywords: Digital literacy, information ethics, in-service education, teacher training, language activities

Introduction

As living and media environments are changing, child literacy is changing. The literacy acquired at school and the literacy that children are using from the influence of media etc. out of school are intricately entangled, and the influence of this is beginning to show in the literacy education of schools. Under these circumstances, teachers are also turning to literacy acquired out of school and beginning to examine the content and method of considering the acquisition of literacy required at school [4].
Various surveys on media usage behavior, studies related to awareness, views, thoughts, perception, traits etc. have already been conducted at the school, teacher training and in-service training levels[1] [7] [8] [9], related to these changes in media environment and changes in children, school and family[6]; the countermeasures have also been investigated [2] [3].

1. Purpose and Objectives

Thus in this report, in order to have a more detailed picture of the similarities and differences in media usage behavior of junior high students, in-service teachers and university students aspiring to become teachers, I decided to analyze the results of a study conducted with the same questionnaire [5] and validate the content of the previous studies above, while making reference to these previous studies. In other words, to gain a more clear understanding of the situation through an actual investigation by asking if ‘student teachers and in-service teachers are experiencing a situation where they can understand the children’s digital literacy.’ The objective was to identify if student teachers and in-service teachers ‘are in a situation where they understand that the literacy acquired at school and the influence of media out of school, and its literacy are intricately entangled, and that its influence on literacy at school is beginning to show'.

2. Method

A questionnaire survey was conducted with the cooperation of one junior high school (255 boys, 247 girls – a total of 502; for details, refer to Table 1. An inventory survey was conducted at the school in November 2009 with a 93% response rate, as many students were absent due to influenza at the time of the survey.), 88 third-year student teachers at a national teacher training university (45 male, 43 female; 20–22 years of age; the survey was conducted in June 2009 at a lecture for third-year students at the same university aspiring to obtain elementary or junior high school teaching licences; responses were collected from a collection box once completed with a 55% response rate), and the cooperation of 324 in-service teachers at elementary and junior high schools in Prefecture A (115 male, 209 female; for details, refer to Table 2. The survey was conducted during a refresher training course (common compulsory subject) for all teaching staff; responses were collected after the training with a 99% response rate) with a questionnaire.

Table 1: Students at junior high school

	Y1	Y2	Y3	Total
Boys	98	69	88	255
Girls	83	77	87	247
Total	181	146	175	502

Table 2: In-service Teachers

	30 years	40years	50years	Total
Male	17	32	66	115
Female	40	59	110	209
Total	57	91	176	324

3. Results

The results were consistent with other studies: (1) The rate of mobile phone ownership among junior high school students increased with year level, with more girls than boys having one (especially Year 3 students); (2) Girls begin to use their mobile phones earlier than boys, from late elementary school; (3) Girls use their mobiles phones more times a day than boys do, which increases with year level; (4) Girls feel mobile phones to be more necessary than boys do, which also increases with year level etc. Further, girls in all year levels placed 'the importance of a mobile phone' slightly higher than boys did, with third-year junior high school girls clearly placing quite a high importance on it.

On the other hand, 70–80% of school students responded that they had never encountered the problem of information ethics in online communication. However, if we look at the ownership ratio, we cannot say that these encounters seldom occur; we can see that girls actually often experience them. As expected with higher ownership and usage, girls also had more methods for avoiding these encounters, and they were able to relate in their own way what methods they were using. Further, while there was not much overall demand for learning how to communicate more effectively, when considered with the rate of ownership, the demand was high. Responses to why learning more was necessary showed a mixture of concern for avoidance of danger and for effective usage, with responses such as 'information on dangerous sites', 'what to do if in trouble (what to do if someone writes something strange; what to do if you discover someone writing something strange; what to do if you get a strange request etc.)', 'effective use of the net' and 'information on useful sites'. Further, as shown in the results above, the need for learning about net usage was greater than the need for learning about communication. In fact, from the space on the questionnaire provided for a qualitative response on methods taken in online communication, we can see that people are trying to communicate without misunderstanding. In their interaction, they are 'using a choice of words that match the other party' and 'using pictorial symbols to avoid misunderstanding', and getting their information from 'friends' and 'magazines and TV'.

Further, expanding slightly, in terms of media used most often, internet usage was high among both girls and boys in all year levels; mobile phone usage was higher among girls, as mentioned above, especially in girls in third-year junior high. More boys used game consoles; however, the usage declined by third year of junior high school, with a tendency to moving on to music players etc. Overall, there was not much usage reported of social networking tools using Web 2.0 technology, such as SNS or blogging; however, there was a trend for this to increase temporarily in the second year and then tapering off again. There was a tendency for blog usage among girls (see Table 3).

Table 3 (multi answer)

	SNS	blog	net shopping	game	collect info	ticket buy	writing
Y1 Boys	6%	9%	10%	34%	38%	4%	5%
Y1 Girls	5%	18%	6%	37%	40%	6%	7%
Y1	6%	13%	8%	36%	39%	5%	7%
Y2 Boys	14%	9%	9%	32%	32%	7%	6%
Y2 Girls	19%	21%	19%	35%	45%	12%	8%
Y2	17%	15%	14%	34%	39%	10%	7%
Y3 Boys	10%	9%	8%	24%	40%	2%	9%
Y3 Girls	8%	28%	9%	13%	52%	7%	14%
Y3	9%	18%	9%	18%	46%	5%	11%
Boys	10%	9%	9%	30%	37%	4%	7%
Girls	11%	22%	11%	28%	46%	8%	10%
Total	8%	7%	7%	18%	22%	5%	6%
	e-mail	music download	video player	graphics	pic edit	video edit	others
Y1 Boys	9%	38%	34%	2%	6%	10%	5%
Y1 Girls	16%	25%	37%	6%	4%	4%	5%
Y1	12%	32%	36%	4%	5%	7%	5%
Y2 Boys	12%	33%	35%	3%	7%	12%	1%
Y2 Girls	26%	48%	53%	3%	8%	6%	8%
Y2	19%	41%	45%	3%	8%	9%	5%
Y3 Boys	14%	49%	33%	2%	3%	7%	5%
Y3 Girls	29%	28%	34%	2%	5%	2%	1%
Y3	21%	38%	34%	2%	4%	5%	3%
Boys	11%	40%	34%	2%	5%	9%	4%
Girls	23%	33%	41%	4%	5%	4%	4%
Total	9%	23%	20%	4%	6%	8%	5%

Next, let us now look at the media usage behavior of student teachers and in-service teachers.

Table 4 Purpose of use of computer and Internet by preservice (multi answer)

SNS	Chat	net shopping	game	collect info	ticket buy	writing	e-mail
51%	2%	34%	26%	70%	11%	63%	36%
music download	video player	graphics	pic edit	video edit	blog	others	
39%	42%	9%	9%	8%	11%	1%	

Table 5 (multi answer)

	SNS	Chat	net shopping	game	collect info	ticket buy	writing	e-mail
male 30 years	18%	6%	24%	12%	88%	12%	59%	41%
female 30years	10%	3%	38%	5%	74%	15%	62%	28%
Total 30yeas	12%	4%	33%	7%	77%	14%	60%	32%
male 40 years	13%	3%	22%	9%	94%	19%	84%	66%
female 40years	12%	5%	22%	7%	69%	16%	47%	36%
Total 40yeas	12%	4%	22%	8%	77%	16%	59%	46%
male 50 years	8%	5%	33%	9%	76%	23%	76%	50%
female 50years	5%	0%	21%	8%	79%	17%	69%	22%
Total 50yeas	6%	2%	26%	9%	77%	19%	71%	32%
Total male	10%	4%	29%	10%	83%	20%	76%	53%
Total female	8%	2%	24%	7%	74%	16%	60%	27%
Total	9%	3%	26%	8%	77%	17%	66%	36%
	music download	video player	Graphics	picture edit	video edit	blog	others	
male 30 years	12%	24%	6%	24%	24%	12%	0%	
female 30years	10%	18%	5%	23%	5%	18%	3%	
Total 30yeas	11%	19%	5%	23%	11%	16%	2%	
male 40 years	16%	28%	6%	19%	13%	3%	0%	
female 40years	5%	10%	2%	28%	3%	2%	7%	
Total 40yeas	9%	16%	3%	24%	7%	2%	4%	
male 50 years	8%	20%	3%	26%	11%	5%	12%	
female 50years	6%	14%	4%	33%	3%	0%	5%	
Total 50yeas	6%	16%	3%	30%	6%	2%	7%	
Total male	10%	23%	4%	23%	13%	5%	7%	
Total female	6%	13%	3%	29%	3%	4%	5%	
Total	8%	17%	4%	27%	7%	4%	6%	

Among student teachers, usage

began earlier in females, with a later start with an increase in age. Both student teachers and in-service teachers showed a high interest in learning about the features and methods of online communication, regardless of age or gender, and showed an awareness of this. Furthermore, everyone showed a particularly high need to understand children's online communication and the importance of learning the actual situation, with similar figures.
Again, expanding slightly, in terms of the media used most often, internet and mobile phone usage was high among both student teachers and in-service teachers, followed by music players for student teachers and digital cameras for in-service teachers. Student teachers used computers for collecting information, writing documents and SNS, mobile phones for telephoning, email, taking photos, using the internet and SNS(see Table 4, Table 5). As expected, email is clearly being done increasingly by mobile phones than by computers.

4. Discussions

As seen among the junior high school students in the survey, the use of media (mobile phones etc.) is definitely increasing among children. Further, it is evident that they are starting to use social tools such as SNS, blogging and profiles. It is also clear that users want to learn about useful sites, usage of online social tools, information about mobile danger and what to do when in trouble, rather than learning about various ways to communicate online. However, as the results have shown, we were able to verify to what extent student teachers took part in using social tools etc., but it was clear that in-service teachers had little experience using these.
From the above, while it is natural for there to be differences in media usage behavior between junior high students, student teachers and in-service teachers in individual variability, usage times and frequency, as far as the usage of mobile phones and media is concerned, there is not a great difference in modern usage experience, other than the use of social tools such as SNS, profiles and blogging. However, the difference between junior high students and in-service teachers is certainly their use of social tools such as SNS, profiles and blogging; if we are considering information ethics education and digital literacy education, this is clearly one key for the future.
On the other hand, from their qualitative responses, student teachers are now using social tools such as SNS, profiles and blogging in their own way, but they say that they are not confident in providing guidance on online communication and are anxious on how to interact with children.
Further, it was understood that many students faced great barriers when communicating by email etc., collecting information on the internet and using social tools. Even if they have had classes at university that used web page creation, bulletin board systems or information sharing software, they cannot connect that in their minds with social tools; it seems they cannot connect what they learnt (or are learning) with the target of their educational activities.
On the other hand, even if methods for usage and creation are being taught at university, no time is being given to activities to teach how to use this as a target towards education, or even if it has been taught, it seems that more measures are needed to make students aware of it.

5. Future Issues

In the above changing situation (Investigation results), teachers are also focusing on literacy acquired by children outside the classroom, considering the acquisition of literacy required at school, and they are beginning to examine the methods and their contents.
However, until now the initiatives for digital literacy in teacher training and in-service training have first focused on tool literacy, requiring the acquisition of literacy for its usage and operation. Next, in the areas of subject teaching and representational literacy, attention has been given to educational and training activities, and the focus has begun turning towards how to effectively use ICT in subject teaching. Recently, training by expressiveness or standing in the place of the producer has also been trialed through critical analysis of information and multimode representational activities. However, with the arrival of Web 2.0, there have been changes in communication such as using the web, 'participation', 'collaboration', 'emergence', 'integration' and 'growth', and the need has also begun for changes in the accompanying literacy (New Literacy: see Figure1).
Through a survey on the actual state of junior high school children and looking at the situation outlined above, students teachers and in-service teachers can understand the facts about children's digital literacy. In this report, we have attempted to clarify through the same questionnaire whether or not they currently have the experience to guide them. From what became clear through the survey above, if consideration is given to information ethics education in teacher training and in-service training in the future, it will be necessary to widely connect it with digital literacy and consider it when the perspective of New Literacy is related to these issues.

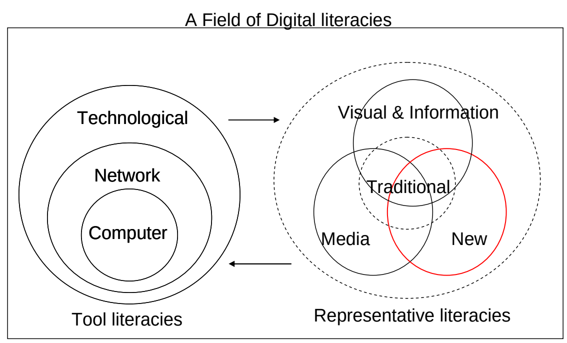

Figure1. Map of Digital Literacies

References

[1] Etoh, A., Imada, K., Suzuki, M.,and Nakamoto, K.(2009). A Study of Improvement in Education Programs for Developing Information Literacy in Teacher-Training Courses (2) : Influences of Compulsory Information Education in High School. *Bunkyo University Annual Report of The Faculty of Education*. Vol.43, 149- 160.

[2] Gotoh, Y.,(2008). Comparative Study of Preconception to Media Among Elementary School, Secondary School and University. *Japan Journal of Educational Technology*. 32(Suppl.), 61-64.

[3] Kobayashi,K. and Fujimura,Y. (2009). Analysis and consideration of questionnaire survey on image of media. *Research Report of JSET Conferences*. 09(1), 315-322.

[4] Oyanagi,W. (2008). A research on methodology about integrating adolescent: media interaction out of school into classroom lesson. *Japanese Journal of Educational Media Research*. 15(1), 29-40.

[5] Oyanagi,W. (2010). An Investigation on Actual Conditions of Children's and Teacher's Digital Literacy. *Nara University of Education Bulletin of Center for Educational Research and Development* No.19 .229-237.

[6] Sugimoto,K., Horita,T. and Ishihara,K. (2009). Investigation about student's actual condition of using mobile phone intended for students, parents and their homeroom teachers (2). *Research Report of JSET Conferences*. 09(1), 1-8.

[7] Tai,S. and Ahama, S. (2007). A Study on the Relation between Teachers' Experience of the Operation of Information Apparatus and Their Consciousness about It (Information Education). Yamaguchi *University Bulletin of the Integrated Center for Education Research and Training*. 23, 191-197

[8] Tuji,Y., Hada, Y. and Nishimori, T. (2007). Survey on the use of media by university students: result of preliminary survey. *Research Report of JSET Conferences*. 07(1), 109-116.

[9] Yokoyama,T. (2009) Tryout of School Based Systematic Information Morality Education : A Case Study at Junior High School through Cooperation of the Students, The Teachers, and The Guardians. Japan Society of Educational In formation, Journal of Educational Information . 25(2), 23-29.

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Computer-Supported Freewriting：Improving Writing Attitude and Idea Generation

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Abstract:. Most students in Taiwan feel anxiety or suffering when teachers ask them to write compositions in class because writing might be viewed as a complex problem solving process and they often lack self-confidence in their writing abilities. Pre-writing has been recognized as especially relevant to successful writing at the beginning. Therefore, it is important to make students be willing to write something without fear at the pre-writing stage and improve their writing attitudes. The paper presents a computer-supported freewriting system (CSFWS) integrated with extensive reading pedagogy in order to improve their attitudes toward writing and to facilitate students' writing idea generation. The results show that after participating freewriting activities by the proposed CSFWS system, students become more positive in writing attitudes. Namely, students have more confidence and willingness in writing in their daily school life. The study found that when the difficulty level of writing topic is corresponding to students' writing abilities, students will be more productive. In addition, students' diction in freewriting should be further evaluated.

Keywords: freewriting, writing attitude, idea generation, computer-supported

1. Introduction

Most students in Taiwan feel anxiety or suffering when teachers ask them to write compositions in class, especially for boys. Students dislike writing because they often lack self-confidence in their writing abilities and most of their writings are evaluated for academic achievement, not belonging to themselves. Furthermore, in a conventional classroom writing environment in Taiwan, students write compositions based on an assigned topic within a limited period of time and follow the teacher's guidance and interpretation on how to write well. After receiving submissions from students, the teacher reviews works. Students generally get feedback from the teacher and then put their works aside. Writing itself is more a teacher-oriented job than a student-oriented task (Yang, 2005).

Writing might be viewed as complex problem solving processes. It is important to make a student feel confident as a successful writer. Rohman (1965) divided writing into three processes, including Pre-Writing, Writing, and Re-Writing. Among these writing processes, pre-writing has been recognized as especially relevant to successful writing at the beginning. At the pre-writing stage, teachers can conduct various activities for students to generate writing ideas, brainstorming, or make an outline to support their writing. Within the area of pre-writing study, freewriting has emerged as one of the most useful pre-writing skills. Students just write down whatever comes to mind without regard to spelling, grammar, etc., and make no corrections. The main principle of freewriting is nonstop writing (Elbow, 1973). The way of freewriting will help students in finding interesting topics and in promoting their motivation in writing. Fishman (1997) finds that freewriting is an effective way for students to get started, an opportunity to discover they do have topics they care about. In addition, he indicates that freewriting is a vehicle for developing students' self-respect, for helping students appreciate their own ability apart from someone else's evaluation.

The aforementioned studies indicated that pre-writing plays an essential role in successful writing for students who lack of confidence in writing. Also, students engaged in extensive reading still get great improvement in writing competency. However, they paid less attention to the integration in pedagogy with both extensive reading and pre-writing. Meanwhile, some studies have shown that the writing with a computer rather than using pen and paper can reduce students' errors (Grejda & Hannafin, 1992) and increase the writing quality (Breese et al., 1996; Lam & Pennington, 1995). Thus, the objective of this study is to develop a computer-supported freewriting system integrated with extensive reading pedagogy in a digital classroom, for students generating writing ideas, establishing confidence in writing, and building positive attitudes toward writing.

2. System Design

2.1 System Architecture

According to above motivation and literatures, we design a computer-supported freewriting system (CSFWS) for enhancing students' writing idea generation and promoting their writing attitudes. The CSFWS was designed based on the previous work on digital classroom environment framework (Liang, 2005) and includes a courseware server, client learning system and real-time synchronized agent. Figure 1 shows the detailed system architecture. The client learning system which consists of four software agents and one login interface can provide the same theme articles for learners to stimulate their writing ideas and then to quick write down ideas with freewriting strategy. It is not only increasing learners' reading skills but also stimulating their writing idea generation. The courseware server, which contains three software agents, two databases, and one management interface, is responsible for supporting a teacher to control learning activities and providing a user-friendly interface for a teacher to manage the required theme-based reading articles and associated vocabularies. Moreover, to support the class-wide learning pace and the monitoring function, the real-time synchronized agent is necessary to be in charge of keeping learners' learning statuses real-time for the teacher monitoring and letting learners in the same learning procedure. In this work, the real-time synchronized technique provided in Flash Communication Server was employed to perform this work.

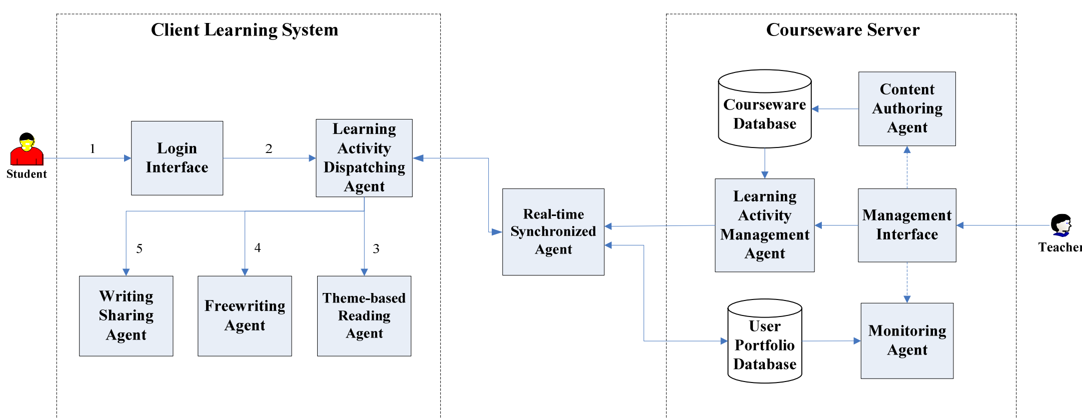


Figure 1. The system architecture of the proposed CSFWS system

2.2 The learning procedures through the client learning system

We designed and implemented the CSFWS system to support a freewriting activity in a digital classroom. For a freewriting activity, the learning procedures basically are based on a student-centered philosophy. We try to let students have much more time to engage in their learning, that is to say, teachers talk less, students practice more. According to this rationale, the details of learning procedures of freewriting activity are illustrated as Figure 2, and described as follows:

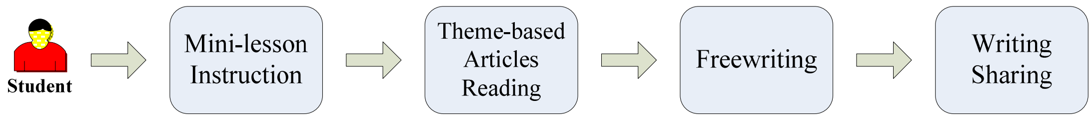


Figure 2. The learning procedures of freewriting activity through the client learning system

Step1. At the every new topic of freewriting activity beginning, the teacher can give some introduction, writing guidelines, or key points of today's lesson as a mini-lesson instruction. A mini-lesson focuses on a specific teaching point and lasts five to ten minutes, not too long. Mini-lessons are ideal for quick lessons leading to active engagement. That is, in the mini-lesson instruction session, the teacher can only instruct one or two teaching points what students have to learn in less than ten minutes.

Step2. In order to stimulate students' writing ideas and supply students' background knowledge, we prepare six themes of freewriting and each theme is arranged four relative articles for students to read. In theme-based articles reading, students can quick read these articles and get writing inspiration or ideas from such relative articles. Furthermore, they can acquire new vocabularies by the vocabulary explanation function, which shows the phonic, meaning, and example of the vocabulary.

Step3. After immense stimulation and input from reading, students can easily jotting down whatever comes to mind at the time. The good phrases from the previous read articles would be recommended and shown to students for reference, if students are willing to use some good phrases in their freewriting. However, the most important requirement is that students never stop lasting ten to fifteen minutes. In such a time, students are engaged in freewriting and are productive.

Step4. The teacher can carry out a writing sharing activity depending on the time left. In the sharing interface, all freewritings by students are anonymous because the freewriting is mess and would not be evaluated suggested by Peter Elbow. In addition, students would not feel anxiety from peer pressure and would be more confident in their freewriting.

3. Experiment

3.1 Participant

Participants were 32 children at fourth grade in a primary school in Taiwan. There were 15 males and 17 females. Children were native speakers of Chinese and were in the same class. Most of the children came from working class families. Children had basic computer skills learnt from computer classes for one year at school, but had no writing experience with netbooks. The experiments were conducted twice a week for three months and each time was lasting forty minutes. Also, the writing attitude and the writing idea were evaluated.

3.2 Analysis

3.2.1 Writing attitude measurement

To evaluate students' attitudes toward writing, a writing attitude measurement referred to Jeng's research (1995) and was modified. The measurement is four-point Likert scale and involves thirteen questions divided into three dimensions, including writing affection, writing practice, and writing expression. The pre-test and pos-test of writing attitude measurement were conducted and twenty six students' data were validated. the paired sample t-test statistics was used to analyze the results of the pre-test and post-test. Table 1 lists the paired sample t-test statistics information (N = 26).
Overall speaking, this study found that the difference of the mean scores between the pre-test and post-test is 0.26 and the results reach the significant level under the degree of freedom is set to 25 ($t = 4.85$, $p < .05$). In other words, after learning freewriting with the proposed CSFWS system, the changes of participants' writing attitudes are positive and achieve significant level. For detail, the writing model of this study in terms of writing attitude not only effects on participants' writing affection dimension ($t=3.82$, $p<.05$) but also effects on their writing practice dimension ($t=2.99$, $p< .05$) and writing expression dimension ($t=2.83$, $p<.05$). That is, participants show more confidence and willingness in writing and they feel that writing is not a hard work and can accomplish compositions by their own.

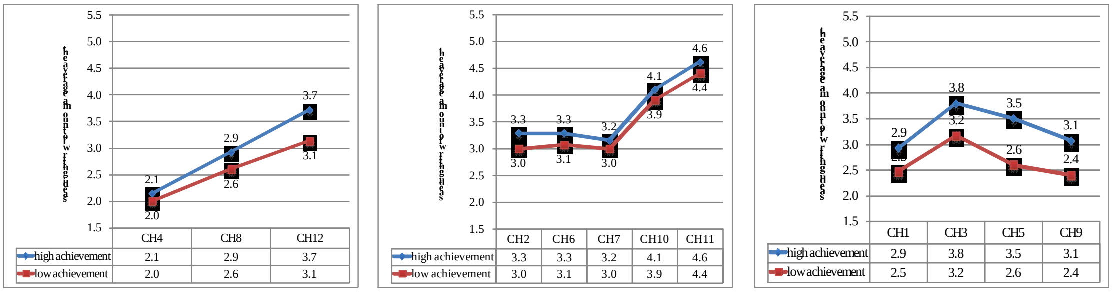
Table 1. The paired sample t-test for both the pre-test and post-test scores

Paired Samples Test

Posttest-Pretest of dimensions	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
writing affection	0.31	0.41	0.080	3.83	25	0.001
writing practice	0.22	0.37	0.071	2.99	25	0.006
writing expression	0.24	0.44	0.085	2.83	25	0.009
Total	**0.26**	**0.27**	**0.053**	**4.85**	**25**	**0.000**

3.2.2 Writing ideas analysis

All ideas of students' freewritings were coded by two Chinese language experts. The correlation is high ($r=.789$). Twelve writing topics were divided into three levels of difficulty, high, moderate, and low, according to students' feedback. All participants also were grouped into two groups, high achievement and low achievement, based on their last term grades in Chinese. As shown in Figure 3, at high level of difficulty, the writing ideas, in general, in both two groups are performed better in Ch12 than in Ch4. That is, students can gradually produce more ideas in the freewriting session. At moderate level of difficulty, for both high and low achievement groups, students generated the most amounts of ideas among these three difficulty levels. It seems to be that students have more thoughts and create more ideas at the appropriate difficulty level. At low level of difficulty, the trend of curves is not intended to increase. Students did not perform well, especially in last two topics. We found that students intended to describe more in words for one event or one idea, not to get ideas diversely at the low level of difficulty topics.



(a) high level of difficulty (b) moderate level of difficulty (c) low level of difficulty

Figure 3. The average amount of ideas generation

4. Conclusion

This study proposes a computer-supported freewriting system (CSFWS) integrated with extensive reading pedagogy to improve their attitudes toward writing and to facilitate students' writing idea generation. The results show that after participating freewriting activities by the proposed CSFWS system, students have more positive attitudes toward writing, not only in the writing affection dimension but also in the writing practicing and in the writing expression dimensions. Namely, students have more confidence and willingness in writing in their daily school life. Furthermore, theme-based articles reading can immediately supply students' background knowledge for writing and stimulate their idea generation. In terms of idea creation, the study found that when the difficulty level of writing topic is corresponding to students' writing abilities, students will be more productive. In addition, students' diction in freewriting should be further evaluated. It would be interesting to see how many vocabularies or phrases students learnt from theme-based articles reading were used in their writings.

Acknowledgements

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References

[1] Chan, T.-W. (2010). How East Asian classrooms may change over the next 20 years. *Journal of Computer Assisted Learning. 26* (1), 28-52.

[2] Elbow, P. (1973). Writing without teachers. Oxford: Oxford University Press.

[3] Fishman, S. M. (1997). Student writing in philosophy: A sketch of five techniques. *New Directions for Teaching and Learning, 69*, 53-66.

[4] Grejda, G. F., & Hannafin, M. J. (1992). Effects of word processing on sixth graders' holistic writing and revisions. *Journal of Educational Research. 85* (3), 144-149.

[5] Jeng, B. J. (1995). How editing strategy effects on writing performance, editing ability, writing attitude for elementary students. (Master thesis written in Chinese). Taiwan National Central Library. No. 084NTNT2576004.

[6] Liang, J. K., Liu, T. C., Wang, H. Y., Chang, B., Deng, Y. C., Yang, J. C., et al. (2005). A few design perspectives on one-on-one digital classroom environment. *Journal of Computer Assisted Learning*, 21, 181-189.

[7] Rohman, D. G. (1965). Pre-Writing the Stage of Discovery in the Writing Process. *College Composition and Communication, 16* (2), 106-112.

[8] Yang, J. C., Ko, H. W., & Chung, I. L. (2005). Web-based Interactive Writing Environment: Development and Evaluation. *Educational Technology & Society, 8* (2), 214-229.

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An Innovation Diffusion Approach to Online Student Question-Generation and its Effects on the Relationship of Perceived Task Value and Learning Approach

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Abstract: The purposes of the study are two-fold: first, to design an online student question-generation activity in light of an innovation diffusion approach, and second, to examine if it influences the relationship between learner perceived task value and their approaches to learning. This study found that the innovation diffusion approach let participants perceive the introduced technology as valuable and that it moderated the predicative effect of task value on the adoption of deep approach. Implications for technology diffusion and instructional implementations are provided.

Keywords: online student question-generation, technology integration, task value, approaches to learning

1. Introduction

Despite that research on student question-generation generally supports its educative efficacy, students exposed to the activity were reported to react differently in terms of perceived task value and learning strategy use [1]. Though differences in personal characteristics (e.g., academic ability, past experience in the adopted strategy) have been examined and yielded useful suggestions for instructional implementation, the effects of context arrangements of student question-generation are less noticed and remain unknown. Thus, the purpose of the study is to design an innovation-diffusion based student question-generation activity and to examine its effect on the relationship between learner perceived task value and their approaches to learning.

2. Innovation Diffusion Approach as the Guiding Theoretical Framework for the Structures of the Online Student Question-Generation Activity

Principles suggested by innovation diffusion theorists were referred to and used as the framework for structuring the online student question-generation activity: informing the relative advantages and compatibility of the strategy, reducing the complexity of the innovative technology, and enhancing opportunities to interact with the technology and observe the consequence [2]. First, learners are informed of the value of the technology for their current learning process and future use so as to enable them to judge the relative advantages and compatibility of the strategy. Second, a training session was design to demonstrate the process of learners interacting with the features of technology so as to reduce the possible anxiety to the innovative technology and to enhance the accuracy of their estimating the cognitive demands for accomplishing the required tasks. Third, learners were given opportunities to practice generating questions as a routine. Finally, as for the constant observation of the consequence of their practice principle, participants received feedback both from their peers and a teaching assistant to accentuate important question-generation practices.

3. The Relationships between Perceived Task Value, Approaches to Learning and Contextual Arrangements

General Value-expectancy theory argues that learners' perceived task value influence their decisions on time and efforts devotion to learning tasks [3-5]. Additionally, according to Student Approach to learning (SAL) theory, students select information processing strategies according to their interpretation of the learning context and requirements [6-8]. Theoretically speaking, the extent and way of students experiencing the question-generation technology should affect their interpretation of the learning task and associated perceived task value, thus, leading to different degree of learning approaches. As the effects of contextual arrangements are less noticed, the study set examined if and how an innovation diffusion approach to online student question-generation influences the relationship between learner perceived task value and learning approaches.

4. Method

Two conditions were set up. For the innovation diffusion approach, 50 university students registered in a teacher preparation course participated in the activity, structured according to innovation diffusion theorists as described. For the non-diffusion approach, one hundred and sixty-one comparable participants, after being briefed about the features and values of online student question-generation technology for teaching and learning, experienced generating questions in one class session.

Two measures were used in this study. Task value, consisted of 9-item, is a 6-point Likert scale (1, "not at all true of me" to 6, "very true of me.") with established validity and reliability [4]. "*The Study Process Questionnaire*" developed by Biggs, Kember and Leung [9] was adopted. It consists of deep and surface approaches, each with corresponding ten items on a five-point scale (0, "never true of me" to 4 "always true of me").

5. Results

Descriptive statistics indicated that for the innovation diffusion approach, the mean scores of perceived task value rested in the upper half of the possible score ranges, while for the non-diffusion approach it rested in the middle. Results on the correlations between task value and deep approach found that the intensity of the correlations in the innovation diffusion group reached the large level, $r = 0.63$, while the non-diffusion group reached the medium level, $r = 0.32$. Moreover, the correlation patterns between the task value and surface approach and between the surface approach and deep approach are very different for the two groups—negative correlations for the innovation diffusion group and positive correlations for the non-diffusion group.

To further examine if and how online student question-generation diffusion approach effects the relationships between task value and learning approaches, moderation analyses was adopted. Results found that the interaction between innovation diffusion approach and task value on the deep approach reached statistical significance, F (1, 207) = 9.89, $p < .05$. Such an interaction on surface approach did not reach significance, F (1, 207) = 1.79, $p > .05$.

6. Conclusions

The fact that learners in the innovation diffusion condition associating higher task value with the introduced technology (as compared to the non-diffusion group) supported the design of the innovation diffusion approach to online student generation-generation activity. Additionally, innovation diffusion approach to the introduced strategy, as shown, lead to the comparatively greater predicative power of task value on deep approach orientation.
According to the innovation diffusion, general value-expectancy and SAL theories, learners' perception of the technology attributes and recognition of the cognitive demands associated with the cognitive gains would influence their level of adoption, their interpretation of the learning context, their perceived value level and their orientation to learning approaches [2-8]. This study further substantiated that the innovation diffusion approach moderated the predicative effect of task value on the adoption of deep approach. Based on the data, it is suggested that instructors aiming to induce learners in adopting technologies (both soft and hard technologies) and construing higher task values shall refer to the innovation diffusion theory. Particularly, by explicating the values of the introduced technology and exposing students to the delicate experience of its use, as found in the study, would influence the magnitude of the predicative effect of perceived task value on deep learning approach (i.e., intrinsically motivated devotion to learning).

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References

[1] Yu, F. Y. & Wu, C. P. (2008). Perceived task value and task difficulty of online student-generated questions: Its effects and implications for instruction. *Proceedings of the World Conference on Educational Multimedia, Hypermedia & Telecommunications, pp. 4516-4521. Vienna, Austria, June 30 - July 4, 2008.*
[2] Rogers, E. M. (2003). *Diffusion of innovations.* The Free Press.
[3] Eccles, J., Wigfield, A., Harold, R. D., & Blumenfeld, P. (1993). Age and gender differences in children's self- and task perceptions during elementary school. *Child Development, 64*, 830-847.
[4] Pintrich, P. R. (1989). The dynamic interplay of student motivation and cognition in the college classroom. In C. Ames & M. L. Moehr (Eds.), *Advances in motivation and achievement: Motivation enhancing environments, 6* (pp. 117-160). Greenwich, CN: JAI Press.
[5] Wigfield, A. (1994). Expectancy-value theory of achievement motivation: a developmental perspective. *Educational Psychology Review*, *6*, 49-78.
[6] Biggs, J. B. (1987). Student approaches to learning and studying, *Australian Council for Educational Research*. Melbourne, Australia.
[7] Laurillard, D. (1979), "The process of student learning", *Higher Education, 8*(4), 395-409.
[8] Ramsden, P. (1979). Student learning and perceptions of the academic environment. *Higher Education, 8*(4), 411-427.
[9] Biggs, J. B., Kember, D., & Leung, D. Y. P. (2001). The Revised Two Factor Study Process Questionnaire: R-SPQ-2F. *Br. J. Educ. Psychol. 71*, 133–149.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Learning with Mario Bros: Living in virtual worlds outside the classroom

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Abstract: This presentation examines, from an ethnographic perspective, how a 5 year old girl performs a process of reflection and implements certain strategies from her activity in a virtual world, supported by an adult. The data come from an ongoing case study aimed at examining children's representations that they constructed from their interactions with specific videogames. We will show how videogames, considered as cultural tools, create new communication environments which can be a good school for learning to think.

Keywords: videogames, children, informal learning, popular culture, problem solving.

1. Objectives

1. To explore communication scenarios created by the presence of new digital tools, especially videogames, when children and adults interact.
2. To discover children's representations which are present in the problem-solving process required by the game, and that take place in virtual worlds.
3. To design new educational settings in kindergarten and primary education, taking as the starting point commercial videogames.

2. Situated cognition and virtual environments

In this paper we focus on the evolution of Alicia, a five years old Spanish girl, when she played Super Mario Bros in a family environment. Our *theoretical approach is rooted on social-cultural psychology*. The idea of situated cognition is relevant to us. We can be certain that if children are playing videogames and talking about them outside and inside the classroom, what they would say and the models they would be elaborating from the game would be different. Looking to complement these two models, we found the concept of *"situated cognition"* as defined by anthropologist Dorothy Holland and his colleagues [2]. Adopting that *perspective, cognition is engaged with environment, action, and expertise*. Furthermore, knowledge is not only embodied through the agent's ability to perform an action (with his/her hands) but it is also embedded in the affordances provided by the environment and which are meaningful in specific contexts [1]. Looking at the games, these affordances are present in specific settings and related to precise rules that define the dynamics of the game. This is the perspective from which we will analyze some of the following conversations between the adult and the girl [3]. *We will show how the way in which the child interprets her own activities during the game, or those of the characters acting on the screen, depend on the features of the game that she's playing, the specific contexts in which she refers to these activities –*

when she dialogues with the adult or her peers- and even on her own expertise as a player.

3. Methodology

We adopted an ethnographic approach, acting as participant observers [2]. Alicia was observed once a week for about an hour while she played with the console in her leisure time outside of school. All the sessions were audio and video recorded. Photographs were taken of the girl while she was interacting with the game and also when she interacted with other technologies, typically the computer or the Wii console.
She was 5 years and 3 months old in March 2009, when we began to follow her. In this presentation we will follow her evolution during six months *(August 2009)*, and in fact we are even following her now, until she manages to complete the game Super Mario Bros.

4. Learning to solve problems using games

This was a complex process, which displayed a certain development over time. Alicia not only discovered specific rules of the game inductively, but was also able to verbalize them in order to teach the adult how to play.

4.1. Alicia's imaginary: March, 2009

Alicia spontaneously learned to manage the controllers and referred to the game by the character's name. One of her first games was LocoRoco[1]. Even though it comes from another franchise, just like all Mario games it presents a fantasy world organized around small creatures living in harmony with their planet and taking care of the plants. Alicia, when she began to play this game, alternated with those offered by the Mario series, especially Super Mario Bros.
After some spontaneous play sessions we asked her to make a drawing of what she liked most about playing with Mario. Looking at her drawing we noticed that several characters from children's culture were present, although we had asked her to focus on just one, Mario. Even when asked to draw a picture relating to the Mario Bros game, she went further in her drawing, combining the worlds of different games and even television shows. Her production illustrates all the fantasy worlds in which the child's everyday heroes lean, not only on the game but also on certain Disney series, such as Hannah Montana nowadays. Furthermore, her drawing not only includes characters, but also elements related to the puzzles and challenges of the Super Mario Bros game and which appear at the bottom left of the drawing.

4.2 The child as an expert problem solver (August 2009)

The analysis of the child's conversations with the adult shows complex strategies for solving problems, especially relevant if we take into account that she was still unable to

[1] http://en.wikipedia.org/wiki/LocoRoco

read. Her statements are a sign that she is aware of the actions that she must take to achieve her goal "not to kill it and to advance through the world of clouds", therefore she needs to establish relationships between the control and the action she wants to perform. She discovered things by herself, despite being unable to read, she tried various buttons and several alternatives until she understood the mechanism which linked the corresponding button to a concrete action. Moreover, the first descriptions that Alicia makes on her own show that she was aware of the presence of certain rules. Even more, she is able to verbalize her strategies to the adult. She understood that the mushrooms lets Mario get bigger or smaller and only then, Mario can go from one world to another not only through the clouds, but also going through pipes, etc. But it is still possible to go one step further: Alicia is able to teach the adult how to move across the screen in anticipation of what might happen.

5. Why and how can Mario be present in Early Childhood or Primary education?

If analyzing Alicia's activities when interacting with the game teaches us something, it is certainly that she wasn't wasting her time. All the time she was forced to reason and to solve specific problems. Our main question now is, why do schools not take advantage of these resources? By playing the game, Alicia, a five year old girl, was maybe much more motivated to read (to discover special instructions present on the screens). At the same time she was developing other abilities related to solving complex problems that will be very useful in her future life as a citizen of the twenty-first century.

We can ask once more how video games may be used in the classroom. Answers may be multiple, all complementary. Finding information about the game can be the first step. Another important aspect will be to decide which console to use. The small Nintendo DS is perhaps the most appropriate for very young kids because its controls are easily handled by children. They can even bring them to the classroom to play in small groups, organizing the class activities around small projects.

Finally, they may imagine that Mario is already in the classroom. A pre-assembly to generate reflection, asking questions that generate interest, will help children to understand that they can also learn with Mario. After the game session, the general discussion, explaining what happened, including video projections of the game, will help to raise awareness of the problems to be solved, and above all, to re-formulate, to discover the way to solve them and, in the end, to encourage thought and reflection.

6. References

[1] Gee, J. (2008). Video Games and Embodiment. *Games and Culture, 3 (*3-4), 253-263.

[2] Holland, Dorothy, & Lave, Jean (Eds.). (2001). *History in person. Enduring struggles, contentious practice, intimate identities*. Santa Fe (USA) & Oxford: School of American Research Press & James Currey.

[3] Lacasa, Pilar, Méndez, Laura, & Martínez, Rut (2009). Using videogamesas educational tools: Building bridges between comercial and serious games. In Marja Kankaanranta & Pekka Neittaanmäki (Eds.), *Design and use of serious games.* (pp. 107-126). Milton Keynes, UK: Springer

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

(A) Study on the Development of a Class Model of Computer Ethics Based on TPB

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Abstract: Because of the development of information and communications technology, Computer-Ethics education, which is desperately needed emphasizes only necessity, but the real education in school has simply the adverse effect and has fragmentary education to deal with it. For the result, students have a gap between perception and action by not reaching the purpose of Computer-Ethics education which can have a change on the values and attitude. For it, our research with middle school students' information judges what is right or wrong, but by considering the theoretical basis which can explain the reason of inactive Computer-Ethics action, we try to develop the class model for the class. Therefore, we consider planned behavior theory and study Computer-Ethics class model development by deriving the strategy which reinforces the power of the practice of the incomplete actions in the theory that we know but have not been done.

Keywords: Information Ethics, Theory of Planned Behavior, Class Model Development

Introduction

Increasing use of information and communication technologies (ICTs) help individuals to solve several everyday problems. Even though ICTs provide individuals with many advantages, they might also serve as grounds for several societal and ethical problems that include easily accessible filthy and violent media, identity theft, copyright infringement, Internet addiction, etc [1]. However, the most serious problem is that these reverse functions have a negative influence on the middle school students whose identities are not fully established. In fact, according to a survey on the Internet addiction actual condition by National Information Society Agency (NIA) released in 2008, it has shown that the Computer Ethic Behavior (CEB) has yet to catch up with the high level of the Computer Ethic Awareness (CEA) [2]. This is because a fundamental work not only to clarify the reason why inappropriate conducts are done but also to apply to the teaching methods of CE hasn't been carried out in most previous researches and studies despite relating inappropriate behaviors of students related to CE and uncontrollable conducts that students realize results of their own behavior of themselves but cannot control [3]. Therefore in this paper, we would like to present a concrete teaching program to achieve a goal of CE education by developing CE teaching model based on TPB to improve computer ethical behaviors that have yet to catch up with the high level of the Computer Ethic Awareness (CEA).

1. Literature Review

1.1 What's Computer Ethic (CE)

The CE can be defined as a yardstick that can be used to handle ethical issues in information-oriented societies; It defines the basic moral standards-right and wrong, good and evil, and moral and immoral-to attain the most desirable behavior while living in and information-oriented society as well as handling computer and communication devices [4].

1.2 The Four basic principles of CE

In this research, the scope and contents of the CE is classified into four categories as shown below [5].

Table 1: The Principles and Fundamental Concept of the CE

Principles	Fundamental concept
Moderation	Considering current situation, properly control one's behavior based on the decision criteria – what's right and wrong, and what's good and bad.
Respect	Value and admire others as well as oneself; regard others as human beings with dignity by caring for their identity and cherishing their self-esteem.
Responsibility	Predict the outcome of one's behavior onto others and be liable for possible loss and/or sanctions from it.
Participation	As an independent information user, offer help to others while abiding by the responsibility and eager participation. Also create / present valuable information and vigorously contribute to various cyber activities.

1.3 Theory of Planned Behavior (TPB)

The TPB is an extension of Ajzen and Fishbein's theory of reasoned action (TRA). The TRA identifies 3 key constructs that influence behavior: intention, attitudes, and subjective norms. According to the TRA, intention reflects motivation to perform the behavior and is the most proximal determinant of whether the behavior will be performed. Attitude represents the positive or negative evaluation of the target behavior, whereas subjective norms reflect the perceived social pressures to perform the behavior. The theory posits that people are more likely to intend to perform a behavior if they evaluate it positively and believe that other important people think they should perform it. However, the caveat for the TRA is that it is limited to volitional behaviors, exempting any external factors that may be or are perceived to be beyond the control of an individual. The TPB addresses this issue with the inclusion of the perceived behavioral control variable. Perceived behavioral control represents the beliefs that an individual has about the presence of factors that may enable or hinder his or her performance of the behavior and about the perceived degree of control he or she has over these factors, exerting both direct effects on behavior as well as on behavioral intentions [6]. Figure 1 shows the TPB model.

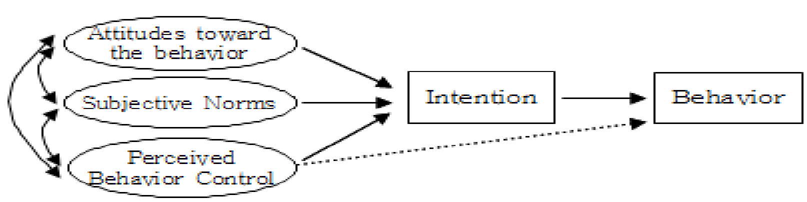

Figure 1: Theory of Planned Behavior Model

2. Methodology

2.1 The Process of Class Model Development

Search various class model development method theories and establish the level of class model development for the systematic and concrete class. Most of the processes of class model development are rectilineally connected with the minor steps, such as analysis, design, development, implementation, evaluation, and have evaluation, modify steps after implementation. However, the Dick & Carey Model [7] follows the same steps as shown blow but tends to have a more flexible and streamlined structure.

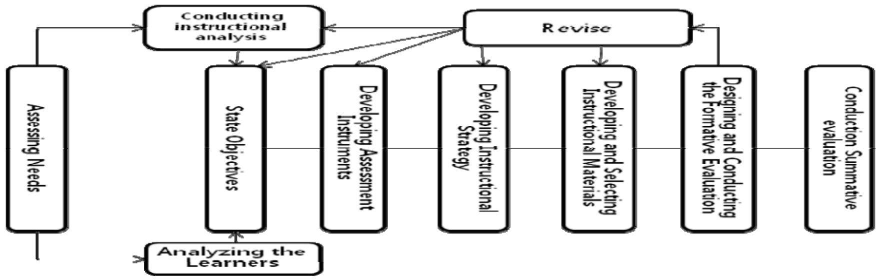

Figure 2: Dick & Carey Model

2.2 Extraction of the Teaching Strategies based on TPB

Extract concrete class strategies and activities of Computer-Ethics class model by searching the theory on the reason why students have computer ethical or unethical behaviors. First, to do an action, the purpose of the strategy of the attitude on an action for improving the power of execution is to have a positive mind. To do so, first of all, people should have confidence what certain result will generate if they do an action for a certain goal, and should give the value of the result. Second, the purpose of subjective norms for improving the execution is to have high norms. To do so, people have to realize that someone, who is very important to you, support the action for certain goal, and should have mind that people try to meet their expectation. Third, the strategy of perceptive behavioral control for improving execution is to have high behavioral control. To do so, by supporting the technique or information for the target action, they can practice and have confidence in their actions.

3. Summary and Results

Because of the development of information and communications technology, computer ethics education is desperately needed. However, our analysis has found the result that the education in school emphasizes recognition itself without any certain and clear class program, and schools do not have any class model about what the action will basically generate. Therefore, on this research, based on the reason of ethical action, we expect that we can reach the purpose of basic Computer-Ethics education which we can fix and complete depending on situations in the middle of the process in the field. However, our research has the limitation that we cannot earn the effect by applying the class model to the field which is for improvement of sense of Computer-Ethics. On follow-up research, we have to reach the point that we can verify the effect with the model by the process of application and modification.

References

[1] KADO (2006). 2006 The research on the actual condition of Internet Use in Korea. Seoul : Korea Agency Digital Opportunity & Promotion (KADO).

[2] NIA (2008). 2008 The research on the actual condition of the Internet in Korea. Seoul : National Information Society Agency (NIA).

[3] Kim, H. (2008). An Empirical study on extending the model of the theory of reasoned action: an application to internet coupon using behavior. Ph.D. dissertation. The University of Sungkyunkwan in Korea

[4] KERIS (2000), A Guidebook for teaching Information Communication Ethics. Seoul : Korea Education and Research Information Service (KERIS). CR 2000-2.

[5] Cho, S. H. & Kim, S. S. (2008). The Delphi Analysis to measure the Information Communication Ethics Consciousness Level of young people. Korea Association of Information Education (KAIE) 12(4), 449-457.

[6] Ajzen, I & Madden, T. J (1986). Prediction of goal-directed behavior: attitudes, intentions and perceived behavioral control. Journal of Experimental Social Psychology, 68, 453-474

[7] Dick, W., & Carey, L. (1978). The Systematic Design of Instruction, Ⅲ. Scott, Foresman and Co.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Designing Sentence Combining System to Enhance Students' Proposition Comprehension

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Abstract: Most studies indicated that reading is very important for learning of students. However, not all students know how to read an article. The sentence combining is a key point, because the strategy help students not only know sentence structure but also understand sentence proposition, and the meaning of article. In order to address this issue, we first examined and clarify the Taiwan's elementary textbook about sentences learning. Furthermore, we proposed a Sentence Wizard, to enhance students' proposition and reading comprehension. In future we will add peer review function which each student can closely inspect and active give comments of their classmates.

Keywords: sentence combining, writing skill, proposition comprehension

Introduction

In recent years, schools increasingly emphasize reading, because reading is very important for learning of students. Moreover, schools have come to promote reading from a young age to teach how to read. No matter what kind of books, students can absorb the knowledge of books into their brain. Besides, this study examined three popular versions of elementary textbooks (1-5 grades) about sentences learning in Taiwan. We also clarified some exercises of sentence types. There are 10 types of sentences that are most commonly used in the instruction or homework. The top three of 10 types of sentences are: undertake sentence: we have to understand the previous sentence before following with an undertake sentence; progressive sentence: it means a sentence that moves forward progressively, further expressing; causal sentences: it means one thing always has a beginning, but later there will be a consequent result.

All three sentence types above have one thing in common, the first sentence needs to be understood, and it will show what kind the next sentence should be. Although sentence combining is not common in Mandarin exams in Taiwan, when we have such exams there are many benefits, such as: in teaching, teachers can have diverse methods to teach students; in learning, it can test students' knowledge of sentence patterns and grammar which will be a great help to students in the future.

Besides, some studies (Gijlers & de Jong, 2005) also proposed discovery learning encourages students to be active agents in their own learning process. Sentence combining and discovery learning's purpose are to develop capabilities of students, nurturing their spirit of exploration. Therefore, sentence combining is also discovery learning. The above studies also indicate that the strategy of sentence combining enlarges student's capabilities to become more understanding of the meaning of the article. They lead one to consider that the design of sentence combining is a significant research issue. Hence, this study develops a sentence combining system to enhance students' proposition and reading comprehension.

1. The Design of Sentence Combining

The definition of sentence combining is taking two or more sentence to combine them into different meaningful sentences (Komolafe & Yara, 2010). This study also mentions that this make students try to restructure sentences which can enhance students' creativity. There are some familiar sentences combining advantages: ability to enhance writing skills to increase understanding, so we have to learn sentence combining. Therefore sentence combining is a way of teaching sentence grammar and skill, which can contain several core sentences combined into a longer sentence and more complex sentences. In sum, the strategies of sentence combination helps students not only know sentence structure but also understand sentence pattern, and even the meaning of the article (Komolafe, & Yara, 2010; Harbusch, Itsova, Koch, & Kühner 2008; Zamel, 1980).

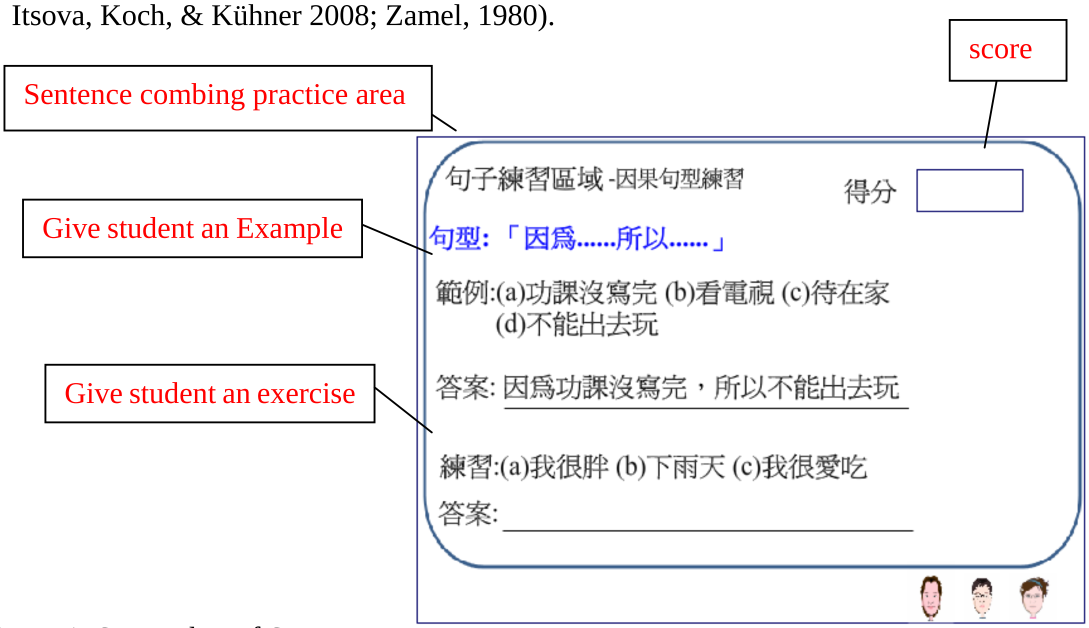

Figure 1: Screenshot of Sentence Wizard.

One study (Sung, Chang, & Huang, 2008) focused on teaching students to use strategies to improve reading comprehension; another study (Harbusch, Itsova, Koch, & Kühner, 2008) mentioned using NLP technology to enable students to better increase their output of the grammatical quality of sentence. This study adopts sentence combining with discovery learning strategies which let students think and solve the sentence combining questions and design a system, entitled Sentence Wizard.

See figure 1, Sentence Wizard consists of three parts: top, middle, and bottom. The top introduces what kind of sentence pattern we want to teach. The middle part gives the students a sentence combination to let students use as a reference. The bottom part is an exercise that give students the core of 3 to 5 sentences, and then lets the students merge several of core sentences in the bottom of the screen. Marion Blank(1992) noted that: teachers spending time in repeating the same tasks over and over, is unbelievably boring. A teacher must simultaneously wipe out all creativity and adopt saint-like patience to be able to give children the time and practice they require. Now there are many new technologies for teaching to encourage students' learning. But many teachers teach students spending much time to repeat again and again, if we can change teachers' teaching methods to make teaching and learning become more interesting, I think we can implement the Sentence Wizard in Chinese class. Besides, each student's learning ability is not the same, the speed of learning is also not the same, and it would be good to use different strategies to learn. Sentence combining can make students have discovery learning abilities and can increase the ability of thinking.

2. Future Works

In future we will add peer review functions which each student can closely inspect and can actively give comments of their classmates. This way will enhance students' critical thinking, reading comprehension and even writing skills. Moreover, we will also conduct case studies to examine the influence on student abilities, as well as incorporate more scaffolding designs to promote students' proposition comprehension and to support students' learning.

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References

[1] Gijlers, H., & de Jong, T. (2005). The relation between prior knowledge and students' collaborative discovery learning processes. *Journal of Research in Science Teaching*, *42*(3), 264–282.

[2] Harbusch, K., Itsova, G., Koch, U., & Kühner, C. (2008). The Sentence Fairy: a natural-language generation system to support children's essay writing. *Computer Assisted Language Learning*, *21*(4), 339. doi:10.1080/09588220802343496

[3] Komolafe, A. T., & Yara, P. O. (2010). Sentence Combining Strategy and Primary School Pupils Achievement in Written English in Ibadan, Nigeria. *European Journal of Scientific Research*, *40*(4), 531–539.

[4] Sung, Y., Chang, K., & Huang, J. (2008). Improving children's reading comprehension and use of strategies through computer-based strategy training. *Computers in Human Behavior*, *24*(4), 1552-1571. doi:10.1016/j.chb.2007.05.009

[5] Blank, M. (1992). The Sentence Master: a new approach for problem readers. *Computing Applications to Assist Persons with Disabilities, 1992., Proceedings of the Johns Hopkins National Search for* (Page. 73-74). doi:10.1109/CAAPWD.1992.217442

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Fluid structures and behavior in inculcating creative reasoning

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Abstract: This paper proposes a descriptive framework for object-oriented comparison and contrast of strategies that aims at inculcating fluid (flexible and constantly evolving) cognitive structures and cognitive behavior (strategies) within adaptable contextual schematic frameworks. The ultimate aim behind this fluidity is to create cognitive flexibility and consequently inculcate systemic and creative reasoning. An example within the strategic marketing domain is provided. Subsequently, implications to technology-mediated instructional design conclude.

Keywords: Fluid structures, strategies, scaffolding, creative reasoning, strategic marketing

1. Introduction

Creativity is often typified by an innate ability to perceive beyond the immediate or the evident, discern between relevant and irrelevant, self-regulate plans and strategies and most importantly, develop novel and *useful* ideas. Consequently, it is crucial to help our students to think creatively and become more productive and innovative members of society.

However, most scaffolds have been very structured. Structure may be restrictive to expert designers. Furthermore, it may train novices to think in a specific way simulating the system designer's way of thinking. Consequently, the novice student may find difficulty in developing his/her own voice (method for reasoning, evaluating and refining).

This paper proposes that it is crucial to structural context as basic scaffolding at the initial learning stages. However, once the initial concepts have been grasped, freedom in reasoning, evaluating and refining should be allowed in order to cater to different ways of learning [1].

In this paper, structured scaffolds to creative design processes are developed based on contextual schema and object-orientation in concepts. The context-based schema enables associations of concepts to the overall context and goal(s). Application of object-oriented programming concepts to context-based schema enables easier instantiations of contexts within which strategies can be transferred (adopted/adapted) based on reflection outcomes and within which learning paths can be dynamically adopted or adapted.

The outline of this paper is as follows: Reasons for a fluid exploration phase are first identified. This is followed by an example of strategies for the theme strategic marketing. Implications to technology-mediated instructional design for creative education conclude.

2. Related work

Let us take a look at designers' creative processes. [2]'s study on designers indicates that almost all respondents apply a wide range of design methods. Some of these methods are scenarios, storyboards, use cases, software prototyping and subsequently the testing of these on focus groups, interviews and field studies through questionnaires. Almost no one used predictive modeling methods such as Goals, Operations, Methods and Selection (GOMS). Instead, a few used software engineering methods (8 percent), experiments (10 percent), contextual design (10 percent) or guidelines (5 percent). Moreover, 85 percent of the respondents said that they depended mainly on their own knowledge such as about affordance to interpret the data that they gather and to find a solution. They are against being constrained by prescriptive theoretical guidelines.

Since non-prescriptive exploration is encouraged, how can we ensure that exploration will lead to fruitful outcomes? The answer lies with goal-based design [3] within goal-based scenarios (GBS). Goal-based scenarios contextualize exploration, discovery and reflection processes. Furthermore, variations in mission structure can easily lead to variations in themes; resulting in rapid lesson development as well as systematic application and transfer of learning from one scenario to the other. Variations in scenarios simulating cognitive flexibility [4] will benefit the inculcation of thinking from multiple dimensions, as students will have to create meaning from the diverse content and formulate associations among concepts and strategies.

3. Contextual schema and object-oriented adaptation of strategies within similar contexts

The theme strategic marketing is used as an example. If a Malaysian company specializing in the manufacture and sale of its brand of cars wants to break into a new market in Indonesia, it can learn from prior successful examples and use the critical success factors (distinctive selling features) from these prior successful examples to formulate its contextual parameters.

Let us assume that the learning objectives are first, to be able to identify goals and sub-goals; second, to be able to link information to the goal/context; and third, to be able to reason using different perspectives. The following example shows strategies to address the three skills that require more attention in the Malaysian context and subsequently, how these strategies can be adapted to the Indonesian market.

3.1 Malaysian context

Goal: To increase sales of the car to be sold

Strategy: Road shows may be boring (less interactive) if only the car and the specifications of the car are displayed at popular spots in the country. Since the objective (sub-goal) of road shows is to inform potential buyers regarding these aspects, the marketer needs to identify the interests of main stakeholders and stakeholders influencing the main stakeholder and cater to these interests.

Hence, to achieve the goal of informing, the marketer can create an interactive web portal for the company which provides more information on the company, the brand’s cars, specifications for each and allow potential buyers to change the color of the car that they like and even allow them to calculate using a financial planning calculator customized to their needs at the company’s website.

In addition, helping students to think from multiple perspectives through simulation of the different interests of different stakeholders is expected to generate more interest and further action by these potential buyers. As such, marketers can target stakeholders who influence the main stakeholders, e.g. the spouse and/or the children. Spouses are more likely to be interested in the aesthetics, reviews of the specific type of car being considered and the type of upholstery. Children on the other hand, may be interested in where they can put their games and fast food in the car.

Associating the interactive portal with the goal, objective and the different interests of different stakeholders is likely to highlight the benefits of having an interactive portal in terms of increased interest by potential buyers and influencing stakeholders, contributing towards the design of future car production. Another benefit is reduction in cost due to focus of resources on the interactive portal and less on road shows and demo.

3.2 Non-Malaysian contexts

In the given scenario above, the goals are expected to be similar in any context. Students need to generate their own alternatives to increase sales. Next, they need to consider the interests of different stakeholders. Both Malaysia and Indonesia are quite similar in cultures. Nevertheless, there will be slight differences in what the main stakeholder, spouses and children would be interested in. Adaptations of marketing strategies from the Malaysian context would therefore come into picture. Similar principles apply to adaptations of strategic marketing strategies from other countries. For example, children may not only be interested in compartments to put their stuff but also consider car TVs as a matter of style and necessity. Selecting suitable strategies (and accompanying reasoning) will hopefully lead to richer transformations of strategies to suit local contexts, richer learning paths and richer learning experiences.

4. Implications to instructional design for creative education and conclusion

The commonly accepted generic model for instructional systems design and instructional design is ADDIE: analysis, design, development, implementation and evaluation [5]. In terms of design, students can take on different stakeholder roles and compare the strategies that each stakeholder would use – similar to a debate where debaters will have to present their points and their counterparts rebut. Only now, each group of students will have to consider both stakeholder roles. Having contextual schema to provide the various possible scenarios and object-orientation of strategies to enable easy cross-reference, adoption and adaptation across stakeholder roles is conjectured to increase the likelihood of students developing cognitive flexibility and systemic thinking which will inculcate creative thinking skills.

With these concerns in mind, technology-mediated instructional design for creative education needs to enable visualization of information and the knowledge space to enable identification of interrelationships among concepts and how these relationships can contribute towards the achievement of goal and sub-goals.

References

[1] Lee, C. S. (2009). Scaffolding everyday creativity: A spiral cascaded development approach. *World Conference on Educational Multimedia, Hypermedia and Telecommunications,* Honolulu, HI, USA, June 22-26, 2009.

[2] Rogers, Y. The theoretical approaches for HCI. (2004). *Annual Review of Information Science and Technology. 38*.

[3] Schank, R. C., Fano, A., Bell, B. & Jona, M. (1993). The Design of Goal-Based Scenarios. *The Journal of the Learning Sciences. 3* (4), 305-345.

[4] Spiro, R. J., Coulsen, R. L., Feltovich, P. J., & Anderson, D. K. (1988). *Cognitive flexibility theory: Advanced knowledge acquisition in ill-structured domains*. In *Proceedings of the Tenth Annual Conference of the Cognitive Science Societ*y. Hillsdale, NJ: Erlbaum.

[5] Strickland, A.W. (2006). *ADDIE*. Idaho State University College of Education Science, Math & Technology Education. Retrieved June 29, 2006.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

Teachers' Perception of Administrators Support towards the Integration of Laptops in Schools: An Exploratory Study

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Abstract: The Malaysian Ministry of Education granted each Mathematics and Science teacher with a laptop. The integration of laptop needs strong support from the school administrators to successfully implement it. Therefore, this quantitative study was carried out to explore how teachers perceived the support of administrators in the integration of laptops in the teaching-learning process. Respondents were 38 secondary school teachers from the state of Selangor, Malaysia. The overall perception of the teachers on the administrators support was reported as satisfying. More than half of the teachers (56.5%) agreed that they received administrators support in integrating the laptops in the teaching-learning process and only a small percentage of the teachers (17.5%) disagreed that they received adequate support by the administrators.

Introduction

Malaysia is taking every attempt in pursuing the technological trends in the education system. In line with this, the Ministry of Education has begun to grant each Mathematics and Science teacher with a laptop to facilitate the teachers' instruction [1, 2]. Nevertheless, the integration of laptops in the schools needs greater support from the higher authority as Fullon [3] stated "Effective school leaders are key to large-scale, sustainable education reform" (p.16). School leaders have the foremost responsibility to assist in making complex decisions concerning the incorporation of ICT into the teaching and learning practice by initiating and implementing the school change [4].

Studies have shown that a high level of successful integration of laptops in the teaching-learning process depends heavily on the support given by the higher authorities in the schools such as the principal or administrators in the school [5, 6]. Although it is seen as vital, thus far there are no studies done in Malaysia regarding the perception of the teachers on the administrators in supporting the integration of laptops in schools. Therefore, there is a need for a study to be done to explore the teachers' perception of the administrators support in their respective schools.

This research employed a quantitative descriptive design which incorporated the survey questionnaire. The scale was developed based on a comprehensive review of the literature. The scale was quantified using a five-point Likert scale, ranging from "Strongly Disagree", "Disagree", "Neutral", "Agree" to "Strongly Agree". The teachers who participated in this survey were 38 Mathematics and Science teachers from the state of Selangor; six male and 32 female teachers and their age varied from 24 to 54 years old. The Cronbach's alpha coefficient was recorded at .75, indicating that the scale had good internal consistency [7].

Results and Discussion

Table 1: Descriptive Statistics on the Teachers' Perceptions of the Administrators Support

Item	Strongly Disagree F (%)	Disagree F (%)	Neutral F (%)	Agree F (%)	Strongly Agree F (%)	M	S. D.
Provides latest equipment (e.g.: laptop, LCD screen, printer etc.)	0 (0.0)	5 (13.2)	7 (18.4)	24 (63.2)	2 (5.3)	3.61	0.128
Encourage the use of the laptop	0 (0.0)	1 (2.6)	3 (7.9)	28 (73.7)	6 (15.8)	4.03	0.096
Motivates the teachers to integrate laptop	0 (0.0)	0 (0.0)	6 (15.8)	26 (68.4)	6 (15.8)	4.00	0.092
Provides adequate training on how to use the laptop	0 (0.0)	9 (23.7)	15 (39.5)	9 (23.7)	5 (13.2)	3.26	0.159
Provides adequate technology support for the usage of laptop	0 (0.0)	9 (23.7)	11 (28.9)	14 (36.8)	4 (10.5)	3.34	0.157
Encourages the teachers to give ideas on how to enhance the integration of laptop	1 (2.6)	5 (13.2)	12 (31.6)	18 (47.4)	2 (5.3)	3.39	0.144
Rewards the teachers who integrate laptop	3 (7.9)	12 (31.6)	15 (39.5)	7 (18.4)	1 (2.6)	2.76	0.153
Monitors the usage of the laptops	1 (2.6)	4 (10.5)	10 (26.3)	22 (57.9)	1 (2.6)	3.47	0.135
Evaluates the usage of laptops by the teachers	1 (2.6)	9 (23.7)	10 (26.3)	16 (42.1)	2 (5.3)	3.24	0.157

From the output shown, the mean score of the teachers' perception towards the administrators support in providing the latest equipment such as laptop, LCD screen, and printer was 3.61 (S.D. = 0.128). According to the findings, 68.5% of the teachers agreed that they are provided with the latest equipment by the administrators and only a minority of them disagreed with the statement. The mean scores of the teachers' perception towards the encouragement of the administrators to utilise the laptop was reported as 4.03 (S.D. = .096). Based on the results obtained, nearly all the teachers (89.5%) agreed that they are encouraged by the administrators to use the laptop.

The mean score of the teachers' perception towards the motivation from the administrator for them to integrate the laptop was 4.00 (S.D. = .092). Thus, nearly all the teachers (84.2%) agreed that they are motivated by the administrators to use the laptop and none of them disagreed with the statement. As for the teachers' perception towards the administrator support on providing adequate training, the mean score was reported as 3.26 (S.D. = .159). More than one third of the teachers (39.5%) have neutral perception on the adequate training provided by the administrator.

Besides that, the mean score of the teachers' perception towards the administrator support on providing adequate technology support was 3.34 (S.D. = .157). Nearly half of the teachers (47.3%) agreed that they are provided with the technology support by the administrator and only a minority of them disagreed with the statement. The teachers' perception towards the administrator's encouragement to give ideas on how to integrate laptop was 3.39 (S.D. = .144). More than half of the teachers (52.7%) agreed that they are encouraged by the administrator to give opinions on how to enhance the integration of laptop only a minority of them disagreed with the view.

Moreover, the mean score of the teachers' perception towards the rewards of the administrator to utilise the laptop was 2.76 (S.D. = .153). More than one third of the teachers (39.5%) disagreed and had neutral perception regarding the rewards they receive from the administrator whereas only a minority of them agreed. The mean score of the teachers' perception towards the observation of the administrator concerning the laptop use was 3.47 (S.D. = .135). Hence, 60.5% of the teachers agreed that the administrator monitors the usage of the laptop. It was reported that the mean score of the teachers' perception towards the administrator's evaluation on laptop use was 3.24 (S.D. = .157). Nearly half of the teachers (47.4%) agreed that they are evaluated by the administrator on the usage of the laptop

The overall perception of the teachers on the administrators support towards the integration of laptops is summarized. Based on the results, 1.7% of the teachers strongly disagreed, 15.8% of the teachers disagreed followed by 26.0% of the teachers who are neutral on the perception, 48.0% of the teachers agreed and 8.5% of the respondents strongly agreed that they receive the support of the administrators to integrate the laptops in secondary schools. Thus, majority of the teachers (56.5%) agreed that they obtained the administrators support in integrating the laptops compared with teachers who disagreed (17.5%). Therefore, it depicted that more than half of the teachers are satisfied with the support given by the administrators in the school and only a small percentage of the teachers are dissatisfied with the support given by the administrators.

Conclusion

This paper revealed that teachers received adequate support from the administrators in the school to integrate the laptops in the teaching-learning process. The findings of this study is preliminary in nature as it gives a glimpse on the extent of support given by school administrators as perceived by schools teachers in four secondary schools. It would be worthwhile to carry out a larger scale study to investigate the relationship between administrators' support and the success of laptop integration.

References

[1] Mas Nida, M. K., Wong, S. L., & Ahmad Fauzi, M. A. (2009). Teachers' concerns of laptop ownership: A preliminary report on laptop endowment programme in Malaysia. *Proceedings of the International Conference on Educational Research and Practice: Enhancing Human Capital through Teacher Education* (pp. 799-804). Putrajaya: Faculty of Educational Studies Universiti Putra Malaysia.

[2] Multimedia Development Corporation. (2005). *The smart school roadmap 2005-2020: An educational odyssey*. A consultative paper on the expansion of the Smart School initiative to all schools in Malaysia. Ministry of Education: Putrajaya.

[3] Fullon, M. (2002). The change leader. Educational Leadership, *59*(8), 16-20.

[4] Afshari, M., Kamariah, K. B., Wong, S. L., Bahaman, A. S., & Foo, S. F. (2008). The role of the school principal in computer education. In Kamisah Osman et al. (Eds), *Proceedings of the International Conference on the Education of Learner Diversity: Managing Diversity in Educational and Community Settings* (pp. 1049-1062). Bangi, Selangor: Pusat Penerbitan dan Percetakan, UKM.

[5] Cowie, B., & Jones, A. (2005). Digital horizons: Laptop for teachers evaluation study update on secondary teacher's experiences. Retrieved October, 30 2007 from http://www.minedu.govt.nz/web/downloadable/ dl8568_v1/laptop-leaders-report-12-9-with-edits-ds.doc. University of Waikato.

[6] Kariuki, M. (2004). Factors influencing preservice teachers' use of laptops for teaching/learning purposes during practicum. Retrieved October 5, 2007 from http://www.iste.org/Content/NavigationMenu/Research/NECC_Research_Paper_Archives/NECC_2004/Kariuki-Mumbi-NECC04.pdf

[7] De Vellis. R. F. (2003). *Scale development*. (2nd ed.). Thousand Oaks: Sage Publications.

S. L. Wong et al. (Eds.) (2010). Proceedings of the 18th International Conference on Computers in Education. Putrajaya, Malaysia: Asia-Pacific Society for Computers in Education.

International Chinese Student Teachers' Professional Development and ICT Integration

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Abstract: ICT can be used to improve international Chinese student teachers' professional development only when they integrate ICT into their future teaching and learning practices. The available research has mainly focused on those student teachers how to develop their language and culture. The present study centers on the impact of International Chinese student teachers' gender, web use. For this purpose, a survey was set up involving student teachers from Beijing Normal University (N=102). Results show that ICT integration significantly correlates with all teacher related variables. Implications for teacher education and further research are discussed.

Keywords: student teachers; International Chinese Teachers, teachers' professional development, ICT

Introduction

Modern educational technology is an indispensable branch of the new-style teacher qualification structure which aims to meet the needs of promoting Chinese Language world-wide [1] (Wang Hong-li, 2008). We can take full advantage of modern educational technologies to support the development of the international Chinese teachers, especially on solving dilemma that lacks instructional resources, which international Chinese teachers will be faced when working abroad. The main purpose of the study is to examine the effect of student teachers' gender and their using web and how to improve their professional development.

1. Theoretical background

To become a mature professional teacher, we need to explore the process of continuous learning and expand the professional content. Currently, there are three types of teacher's professional development orientation: intellectual perspectives of teacher professional development, practical-reflective perspectives of TPD and ecological perspectives of TPD [2] (Xu Bin-yan, 2008). We find that ICT can facilitate the growth of teacher knowledge, build teaching community building Network, increase the practice and reflection, promote the exchange and interaction in a network environment and doing scientific education research, and so promote international the growth of Chinese language teachers[3][4].

2. Method

The paper takes a sample from the 2006th and 2008th Master of Chinese international education classes held at Beijing Normal University. Those grades had different biased focus on basic training methods, respectively. This survey was totally completed by e-mail, and we finally got 97 copies of questionnaires, with 58 valid copies, and the effective recall rate is 59.7%.

3. Results

In this study, samples are taken from over 30 cases, conforming to the Large-scale Controlled Sample Analysis. The reliability of questionnaires (Cronbach's alpha) is 0.875, falling down within the range of our surveying requirements. According to factor analysis with SPSS 16.0, the KMO coefficient was 0.846, close to 1.

3.1 Descriptive analysis

Firstly, we use descriptive analysis, which tells us the average performance of each dimension. The highest average performance is the “learning needs” of internet, reaching 3.90 points. This shows that the respondents have a high desire on the knowledge and skills to continue learning network. The lowest performance is the “online discussion”, only 2.77 points. From the data, we can see that they have not reached the natural use of the network to collaborate or support with each other. If we can build mutual sharing network platform, these issues will be improved.

3.2 Correlation analysis

This study use Pearson product-moment correlation analysis to obtain the correlation matrix. It clearly shows that the seven dimensions of the survey have a significant correlation between-related, indicating the internal consistency between the factors performed well. In addition to “network effects” and “teaching reflection”, which related coefficient is 0.272 ($p < .05$), the others are in excess of 0.349, and the significant coefficients are achieved ($p < .01$). The significant correlation between the factors reflects the analytical data of the high internal consistency.

3.3 Multiple regression analysis

In order to explore whether there is a causal relationship between variables, this study was carried out by multiple regression analysis. The results showed that: enter the regression equation, a significant total of three variables, which are, "teaching reflection ", "network effects" and "the grade." Through analysis, we obtain a standard regression equation as: Professional development =.506* Teaching reflection+.437* Network effects +.188*Grade. We can see, the international Chinese language teachers to use the Internet in professional development can be described by three variables to predict. Among them, “teaching reflection” in the “professional development” process has played a most prominent role. Which shows that using the internet for teaching reflection, can effectively promote the professional development of teachers.

4. Discussion

Currently, the international Chinese language teachers are faced with two outstanding issues of the teaching resource-poor and work in the sense of isolation. This study was to combine the above survey data and studies related to practical investigations carried out from three aspects of international Chinese language teachers to discuss the training and development.

4.1 Network has a positive impact in the process of professional development to the international Chinese language teachers

Master of Chinese international education learning process has better use of computer network. In this open-ended survey, 87.9% respondents reflect their fight to the more familiar on the network level. Of these, 67.2% of people are more frequently used blog. In particular, the 2006th students in internships abroad, not only over 90% of the teachers to establish a personal blog, and to establish a blog on behalf of class groups, thus the use of these tools, according to record their overseas teaching and living, share their experiences and experiences in the form of network learning community played a good role of cohesion and resource sharing.

4.2 International Chinese teachers still need to further raise the level of network applications, especially in the network reflection and online collaboration

At present, the Chinese International Education Master's treatment of e-learning and related issues also have a relatively high learning needs. Of these, 96.6% of the respondents said that if conditions permit, we hope to continue to accept the new network training. Open-ended survey results, they also suggest ways to change from their own point of view and practice, in order to use the Internet as soon as possible to obtain two professional developments. Changing concepts of education is to meet the information technology environment, particularly from the traditional lecture-style teaching of teacher transition to information-based model of learning and teaching to go.

4.3 Relevant agencies of the network resources and environment construction of culture conditions to promote the intrinsic motivation of teachers and development of sustainability

Beijing Normal University for the first time information technology courses as a required course for the introduction of International Chinese Teachers Culture. The school of public information technology, lessons for the prototype, have established a computer resource utilization, and courseware production course, using collaborative learning theory, emphasis on students practical abilities, evaluation methods from the past written tests, computer-based testing into a mission-driven assessment, to evaluation Real application ability learners.

5. Conclusion

The findings suggest that successful ICT integration is clearly related to the thinking processes of classroom teachers, such as teacher beliefs, teacher efficacies, and teacher attitudes toward ICT. The results underpin the importance of an integrated and concurrent understanding of teachers' thinking processes. The study also suggests that in order to improve the innovation of classroom activities, teachers' thinking processes should be challenged.

References

[1] Wang Hong-li(2008). Study and Training on the Competency of Teachers Promoting Chinese Overseas. *Unpublished doctorial dissertation*. China: Beijing Normal University.

[2] Xu Bin-yan(2008). Multiple approaches of teachers' professional development. *China: Shanghai Educational Publishing House*.

[3] Zhou Su(2007). The support of Teachers Learning Community to the professional development of teachers by Network. *E-education research*, 2007(6), 45-48.

[4] HU Xiao-yong(2009). Research on the Construction of Online Learning Community for the Professional Development of Teachers. *Open Education Research*,2009(4),87-91

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A Pen-Based System to Support Mathematics Problem Solving and Peer Assessment for Pupils

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Abstract: E-learning systems now currently existing almost using the mouse and keyboard to interact with learners. Apart from learners should waste time to learn how to manipulate the mouse and keyboard and also increase their cognitive loads on learning tasks. In the case of the teacher marking corrections on students' homework, the teacher need to correct the same questions again and again by each student, and the teacher usually can only find whether their answers were right or wrong. In particular, when the answers were wrong, it is difficult for the teacher to understand the problem solving process and to grasp the bottlenecks the students encountered. In this study, the authors develop a pen-based system to assist students in mathematics problem solving. The system can record problem solving process and in peer assessment process, students can review the record by each other. The preliminary results showed students can use the system more naturally and learn different problem solving methods from the peers.

Keywords: pen-based learning, peer assessment, mathematics problem solving

1. Introduction

Although e-learning systems have improved on our teaching and learning become more easily and effective, their interfaces have remained less the same – mouse, keyboard. In contrast, pen-based input type is related to students' school life and work, the system with pen-based input type just like the pen with book in reality.

2. Literature Review

2.1. Portfolio & Peer Assessment

Zhang & Tong [1] pointed out that the portfolio is a purpose to collect students about the learning-oriented activities or work, so that teachers, parents and students can take this understanding and assessment of student learning process and progress of the case and learning outcomes.
Topping & Ehly [5] pointed out that peer assessment among learners study aims to look forward to learners through collaboration with peers, teach, observe, counseling, monitoring, assessment, feedback and so different ways of learning.

2.2. Tablet PCs in Education & Handwriting Advantages

Teachers find that save children's handwriting online is beneficial for themselves and their students [3]. Research by Simon [4] has manifested that the tablet PCs which used as a substitute blackboard for both teachers and students is advantageous. Pen-based mathematics interfaces are also becoming popular in research topic in several years. It is believed that handwriting was faster and favored modality than typing [2].

3. System Design

A Pen-Based System was designed to support mathematics problem solving and peer assessment for pupils (Figure 1).

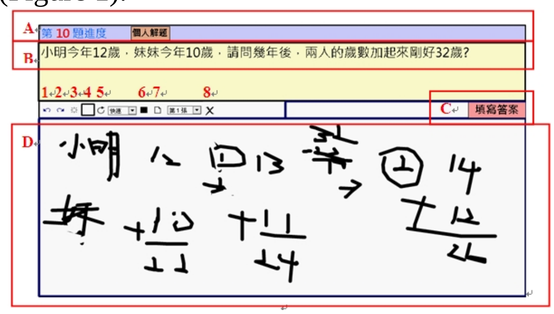


Figure 1: Snapshot of the system

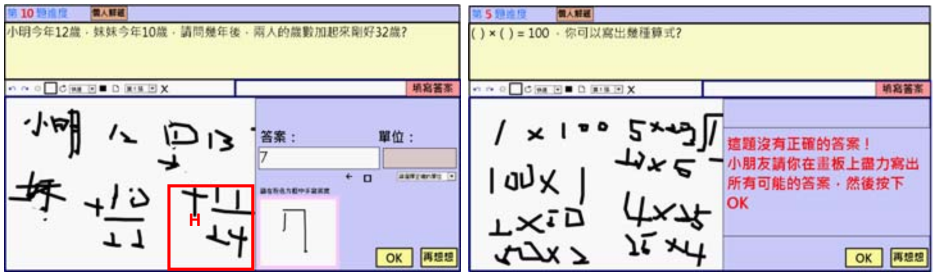
3.1 System Overview

A. Status Bar: show the status of each question that the student have achieved.
B. Question Field: show the question text of each question.
C. Answer Field: click the button than show the answer field.
D. Handwriting Field (paper): student can write something to help them to solve problems. There are eight tools for handwriting, from 1 to 8 are undo, redo, clear, pen/eraser, replay, stop and new paper.

3.2 Each Step in Problem Solving Process

With problem solving process, there are five statuses in each question.
(a) Individual problem solving: the pen color is black and student starts to solve problem.
(b) Peer assessment and review – 1: After status (a), student will get peer problem solving record. In status (b), they will get the record three times. Student can review the peer record to observe and learn other's problem solving strategy every time. Therefore, student should use the red pen to correct peer record and evaluation.
(c) Revise the answer and writing record: In status (c), the pen color is blue, student can revise their answer; both answer field and handwriting field. Furthermore, student receive the feedback from peer.

There is a big challenge for common e-learning system – open problem. In this pen-based system, we have supported unique solution problem (Figure 2(a)) and open problem (Figure 2(b)). We have developed a simple handwriting recognition module (Figure 2(a (H))).



(a) Unique solution problem (b) Open problem

Figure 2: Pen-based system have supported two type of problem

3.3 Peer Assessment Design

There are some rules in the method, we will explain as follows.

(a) Student can't get records which have written by themselves.
(b) Student can't get same record which they have gotten.
(c) Student will get three records in each question.
(d) First record delivers by the speed. The speed means student who have completed status of individual problem solving.
(e) Second record delivers by the grade which have evaluated in status of peer assessment and review – 1.
(f) Third record delivers by the same grade – 2.

4. Conclusion

It's the time to throw out the keyboard and mouse, and we all should think seriously what pen-based and handwriting will affect our life and point out the new way to change our learning and teaching. The objective of this research is to evaluate student interacted with the system which support mathematics problem solving and peer assessment. The experiment is still ongoing; we will get more and more data from digital classroom. We all hope this system can really help student to solve mathematics problem either mathematics difficult problem.

Acknowledgements

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References

[1] Ji-Cheng Zhang, Hui-Yi Tong (2000) . Web-based portfolio of research evaluation and effectiveness analysis. "Distance education" ,15,16,98-111.
[2] Lisa Anthony, Jie Yang, Kenneth R. Koedinger(2007).Adapting Handwriting Recognition for Applications in Algebra Learning.
[3] Senior Honors Thesis, Daniel D.(2007) PettyIntegration and Perception of Tablet PC Software in Elementary Mathematics Education.
[4] Simon, B., Anderson, R., Hoyer, C., and Su, J. 2004. Preliminary experiences with a tablet PC based system to support active learning in computer science courses. In Proceedings of the 9th Annual SIGCSE Conference on innovation and Technology in Computer Science Education (Leeds, United Kingdom, June 28 - 30, 2004). ITiCSE '04. ACM Press, New York, NY, 213-217. DOI= http://doi.acm.org/10.1145/1007996.1008053
[5] Topping, K. J., & Ehly, S. E. (2001).Peer.-assisted learning. Journal of Educational and Psychological Consultation, 12(2), 113-132.

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