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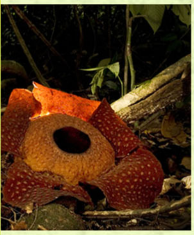








Editors
Tsukasa HIRASHIMA
Ahmad Fauzi MOHD AYUB
Lam-For KWOK
Su Luan WONG
Siu Cheung KONG
Fu-Yun YU

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Preface

This workshop proceedings includes accepted papers at nine workshops of the 18th International Conference on Computers in Education (ICCE2010), held on November 29 through December 3, 2010, Putrajaya, Malaysia. ICCE that was started in 1989, now is an annual international conference organized by the Asia-Pacific Society for Computers in Education (http://www.apsce.net/), and has become a major international forum for the exchange of information and ideas on related researches, development and applications in the filed of computers in education. The organization of workshops alongside with the ICCE provides an extra opportunity to have deeper discussion of a specific research topic, to allow preliminary report of work-in-progress, or to promote community building. This year, we hold nine workshops that aim to explore focused issues in various themes as follows.

- Workshop on Virtual Worlds for Academic, Organizational, and Life-long Learning (ViWo 2010)
- The 4th International Workshop of Modeling, Management and Generation of Problems/Questions in Technology-Enhanced Learning
- International Workshop on Models, Methods, and Technologies for Learning with Web Resources
- Human-Centered E-Learning
- Technology-Transformed Learning: Going Beyond the One-to-One Model?
- The Design, Implementation and Evaluation of Game and Toy Enhanced Learning
- The First International Workshop on Real Education In Second Life
- Workshop on Open Technology, Open Standards and Open Knowledge in Advanced Learning
- Workshop on New Paradigms in Learning: Robotics, Playful Learning, and Digital Arts

All workshops were proposed and organized by international program committees and all accepted papers included in this proceedings were peer-reviewed by the committees to ensure high quality work. The workshop papers from various topics will certainly stimulate more interesting research work in Asia-Pacific countries and all over the world. We hope that readers will find the ideas and lessons presented in the proceedings relevant to their research work.

We are grateful to the authors for the papers, to program committees for the respective workshop, and ICCE2010 local organizers and PC members.

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Workshop

Workshop on Virtual Worlds for Academic, Organizational, and Life-long Learning (ViWo 2010)

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Preface

Our society of the 21st century makes great demands on its members caused by rapid developing and ever-changing political, social, economical and technological situations. Consequently, it is expected that members of the society keep pace with these mutable situations, adapt their skills and expertise. As a result, modern instructional design, learning goals and processes as well as appropriate learning environments must support the development of the aforementioned skills and expertise. Consequently, educational approaches have changed dramatically over time from less formal schooling in the agrarian society to remedial repetitive learning in the industrialization age to learning with an understanding in today's knowledge society. Based on that, different modern educational strategies have been developed which includes aspects such as self-directed learning, collaborative learning, experiential-based learning and actively participating. Educational approaches have also been influenced by technology but have also increasingly applied technology over the last decades, such as motion pictures, radio, television, computers and other emerging information and communication technologies (ICT).

Last year's hype surrounding the virtual world "Second Life" has also generated significant interest in the education community. Although virtual worlds have been an active research topic for a long time, technology was not ready for complex application scenarios since recent years. New interesting and powerful platforms and tools, such as Second Life, Active Worlds, Multiverse, Open Croquet, OpenSim and Open Wonderland, have been emerged applicable to complement or even replace other knowledge transfer and learning settings. Modern virtual worlds are seen from an optimistic viewpoint as a disruptive and transformative technology. However, it still remains unclear to some extent where the real benefits and limitations of using virtual worlds as knowledge transfer and learning environments are when compared to more traditional methods. In order to avoid the same pitfalls of past e-learning solutions by just applying traditional learning approaches to a new technology, this special track is indented to offer a multidisciplinary platform which brings together international researchers from different organizations in order to share their experience with this technology.

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ReW: Reality Windows for Virtual Worlds

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Abstract: In this paper, we present the ReW system, a two-way bridge connecting Virtual and Real worlds, aiming at improving the virtual world extension of classical classroom didactic, facilitating the diffusion of blackboard content in virtual environments. The system adopts low cost hardware and is not intrusive in common lecture practices since its classroom front-end is controlled by a virtual button on the blackboard that results really usable for the teacher and does not require to alter his/her didactic habits. In this way, the system aims also at affording one of the obstacles against the adoption and diffusion of virtual worlds, the effort required to control the didactic and collaborative actions. The system has to be intended as a support to already available presentation systems and was specifically created for quickly distributing hand-written content produced during lectures. The prototypes have been developed for two diffuse 3D virtual worlds, with some slight differences due to different technological support offered by the underlying technologies.

Keywords: virtual worlds, e-learning, virtual-real worlds bridge, virtual blackboard, image analysis

Introduction

This paper presents the ReW (Reality Windows) system, a hybrid solution distributed between the real classroom setting and its Virtual Worlds replicas. The proposed system (available from http://delta4.dmi.unisa.it/software.html) provides a source of information for the distance learning actions by recording the classroom blackboards or whiteboards (henceforth, the word blackboard will stand for both, black and white ones) and complements the content provided in-world by available virtual world presentation systems with on-line hand-written data.

The main drawback of Virtual Worlds is also the main obstacle for their adoption and diffusion in distance learning and collaboration: novel users need to cope with an initial complexity when controlling their actions. Indeed, the representation of a 3D environment on a 2D medium (i.e., the screen), requires the implementation of some tricky form of control that may result unfriendly to not expert users. In particular, in e-learning scenarios, while for student it is possible to expect a technological background or skill improvement, one of the actors is the teacher. It appears difficult to force traditionalist teachers to change their didactic habits for adopting a different way of providing content but, more in general, for a different way of conducting their didactic actions.

ReW tries also to be a low-cost solution to previously exposed problem, since it implements an easy way to support the classical lecture based on blackboard writing and classroom interaction. In particular, the interaction required to the teacher during the lecture is restricted to an area on the blackboard, which is reserved to control the ReW real front-end. When he/she needs to save and transmit to the virtual world ReW window an image of the board, the teacher needs only to pass his/her hand (or the rubber, before deleting the text) on this area. Alternatively, the saving can be requested directly in-world (i.e., when in the Virtual World). An additional benefit provided by ReW system to Virtual

World didactic and collaborative action is an improved sense of immersion and realism. The remote users are immersed in replicas of the real classroom and ReW increases their sense of immersion by providing them real blackboard images contemporarily improving the perceived realism and involvement.

1. Related Work

Several authors, such as [7] and [13] affirm that 3D web Virtual Worlds may really represent a likely hypothesis on the future of the web and it can be easily foreseen how the evolution of web exploration scenarios and interaction metaphors will go towards more natural real world practices and attitudes.

The metaphor of 3D collaborative virtual meeting rooms hosted in Virtual Worlds is really diffused and accepted. It is proposed by several tools available in different Virtual Worlds, such as [2], [11], [14], [19], [20] and [5]. In all these environments human participants are represented by avatars. In [5] a Second Life (SL) virtual environment supporting the control and setup of collaborative learning activities has been proposed. In [20], a remote physical experiment, concerning magnetism, is reproduced in Wonderland [23] and effectively exposed to the interaction with students. Wonderland was an interesting framework for the development of pure JAVA 3D virtual setting, but, after the acquisition of SUN by ORACLE, the Wonderland project has been dismissed. As a proof of interest towards these technologies, a non-profit corporation, the Open Wonderland Foundation [15] is continuing the development of a community fork of Project Wonderland.

As a confirmation of interest for the chances offered by virtual worlds to collaboration, Lindeman et al. in [12], experiment the use of SL for the yearly cycle of a program committee meetings (IEEE Virtual Reality 2009). They conclude that SL is a good and cheap alternative to face-to-face settings and avoids the time and money wasting associated with face-to-face meetings.

Virtual Worlds such as Active Worlds [1], Croquet [4], Open Wonderland [16] and SL [21], propose didactic and collaborative environments which are quite diverse, ranging from realistic replicas of real universities to simulations of other planets, or completely fantastic settings. Considering that future users are today's 'digital natives' (i.e., they are growing up in a technological environment, such as multi-player online games and instant messaging), it will be natural and pleasant for them to use a virtual world for distance learning and collaboration.

In the context of software requirements negotiation, Erra et al. compare in [8], face to face meetings, a three-dimensional virtual environment and a text-based structured chat. Underlining the importance of communication media richness, they report that the teams using the three-dimensional environment perform most like those in face-to-face groups.
However, as stated by Witmer et al. [22], several factors contribute to increase the success of an immersive experience aggregated in the perception of presence: Control, Realism, Distraction and Sensory input. Also Chittaro et al. assert in [3] that disappointment can negatively influence users' predisposition to learning: when the expectation of learners contrast with the perception of the system, users are less involved in the learning process. In particular, they underline the amplified participation of learners in presence of increased realism.

In that direction, our system enhances the perception of realism by opening a "window on the reality" and increases the sensation of efficacy by letting users control the Reality directly from the Virtual World. In particular, we expose the classroom blackboard to virtual world users without altering the teacher habits and in usual classroom settings.
Before dismissing the Wonderland project, SUN was proposing the Porta-Person hardware component, a system with functionalities analogous to the proposed ones. Porta-Person is a

tele-presence device aiming at improving, like the ReW system, the connection between the Virtual World and the real setting of a meeting. It is based on a rotating display that shows a remote participant's video image or their animated representation [24].

Several commercial systems propose expensive hardware to implement electronic and, in the best cases, interactive boards, that can be considered affine to the ReW one. Proposed solutions range from simple screen for saving board content to complex interactive instruments capable also to run didactic simulations.

Multimedia Interactive Boards are hardware devices that use a computer, a projector and some touch detection mechanism on the screen to gain the position of the mouse pointer and the pressure of its left and right buttons. The interactive solutions available on the market require an economical effort ranging from few hundred of Euros to several thousand for multi-touch active models that do not require the projector. As an example of extreme sophistication, Hitachi proposes an interactive 50 inches touch screen overlay system for boardrooms [18], customer meeting rooms, training, distance learning and video conferences. The overlay hardware adds an infrared image sensor system to plasma displays obtaining a resolution of 500 lines/inch.

The proposed system, in particular the EleBBo front-end, adopts a quick technique for board command detection, that are collected on the blackboard as shown in the following. In our case the resolution obtainable with adopted webcams (and the related light frequencies) is adequate for our goal but not comparable with the commercial solutions.

2. The Proposed System

The proposed system spans from the classroom to the virtual world and requires only a low cost webcam as main input source.

It is important to point out that Open Wonderland is still equipped with a specific module for viewing live streaming video from webcams [17], but our solution is slightly different:

- The teacher controls when the blackboard is to be published by simply acting on it
- The produced output of the system is a set of recorded images and not a video stream.

Figure 1 depicts the architecture of the proposed system whose component can be classified respect to their location:

- Classroom front-end (EleBBo)
- Virtual World front-ends (ReW and ReW4SL)
- Data Server.

EleBBo (i.e., Electronic BlackBoard) is the classroom front-end of the system and is depicted in the central part of Figure 1. As previously specified, it is hosted on a normal desktop pc set on the classroom desk and equipped with a webcam pointing at the teacher blackboard. EleBBo is the source of blackboard images and is usually controlled by the teacher, even if it exposes a socket interface to the saving requests coming from the other subsystem. In this way, it is possible to control the classroom actions also from the Virtual World front-ends.

ReW and ReW4SL (Reality Window and R.W. for SL), the two prototype front-ends to the virtual part of system we developed, are depicted in the leftmost side of Figure 1. ReW has been developed for Open Wonderland technology while ReW4SL is its porting to SL. Both are hosted in realistic replicas of the real didactic settings.

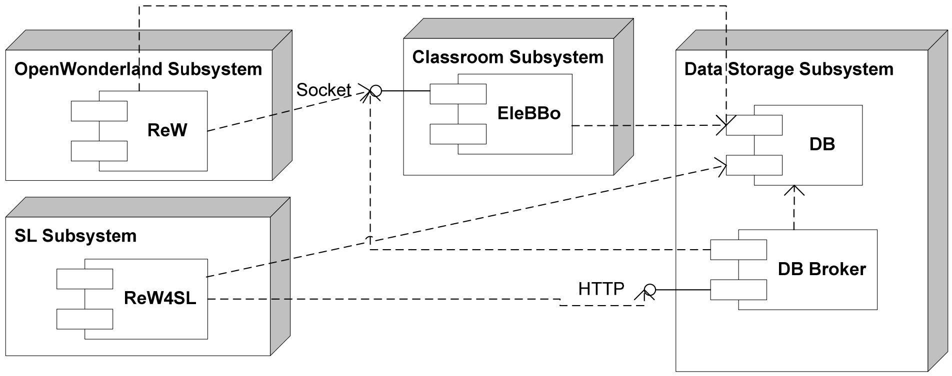

Figure 1. The ReW system architecture: dashed lines represent connections between nodes.

While the ReW component, implemented using the Java program language, is capable to directly connect to the EleBBo socket interface and control its actions, as well as to connect to the DB and fetch the images, the ReW4SL one needs to connect via HTTP request to the DB Broker to overcome proprietary language restrictions. The DB Broker is depicted in the rightmost side of Figure 1 and is a component of the Data Storage Subsystem which is responsible of controlling data storage and retrieval.

When not explicitly specified, in Figure 1, components connect with the adopted MySQL DBMS using JDBC API [10].

3. EleBBo: the Classroom front-end

The EleBBo front-end is the teacher interface to the system and is hosted on a desktop PC in the classroom. The front-end exposes two interfaces as depicted in Figures 2 (a) and (b). The former controls the image acquisition while the latter regulates the access to stored images. Combined with a classroom projector, the EleBBo subsystem can also be useful for retrieving previously stored content. To start the acquisition modality, the EleBBo subsystem requires the teacher to physically set a visual marker on the board. The marker should be adequately in contrast with the board surface: a white one is good for blackboards, a darker for whiteboards. Since our board is white, in Figure 1, a black marker has been used and is visible in all the five pictures. The marker will represent the virtual button to press when the teacher wants to save a 'screenshot' of his/her classroom board.

The detection of the marker is started by the teacher who clicks on the part of image exposed by the acquisition interface and depicting the marker. After this input, the system is capable to detect the button area on the image by searching all pixels similar, in term of intensity, connected to the clicked area.

It is important to point out that our images are memorized in terms of their three color bands: red, green and blue. Without loss of generality, the rest of the discourse will consider all bands as a single grayscale image or, equivalently, the tree bands average. Figures 2 (c), (d) and (e) depict the image elaboration pipeline adopted to enhance the virtual button detection. The original video frame is depicted in Figure 2 (c). The pixel values of the images are then stretched in the full range [0 255] obtaining the frame depicted in Figure 2 (d), without any loss of information. Indeed, if m is the minimum intensity value among all pixels of the image and M the maximum, for all pixels of the image represented by the matrix $PIX[i,j]$, the stretched values will be:

$$PIX\_STRETCHED[i,j] = 255\,(PIX[i,j] - m) / (M - m)\,.$$

The quantization noise is then removed by applying an average local spatial operator [9] and obtaining the image depicted in Figure 2 (e). As shown in the enlarged box of Figure

2 (a), the detected button is circled with a colored box with the word “SAVE”. The image elaboration pipeline adopted ensures good detection performances, but it is important to point out that the button setup procedure is supervised by the teacher who may repeat it in the case of errors.

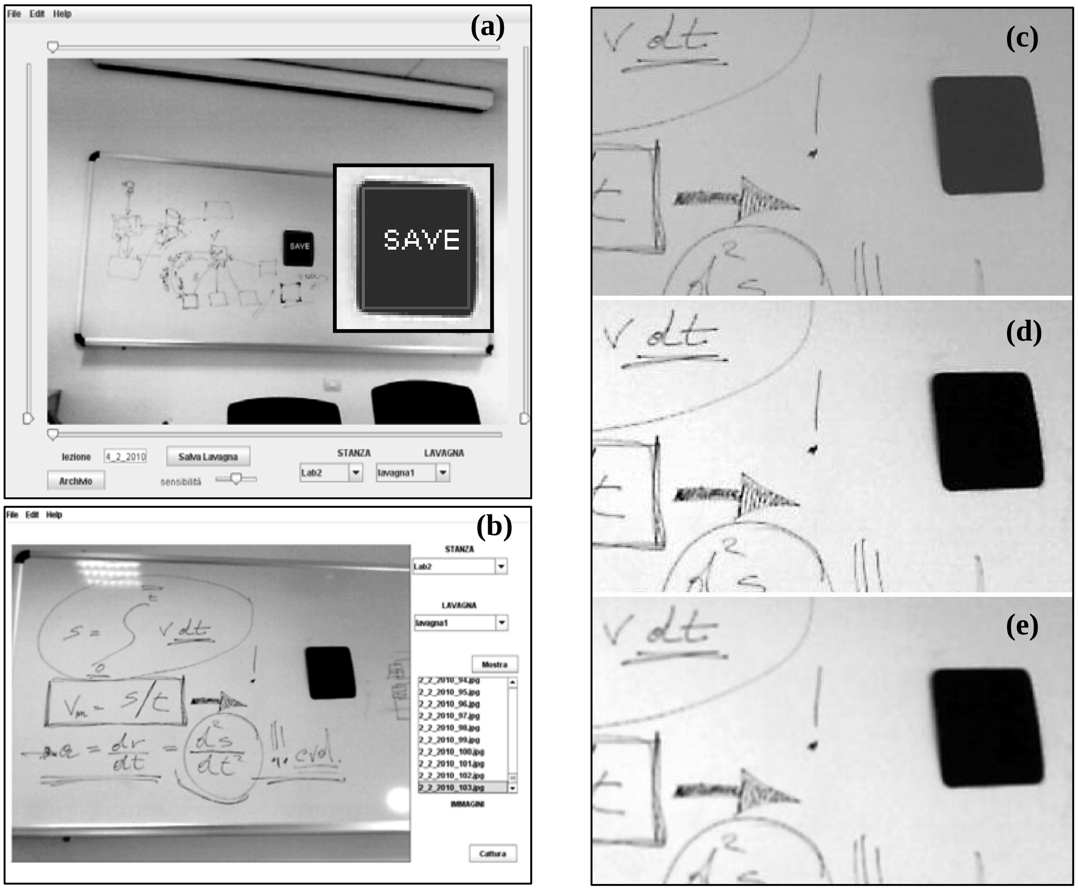

Figure 2. The Classroom EleBBo front-end (a and b) and the image elaboration pipeline applied during the button detection (c, d and e).

After the setting of the virtual ‘SAVE’ button, when the teacher needs to save the board content updating what is shown to remote users, he/she passes a hand on the button. The EleBBo subsystem detects the luminosity change in the controlled button area and stores an image of the starting RGB picture on the Data Storage subsystem, signaling with an audio feedback the successful recording.

The system is useful also to save blackboard hand written content: the interface proposed in Figure 2 (b) is used for lately retrieving stored pictures.

4. ReW and ReW4SL: the Virtual World front-ends

ReW and ReW4SL are the Virtual World front-ends to the system; they are virtually represented by virtual boards, they are hosted in the replicas of the classrooms, as depicted in Figures 3 (a) and 4.

The ReW prototypes have been developed, with some differences, for two diffused Virtual Worlds: respectively ReW is the Open Wonderland version (see Figure 3 (a) and (b)) and ReW4SL the SL one (depicted in Figure 4).

During the remote lecture, the teacher avatar stands near the ReW clients, both representing a reference point for distance learners and streaming to the Virtual Worlds the audio of the lecture. When in on-line modality (always in the case of ReW4SL), the virtual boards poll a periodic request to the Data Storage subsystem querying the last saved image. In this way remote users, both in Open Wonderland and in SL, can see the last saved image of the classroom blackboard. ReW exposes to users the configuration interface depicted in Figure 3 (b) that is used also to access stored data. The teacher may customize the update delay acting on the slider and can select and retrieve previously stored images.

(a) (b)

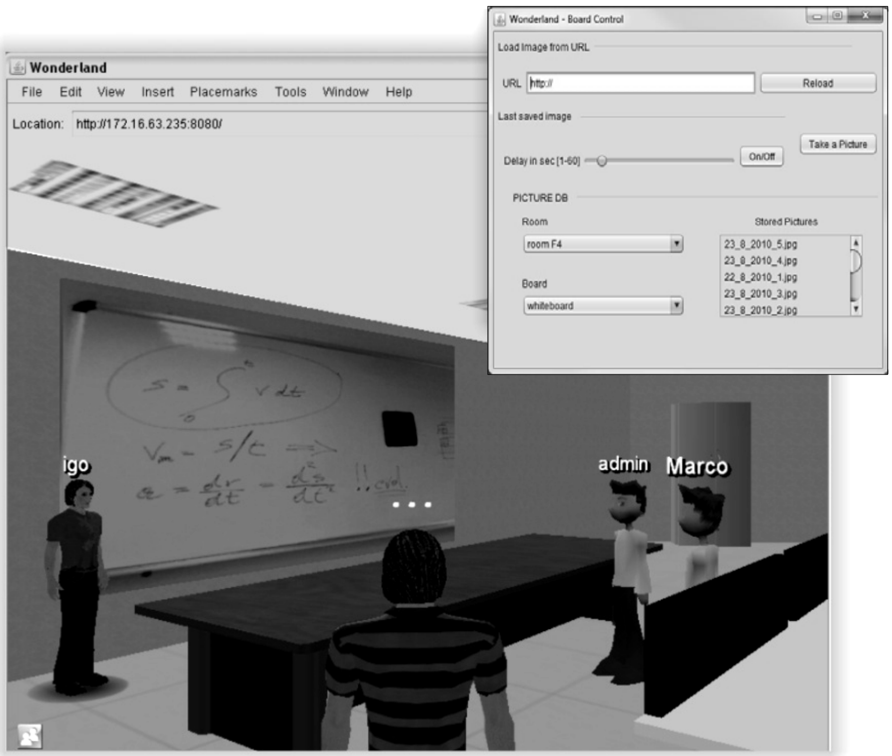

Figure 3. The Open Wonderland ReW front-end (a) and its control interface (b).

A different usage scenario enables remote users to request the ‘SAVE’ operation in the real lecture setting (i.e., the EleBBo front-end) and update the image shown in the virtual setting.

At this aim, the ReW front-ends expose a ‘Take a Picture’ button that cause EleBBo to save a picture of the classroom blackboard. This scenario strongly increases the immersion perception of remote users since they feel, as it really happens, to directly act on the real setting.

The Rew4SL front-end overcomes the limitation imposed by SL technology on connections outside SL world by connecting to an intermediate broker for sending ‘SAVE’ commands and retrieving the images. Exploiting the capability of SL objects to address HTTP requests outside the Virtual Worlds, it connects to the DB Broker of Data Storage Subsystem that returns the image in the form of web images displayed in-world. For the difficulty of listing big amount of data in SL, the ReW4SL front-end does not offer the image archive access and permanently exposes the control area. It enables the teacher to choose among three pre defined update frequencies and to control the saving and updating of the blackboard image.

Figure 4 shows, in the rightmost side, the ReW4SL system near a pre-existing presentation system [5]. In this case the ReW system fully reveals its utility in a concrete scenario: for normal lecture exposition the teacher uses the ‘traditional’ presentation system, while he/she distributes the notes written on the blackboard via the ReW(4SL) system.

Figure 4. The Second Life ReW4SL front-end.

The right part of the ReW4SL front-end exposes the control area where the teacher can set the update frequency and push a SAVE command to the EleBBo subsystem.

5. Conclusion and Future Work

In this paper we presented the ReW (Reality Windows) system. It is a hybrid solution distributed between the real classroom setting and its Virtual Worlds replicas and provides a remote camera on the classroom blackboard complementing the content provided by available virtual world presentation systems, with on-line hand-written data.
First users’ opinions about the system have been really good. In particular, even if a video stream is not an innovation for Virtual Worlds, users were favorably impressed by the ability to control directly in-world the webcam in the real classroom. The ReW system seems to create a high contextualization of remote actions and to ideally enforce a strong connection between the Virtual World and the Reality.

Exploiting this characteristic, a further new extension of the proposed Virtual-Real worlds connection will be in the context of remote collaboration. The system proposed in [6], enables users to collaborate, via mobile devices, in augmented reality collaborative forums, spatially contextualized in typical classrooms or laboratories. Virtual Words will be used to provide remote access to the collaborative forums in such a way to respect the contextualization of collaborative spaces: the remote access will be still contextualized adopting the virtual replicas of the places. The benefits will be both for the collaborative augmented spaces user, who will be free to remotely work on forums and for the Virtual Spaces, populated by (virtual) spatially localized user bots.

As a future work, we are also planning to empirically evaluate the efficacy of the proposed system in a controlled experiment and to enhance the system capabilities by exploiting and combining the classroom projector with the blackboard.

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Enhancing Intelligent Pedagogical Agents in Virtual Worlds

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Abstract: Intelligent Pedagogical Agents (IPAs) are software agents which have educational purposes. They are able to communicate, cooperate, discuss, and guide other students or agents. Some studies conclude that if agents look like and interact as humans, they will enhance the learning process and the motivation of the students. This paper presents a proposal to add Semantic Web Knowledge to Intelligent Pedagogical Agents. In our solution, the IPA has a modular knowledge organization composed by four differentiated areas: (i) the rational area, which adds semantic web knowledge, (ii) the association area, which simplifies building appropriate responses, (iii) the commonsense area, which provides commonsense responses, and (iv) the behavioral area, which allows IPA agents to show empathy. Our main objective is to create more intelligent and more human alike Mentor IPAs, enhancing the learning experience of students in 3D Immersive Virtual Learning Environments for various learning settings.

Keywords: Virtual Worlds, Intelligent Pedagogical Agents, long-life learning, guided learning, linked open data

Introduction

Virtual Worlds (VWs) represent social persistent worlds, generated through computer-simulated environments that allow interaction between avatars (i.e., the computer representation of users). This term is used in different ways such as simulated worlds, digital worlds, virtual environments, virtual reality, virtual worlds, or cyberspaces, by academics, industry professionals, and the media [4]. The first VW, still text based, was developed in the 1970s. Since then, a lot of VWs have been developed, and currently the use of 3D technology is a standard. The available VWs cover all topics of interest, although is in the education where they have attained noticeable importance during the last decade [5]. Examples of 3D VWs platforms are Open Wonderland [13] and Second Life [14].

Virtual Learning Environments (VLEs) integrate several educational resources to the learner including multimedia learning material, communication tools, recommender systems, etc. [16]. When VLEs are based in 3D VWs, they are called 3D Immersive Virtual Learning Environments, where the learners are immersed into the 3D VW being represented as avatars, and it is possible to meet other students or educators making the learning process very dynamic.

Intelligent Pedagogical Agents (IPAs) are software agents which have educational purposes. Their priority target is to stimulate the students to do their best in the learning process. One significant difference between IPAs and conventional computer-based learning environments such as Intelligent Tutoring Systems (ITS) is their ability to simulate social interactions, and to make use of non-verbal and verbal communication. This means that pedagogical agents are able to communicate, cooperate, discuss, and guide other agents or students represented through avatars [6]. IPAs integrated in VLEs can play different roles such as provide intelligent visual appearance, intelligent navigation in the environment for pedagogical objectives, serve collaborative learning functions, and provide narrative and dialog functions guidance [16]. If agents look like and interact as humans, they will enhance not only the learning behavior, but also the motivation of the learning students [18].

To date, the majority of works found in the literature proposed two different functional roles for IPAs: (i) agent as an expert (knowledgeable), and (ii) agent as a motivator (supportive). We think that a new role is required, as a well performing human mentor does not simply transfer information, rather he or she provides guidance for the learner to bridge the gap between his current and desired skill levels, he should not be an authoritarian figure, but rather a guide or coach with advanced experience and knowledge that can work collaboratively with the learners to achieve goals, and he should demonstrate competence to the learner while simultaneously developing a social relationship to motivate him. Therefore, we propose a new approach: IPA as a mentor (knowledgeable and supportive). This insight has motived us to initiate a research project to design a novel approach to provide knowledge to Mentor IPAs integrated in 3D Immersive VLEs. These Mentor IPAs will be provided with knowledge based on semantic repositories, aiming to support students in their learning process. Our proposal may bring great benefits in computer-aided learning.

This paper is organized as follows: Section 1 describes the related work with regard to Intelligent Pedagogical Agents. In Section 2 we introduce the different problems that motivated our work. Section 3 details our proposed architecture. Finally, Section 4 presents some concluding remarks.

1. Related Work

When Virtual Learning Environments become greater with lots of available places to visit and learn from, guidance is needed. The intelligent guidance for learners in 3D immersive VLEs can be achieved by the use of IPAs, which should have pedagogical abilities and a suitable knowledge base to support learners to achieve their educational aims.

Previous research works regarding to IPAs which support learning in different fields can be found in the literature.

In [8] author gave an overview of current research on animated pedagogical agents at the Center for Advanced Research in Technology for Education (CARTE) at the University of Southern California. They developed some systems that, combining ITS with embodied conversational agents, help learners to acquire a variety of problem-solving skills in virtual worlds, in multimedia environments, and on the web. Examples of pedagogical agents developed are Steve [7] and Adele [15].

Steve (Soar Training Expert for Virtual Environments) is an agent designed to be a tutor for the students to perform physical and procedural tasks in the field of naval training. Steve demonstrates how to operate different devices, and the student can ask Steve to finish the task. In this case, Steve will monitor the student's actions and provide assistance. Examples of tasks supported are to control the engines aboard ships, or to inspect air compressors in the engines.

Adele (Agent for Distance Learning: Light Edition) is a case-based reasoning agent [1]. It is runnable at the student's computer since it is a web-based application. Adele has been designed for medical purposes, since it can help the students to perform a disease treatment based on a clinical case. Through Adele, the student is able to perform a variety of actions on the simulated patient, such as to ask questions about medical history, to perform a physical examination, to order diagnostic tests, and to make diagnoses and referrals.

Baldassarri et al. [3] presented Maxine, a script-directed engine for the management and visualization of 3D virtual worlds. Maxine can load models, animations, textures, sounds, embodied animated agents, etc., into a virtual representation in real-time. Despite being a very generic engine, it is oriented towards working with animated virtual actors in virtual scenarios. Maxine supports real-time multimodal use interaction by text, voice, image, and movement. This broadens the spectrum of potential users of the system by allowing interaction with people with special needs, and people of different ages and with different levels of education (i.e., people with or without computer knowledge). Three different applications using Maxine have been developed: (i) virtual presenters for PowerPoint-like presentations, (ii) interactive virtual teacher in the field of Computer Graphics, and (iii) control of a domotic environment.

Multitalker [17] is an intelligent agent primarily designed to tutor students while they try to work together on group homework assignments in Second Life. It was developed using Basilica, an event-driven framework, which enables development of conversational agents.

MultiTalker is expected to suggest actions and offer reflective advice when group discussions stall, or if progress towards the assigned goal seems to be staggering. When conversation dies down, becomes off-task, or unproductive, the agent waits a specified amount of time and interrupts with some reflective prompt, inviting members of the group to discuss some likely relevant aspect or their task. The agent will ask members of the group to answer questions, and it will confirm if answers are correct and follow-up with implications of the correct answers until productive students' conversation resumes.

To the best of our knowledge, although there are several research works regarding to the use of IPAs, none of them have studied how IPAs would support users in their learning process when attempting to find information through semantic repositories in immersive Virtual Learning Environments (VLEs).

2. Motivation

The use of VWs in education provides significant benefits for students and institutions [9]. These include: (i) education is not location-dependent, (ii) avoids discriminations since the users' avatars can be adapted in many ways, (iii) the simulation requires an active learning, (iv) educational experiments can be performed in different and unusual points of view, (v) enables students social interaction, (vi) supports high degrees of individualization not possible in classical classrooms, (vii) favors the international education (people or educators from other countries all around the world), (viii) offers great flexibility and numerous learning opportunities, and (ix) the educational support is available 24 hours a day, 7 days a week.

On the other hand, the use of IPAs in education also provides benefits to the educational process [16]. IPAs can: (i) increase the students' engagement, (ii) add value by giving new educational possibilities and computational-richness support, (iii) improve the interactions between the computer and the learner, (iv) act as a teacher, learning facilitator, or even a student peer in collaborative settings, and (v) act pedagogically on behalf or with learners.

Although the use of VWs and IPAs in education can favour effective computer-aided learning, these kind of learning environments present some drawbacks: (i) although the level of realism is being improved more and more, they lack of face-to-face interaction, (ii) require intelligent support and guidance, (iii) the use of 3D immersive environments can distract students from the main goals of the course, and (iv) IPAs usually are not human alike, or they are far from human appearance and behavior.

Integrating autonomous Mentor IPAs enriched with suitable semantic knowledge could mitigate some of the above problems, since semantic knowledge databases provide them documentation of knowledge, intelligent decision support, self learning, commonsense, and reasoning abilities [2].

3. Our Proposal

In this section we present our proposal in detail, explaining the different knowledge areas that an IPA should have in order to facilitate and improve the students' learning process in 3D Immersive VLEs. Figure 1 shows our proposed conceptual architecture. As shown, students can express a problem to the Mentor IPA about something of their interest, and it will provide them with a suitable answer. One important issue to be considered should be user modeling and understanding. Hence, user's parameters such as behavior, background knowledge, needs and preferences will be important for the IPA to contextualize its performance.

Our Intelligent Pedagogical Agent has four differentiated areas: (i) the rational area, (ii) the association area, (iii) the commonsense area, and (iv) the behavioral area. In the next subsections we explain them further.

When someone states a question or a problem, the IPA processes it, and performs different tasks: it searches in a Commonsense Knowledge Base, also in different Knowledge Bases, and tries to find the most appropriate emotion in this context. These tasks can be done in parallel, reducing its response time. Once, it has obtained the results, it makes the associations and builds the correct answer. In order to increase the level of realism, the interaction with the students could be done with voice.

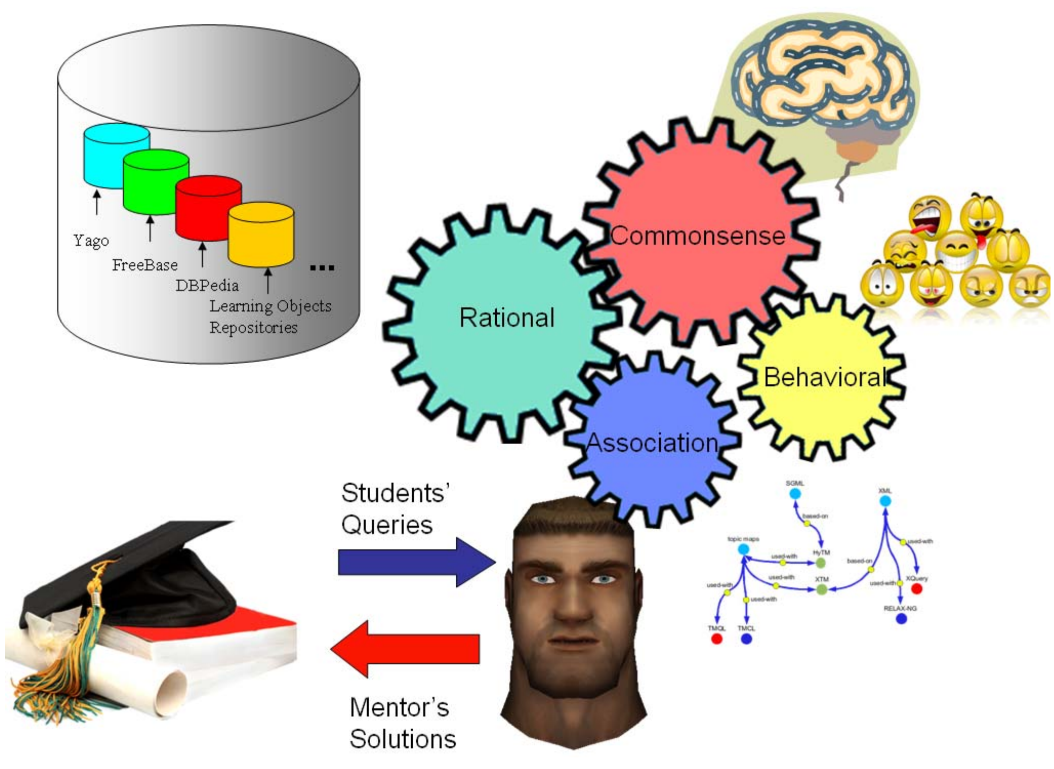

Fig. 1. Proposed conceptual architecture.

3.1 Rational Area

Our main objective is to provide Mentor IPAs with Semantic Web Knowledge, so this is one of the most important areas. The IPA will consult some different semantic web repositories to obtain the most suitable contents regarding the student's needs. We have decided to use both semantic repositories, enhancing Mentor IPAs with automatic reasoning about data, and learning object repositories, making it possible that the IPA can share educational materials with the students. As previously mentioned, this system allows parallel search in different repositories, and so reducing the response time. Moreover, this design presents high scalability since new metadata schemata can be easily integrated. Table 1 shows some of the possible knowledge repositories that our IPA could integrate.

Table 1. Characteristics of some semantic and general Learning Objects Repositories

Name	Description
YAGO[1]	YAGO is a huge semantic knowledge base. Currently, YAGO knows more than 2 million entities and 20 million facts about these entities. Unlike many other automatically assembled knowledge bases, YAGO has a manually confirmed accuracy of 95%.
DBPedia[2]	DBpedia is a community effort to extract structured information from Wikipedia and to make this information available on theWeb. Dbpedia allows users to ask sophisticated queries against Wikipedia, and to link other data sets on the Web to Wikipedia data. The DBpedia knowledge base currently describes more than 3.4 million things, out of which 1.5 million are classified in a consistent Ontology.
FreeBase[3]	Freebase is an open, Creative Commons licensed repository of structured data of more than 12 million entities. Freebase is also a community of thousands of people, working together to improve Freebase's data.
Connexions[4]	Connexions is an environment for collaboratively developing, freely sharing, and rapidly publishing scholarly content on the Web. Its Content Commons contains educational materials for everyone (from children to college students and professionals) organized in small modules that are easily connected into larger collections or courses. All content is free to use and reuse under the Creative Commons license. It contains 16752 modules.
MERLOT[5]	MERLOT is a free and open online community of resources designed primarily for faculty, staff and students of higher education from around the world to share their learning materials and pedagogy. The MERLOT repository includes learning materials, but assignments, comments, personal collections and Content Builder web pages.
MIT OCW[6]	MIT OpenCourseWare (OCW) is a web-based publication of virtually all MIT course content (undergraduate and graduate subjects). MIT OpenCourseWare averages 1 million visits each month.

[1] http://www.mpi-inf.mpg.de/yago-naga/yago/
[2] http://dbpedia.org/
[3] http://www.freebase.com/
[4] http://cnx.org/
[5] http://www.merlot.org/
[6] http://ocw.mit.edu/

3.2 Association Area

This area will merge the results obtained in the Rational Area, making the appropriate associations and decision-making.

The traditional information organization has been always focused on documents, folders, and files. However, the Semantic Web which adds modular, and reusable knowledge resources, is difficult to comprehend by the end user due to the complex structure of knowledge contained in semantic repositories and learning object collections. Humans do not usually look for a certain document or folder, instead they look for information about a particular subject that they are interested in. According to this, we suggest for this area a subject-centric approach, in which information should be organized by subjects, as users typically think.

To implement this area we planned to use a context-aware adaptive system which can adapt its behavior depending on the different user requirements in every moment. The different knowledge resources managed by the IPA (i.e., Knowledge Bases, Learning Objects Repositories, and Commonsense Knowledge Base) can be searched in parallel, but the results must be correctly merged to obtain the most suitable answer depending on the context. In this way, the IPA could assign different weights to the available results obtained from the knowledge resources. In the future we want to test some state-of-the-art artificial intelligence algorithms to find the most suitable to be used by IPAs for educational purposes. Therefore, we argue that our proposal can be used in quite different learning scenarios, such as formal learning, lifelong learning, or vocational learning and training.

3.3 Commonsense Area

As previously mentioned, our IPA will be provided with knowledge repositories. Since the resources offered by knowledge repositories are commonly limited to formal taxonomic relations or dictionary definitions of lexical items, we think that our system should also integrate commonsense knowledge (i.e., the collection of facts and information that an ordinary person is expected to know).

Thanks to this area, the Mentor IPA will be provided with Commonsense Knowledge. This area will help to analyze and process both the input queries, and the output responses. It will also support the behavioral area to find the most appropriate emotion according to the context. To accomplish this, a resource which captures a wide range of commonsense concepts and relations, and allows commonsense inferences should be integrated. Table 2 shows a comparison of two open Commonsense Knowledge initiatives which could be used in our system.

Table 2. Comparison of two open Commonsense Knowledge initiatives

	OpenCyc[7]	**ConceptNet**[8]
Generation	Largely handcrafted	Automatically from OMCS Corpus
Acquisition	Knowledge Engineers	General Public
Reasoning	Formalized Logical	Contextual Commonsense
Content	Mapping text	Real-world texts

[7] http://www.opencyc.org/
[8] http://web.media.mit.edu/~hugo/conceptnet/

3.4 Behavioral Area

An important issue in developing pedagogical agents is emotion. A pedagogical agent can motivate the student to learn efficiently with an appropriate usage of several emotions.
This area will make it possible to increase the level of realism of the IPA, addressing some of the key drawbacks that the majority of IPAs present (i.e., the lack of realism, emotions, personality and social interactions). Behavioral area should cover facial expressions as well as body language, or more general non-verbal communication, but also interaction patterns with the learners, etc. The IPA will react accordingly the context and the sense of the queries made by students, including facial and vocal expressions of emotion.

The relationship with a user should affect the emotional reactions of the IPA, and its emotional status and mood must be updated with emotional impulses from the environment [10]. For example if the user is saying something bad happened to him and the IPA has positive impressions of the person, the resulting emotion will be sorry for this situation.
Generally, agents exploit two different channels to show their emotions: Visual and aural channels [12]. Before exhibiting an emotion, the agent has to ”feel” something, and then he can show his feeling using the aforementioned channels. A pedagogical agent may feel excitement and joy when the learner does well and it can be disappointed when problem-solving progress is less than optimal. Eliciting emotions is much more difficult concern than conveying emotions. For this purpose, the agent has to recognize the facial expression as well as gesture and speech of the user.

4. Conclusions

In this paper we present a proposal to add semantic web knowledge to Intelligent Pedagogical Agents. Our proposed Mentor IPA does not simply give out information, it also provides guidance for the learner, and demonstrates competence while simultaneously developing a social relationship to motivate him. Our main objective is to create more intelligent and more human alike Mentor IPAs, enhancing the learning exerience of students in 3D Immersive Virtual Learning Environments.

We believe that integrating an autonomous Mentor IPA merging suitable semantic repositories could mitigate some problems detected in current VLEs, since it will increase the level of realism, reaching a level of interaction similar to face-to-face. Mentor IPAs will also provide intelligent support and guidance to mitigate the “infoglut” (i.e., when a person is overwhelmed by the presence of too much information).
Shifting the information architecture to a subject-centric perspective, means: (i) changing the way that software and interfaces are designed, (ii) deciding whether or not two different objects represent the same subject, and (iii) empowering a new level of interactivity between systems at global scale [11].

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University of Hamburg in 3D: Lesson Learned

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Abstract: Virtual worlds are difficult to classify. On the one hand, they caused one of the biggest hypes in the last years and were seen as the solution to push social networking and collaboration to a new level. On the other hand, the run for virtual land and designing the most impressive installation slowed down quickly and people got unconfident about the benefits. Even though many companies withdraw from virtuality, the number of worlds grew and many (research) institutes started to populate one of the largest playgrounds. In this contribution, we are going to share our experiences, but also claim the need for a sophisticated methodology to support development projects, increase the security, protect the property, close the gap between the worlds, and create a common database of knowledge and experience for other to read about *lessons learned* in (successful and failed) projects.
All projects done on the *University of Hamburg* Island in Second Life would span beyond the page limitation. Thus, this contribution can be seen as a movie trailer: Receiving an overview of the student projects with references to publications with more details. In this spirit, grab the popcorn, lean back, and enjoy the reading.

Keywords: 3D Digital Ecosystems, Education, Student Projects, Virtual World

Introduction

In 2007, we were pushed into the virtuality more by accident than having great plans to take advantage of the technology or even change the way education could be. And according to many reports, blogs, or publications around that time, we were not the only one who got caught unexpected by the wave of Second Life and all other rising worlds. First, the fun part dominated and the discovery of new developments in and around virtual worlds (aka 3D Digital Ecosystems (3DDE)) lead to great, but mainly uncoordinated ideas with generally no (or at least not much) concept or methodology behind it. Numerous companies, organizations, universities, or private people created installations of either real world replicas or designs that could be done nowhere else; sometimes without realizing that the bubble about 3DDE could burst, as it happened with Web 2.0 [3]. In particular, if sustainability was not considered as part of the overall concept. The growth during the first years was immense but left behind the required *customers* to fill the many locations; to make it a lively place. Paired with common scandals, the hype caused a delusion [14] and it got quieter about SL. Involvement and investment became a risky mission and many turned their back towards the former, and still, successful technologies like Web 2.0, Social Networks, or Mobile Computing [3].

Did 3DDE fail and have to be considered dead? The answer is probably yes and no. Without diving to deep into this discussion, we believe that the time of the hype was an important lesson to learn; i.e. about what is working and what is not. And taking a look back, we shall notice that the (Internet) community was not ready yet to add *depth* as another dimension to the Web. First, we locked many users out as the hardware requirements (i.e., bandwidth and computational power) overstrained their *window to the virtuality* []; second we overestimated the navigation and interaction in 3DDE, and third, forgot about added values that would attract and keep the general users in-world. No doubt, there are great scenarios [1, 12, 32, 33]. But same with web-sites: if there is no progress, why should I bother to come back; even if it looks perfect.

What is the paper about? The title spoils the content as the paper is basically about the work done on the *University of Hamburg Island*: A brief revue of projects and lived experiences. Nevertheless, the second part covers the findings or lesson learned and promotes research projects we engaged to increase the value of 3DDE and support future development. Especially the latter one is addressing the community and their contribution to create a source for future projects and providing sustainability for 3DDE. Section 1 covers the background on the *University of Hamburg Island* and how 3DDE provide opportunities to involve students; i.e. performing (international) research projects and collaborations (Section 2). Section 3 presents current approaches on methodologies for 3DDE for target-oriented development, and discusses, in our opinion, the most crucial needs for successful 3DDE development. The paper is concluded with an outlook and our expectations in Section 4.

1. Projects on the University of Hamburg Island

29th April 2008 marks the officially opening day of the island in Second Life, but the first steps in virtuality were done almost a year before that on the *Campus Hamburg Island*: A group of students, researchers, and most amazing, private people started their first project: visualization of a container terminal and its processes.[9] Over the period of the next two years, the idea of virtuality was integrated in the classroom, but extended beyond Second Life, which had too many limits regarding the inclusion of the real world. Other investigated worlds included Project Wonderland (called Open Wonderland [22] after Sun was bought by Oracle, who stopped further support for the Open Source project) and Open Simulator [23]. In addition, the projects resulted in spin-offs on the iPhone. The main projects are given in Table 1. And with all respect for other projects worldwide, even a small coverage would "blast" the page limitation, so that we have to restrict ourselves in that matter.

Project Name	**Realization by**	**Lit.**	**Short Description**
Container Terminal	T.Reiners, S.Wriedt F.Burmester	[2] [35]	First project demonstrating the processes on a container terminal with focus on the waterside.
Queue Simulation	M.Ebeling	[35]	Simulation of a pharmacy queue, where the user can set various parameters like kind of queue, customer arrival, or number of pharmacists.
Supply Chain Simulation	S.Wriedt	[35]	Interactive teaching scenario for the bull-whip-effect using the container terminal as supplier and the pharmacy as customer.
3DDE-Lecture	T.Reiners	[6] [13]	Lecture with international guest speakers and demonstration of production and logistics locations in Second Life. The course combined classroom and distance education as both reality and virtuality was projected in both worlds.
Bottle Factory	A. Erlenkötter H.Miu, F.Sommer C.-M.Kühnlenz	[9]	Student project about a production unit for a soda drink to demonstrate processes in lectures and to learn about requirements for designing production equipment.
Interactive Classroom	T.Reiners C.Dreher N.Dreher H.Dreher S.Gregory, B.Tynan	[6] [30] [13]	The joint project with the Curtin University was about transferring software development into Second Life, where the students learn the whole software development cycle. The results are shown on the *Australis 4 Learning* Island.
Business Departement	T.Reiners, S.Wriedt	-	Providing a space for institutes in the department
ePUSH	A.Hebbel-Segger C.Kuhlenkampff	[8]	The virtual world part of the project was about creating a seminar room, whereas the main technological development consisted of a holodeck implementation, where scenarios (e.g., arrangement of chairs/desks, objects) can be switched

[9] Note that the installation had to be abandoned due to space limitations.

			through a panel.
Graffiti (OpenWonderland)	S.Büttner M.Naumann L.Visser	[26]	Interactive pin-board in Project Wonderland which is accessible and synchronized from other media devices (iPhone), web-sites, and worlds (Second Life).
3D WII-Remote Input*	S.Leder	[26]	Extending the Wii-Remote input by J.C. Lee [19] to the third dimension and transferring the input to multiple worlds at the same time.
Avatar Tracking/Reporting*	Johannes Siep	-	Reports about movements, position, and actions of avatars on a web-site.
Interactive 3D Catalog*	C.Kuhlenkampff M.Wolter B.Altmann A.Wolter, R.Lindow	-	Designing and building an interactive catalog for 3D objects including a web-based repository. Later applications are, e.g., shopping support for stores like IKEA or a portable repository of all objects someone owns.
Harassment Simulator	J.Sponholz E.Born	[28]	Role play inhabits a viral role for virtual worlds. This project demonstrated how a simulator for harassment at the workplace could be realized.
Virtual Navigation	C.Miu	-	Using the IPhone to navigate through building; i.e. projecting information about locations on the camera and/or virtual representation of the building.
Automated Assessment Lab*	C.Dreher H.Dreher T.Reiners	[27]	For the interactive classroom and to demonstrate an automated essay grading software, we set up a lab including an advanced classroom, interactive posters, and a drop box for assignments.
Object Security Framework	T.Reiners S.Wriedt A.Rea	[25]	Introduce a feasible concept of object security. The proposed framework protects property and presents a methodology for exchanging objects across multiple 3DDE.

Table 1: List of projects done on the *University of Hamburg Island* in Second Life. The references show already published papers, others (marked with *) are currently prepared and close to be submitted to conferences and journals.

2. (Student) Projects to Cross Worlds: Summary and Lesson Learned

The initial motive, after deciding to have projects in 3DDE in the first place, was about creating a place for educational projects for students done by students. Therefore, projects were only started when either students took the lead (not necessarily providing the initial idea) or the project was in favor for teaching; i.e. designing classrooms and creating drop boxes to submit assignments. With respect to the paper length, we depict features to highlight the core aspects of projects rather than describing one or two projects in full details; see also references in Table 1.

Student Dreams Come True: All projects have one thing in common: No limits. We suggested subjects, but wanted students to decide on *what* to implement *how* in *which* environment. The *no guidance approach* for the first stage was challenging; i.e. considering their little knowledge in this area. The projects were open for students with major in, i.e., Business Administration, Information Systems, Engineering, Computer Science, Law, and Psychology; implying a broad variety of knowledge but not necessarily in programming, construction, or design. Nevertheless, we received a positive feedback from all students; i.e. addressing 1) the (motivating) game-like environment; 2) the inspiring freedom; 3) the publicity which encouraged the students to perfect their outcome as everyone is able to see and judge, and; 4) the opportunities of using innovative technology. In comparison to a classroom lecture (presenting and discussing slides), we experienced that students are far more interested in looking deeper into a subject to cover practical and theoretical concerns (kind of comparable to science fairs) and spend in average more hours than we expected and asked for. Note that the extra hours were used to improve the outcome (and not dealing with problems or class requirements).

Most students started with an introductionary course about 1) what are 3DDE; 2) what can be done in 3DDE, and; 3) what did other do in 3DDE. Especially invited speaker from around the world encouraged students to accept the new technology and apply it to some of their ideas. While we suggested SL, some verified suitability of different 3DDE first and chose the one matching best their requirements; a step strongly encourage by us to lower given barriers. We were surprised that students accepted the challenge as there was basically no experiences how it would turn out with respect to grades (which is a major issue for students) and workload. Obviously, not all went smooth, but compared to other software projects we had in the past (Java, C++, proprietary software), the number of complaints about, e.g., usability, learning curve, problems, or invested time was far below our expectations.

The project *Bottle Factory* is a good example to demonstrate the motivational aspect of 3DDE. Here, the students (major in Information Systems) had to design a production line for a *real* product; considering restrictions like space for the machines, access for maintenance, and coverage of all production steps. For the product, real-world companies were contacted by students; they analyzed different designs for machine settings; learned programming; and reviewed literature; and all with more commitment than anticipated from a group of four students. The outcome reflects all technical aspects of the production and is even now a point of interest for other students. The project *Harassment Simulator* [28] was inspired by the fact that students had to perform real-life role play but could not identify truly with their played roles. Therefore, the experiments were transferred to SL using the avatar in a mock-up office with different stations to walk through. Notable is that the experimental results are compared to existing case studies; accessible online together with a theoretical report on the subject. Compared to the other project, the user of the installation takes an active role and is in the focus of the experiment. It allows student to experience certain scenarios by themselves to learn about it, whereas further consolidation still requires communication with experts.

In summary, the given freedom on the subject in an unknown but rich (3D) environment turned out to be the key factor for above average results. Instead of following straight paths to the results according to their assignment, they could experiment with ideas and create something, which would be later (and during the development) accessible to the public (and not archived as most student projects). The visibility also supported collaboration and team work as meetings happened online. Furthermore, projects in SL turned out to be more equitably than offline projects as implementations (creator of objects) as well as online time can be logged for each student.

Crossing Worlds: Unfortunately, SL also reveals additional barriers. Students experienced a lock-in feeling as a result of restricted media integration and reduced connectivity to the outside world. Furthermore, the claimed immersion is difficult to achieve if keyboard and mouse has to be used for inputs. In some projects, we took a look around the corner to find answers to some pertinent questions, such as: (1) what are the alternatives to SL providing similar or additional features; (2) how can we increase students' connectivity and reduce the gap between the real and virtual world; (3) how can we increase the immersive feeling? The 3D-Wii-Remote project [26] provided an immersive control to interact with the 3DDE, whereas the Graffiti-Wall synchronized interaction across different worlds and devices [26]. Graffiti is about different media objects (e.g., images and notes) being placed on a virtual wall; including further operations like annotation or moving. All environments are synchronized; every change is immediately visible on all outlets. As all devices have different means of input (avatars in 3DDE, touch screen on mobile devices, mouse on Web-sites), the student learned about user interfaces and how to display and handle data objects; and Technology Acceptance Models.

Over the last three years, we learned that students require a large variety of (unique) projects. In addition, we observed the interest of students in emerging technologies, e.g., mobile computing and Web 3D. Therefore, we had to broaden our interest and in addition to 3DDE, consider related fields. According to feedback from students about their interest, it got more important that there are no dependencies to a specific 3DDE, not having to be online to work on the project, or having to use (proprietary and large) development environments; in short, having even more flexibility and freedom than any 3DDE can provide. This change was in our interest, as we could define integrated projects; e.g. a 3D catalog, where a mobile device is used as a portable object repository, a server to store and exchange all objects and a 3DDE to use the objects; e.g. classroom or game.

The world became an Open Point: The islands *University of Hamburg* and *Australis 4 Learning* are neighbors. It takes just one click to move the avatar from one to the other island. And 3DDE supports (international) collaboration by providing tools to work in the same space at the same time; e.g. an immersive audio system and synchronized visualization of media. We initiated various collaborations, some over a short period of time like guest speakers, others to realize larger project as we have done with *Australis 4 Learning* – shared island of *Curtin University, Perth*, *University of New England, Armidale*, and *Australian Catholic University, Sydney* [5, 6, 13, 27, 30] – and individuals like Alan Rea (*Haworth College of Business, Western Michigan University, United States*) about object security [25]. 3DDE is going beyond the often cited *flat world*, but eliminates distance completely; allowing students and researchers to be alike and meet without barriers. While social networks are great for asynchronous communication, 3DDE are about getting together to communicate and collaborate in real time.

3. Methodology, Security, Freedom

3D Digital Ecosystems represent important (and still emerging) markets with great expectations for the future; i.e. according to studies by Gartner [10, 14]. The hype had an exponential effect on attracting stakeholders to participate; even without concepts, ideas, or capabilities to realize a product with unique features. Nevertheless, our experiences in the projects as well as various interviews with expert indicate that given 3DDE (providing the required freedom for creating unique scenarios) are still in development or create limiting barriers. While we did not perform a thorough analysis of all existing 3DDE but limited ourselves to the most common in education and research, we were still able to identify three major concerns: Methodology, Security, and Freedom. Here we are able to outline the subject, but have to refer to other outlets for further reading.

Support for Developers and Stakeholders: 3DDE and the Web are not so far apart: if it is not done right, it will not attract interest; unless users are required to use it. Outstanding installations (e.g., [34, 12]) are accompanied by numerous other projects which do not receive the same perception. Even though projects might fulfill their intention, they probably could receive a higher impact by following a specific methodology for 3DDE and including domain experts and knowledge about 3DDE. Note that this is especially the case where 3DDE distracts from the content instead of adding value to it. In the aftermath of the SL hype, it is possible to identify projects that started experimental but later embedded a strategy to increase the outcome. Several methodologies for, e.g., development, evaluation, or learning have been suggested [7, 11, 15, 21, 31] but so far no (holistic) solution achieved an impact being comparable to, e.g., classic software development models like Waterfall or Agile Developing. Our experiences over all projects exposed the similarity to software development, but with further requirements to cover the social rather than technological aspects [18, 24], reflect on the application domain, and take provisions for 3DDE sustainability. It is crucial to cover important dimensions (e.g., stakeholder, application domain, system development method, required 3DDE features, or 3DDE knowledge) and processes for the 3DDE development lifecycle.

Thus, we initiated projects to 1) consolidate the accumulated Know-How of 3DDE projects in a database, 2) build a platform for accessing and intersecting the database (*structural model*), and 3) derive a *process model* for the whole project; from the first sketch to the retirement and reuse of the implementation; called Methodology for Avatar-based Development of Systems (MEADS) [5]. In a nutshell, the so far identified key to success lies in a project team with experts in their fields (compared to having a stage of getting known to, e.g., the 3DDE or programming language), clear aims/goals to achieve within the project (defined *before* choosing the 3D environment), coordination of specifications (i.e., technical and design), selection of the *best* 3D environment (via pair-wise comparison of weighted features), implementation (using classical systems development models), deployment (e.g., the final product or step-by-step as done with Web 2.0 (beta status) products), sustainability (i.e., *keeping the beat* to prevent ghost installations), and retirement and reuse. For all stages, references from a knowledge database are used to support stakeholders in receiving suggestions and finding decisions. The database is used to keep information about finished projects; e.g., application domain, stakeholders, their involvement and 3DDE knowledge, tasks, durations, required resources (workload, money, hardware, software), and 3DDE features.

Security, Encryption, and Inter-Worlds Transfer: Without doubt, the user has a special relationship with his avatar. But even though the gain in value through experiences (i.e., in World of Warcraft) [4], it is also highly influenced by the owned objects (i.e., property); the true building block of virtual worlds [16]. Users have large investments (this can be time as well as virtual and real money) to create, buy, or upgrade objects. Unfortunately, these objects are limited to the originating world and can seldom transferred to either (external) repositories or other worlds; i.e., if the world is operated by companies with the need to make revenue. In this context, security can be seen from two perspectives: Loss of objects and (unauthorized) access by others. If objects are restricted to just one world on external servers (and interoperability or inter-world exchange is not provided), it becomes necessary to assume scenarios where the world is not online (e.g., no user can login to use objects or create financial transfers), closed for good (with all objects being lost), or most potential customers migrate to another 3DDE (such that investments might not produce revenue). Securing objects against unauthorized access is a vulnerable facet and particularly important if 3DDE have open access. In Second Life, object privileges cover modify, copy, resell [20], but even visibility (an important characteristic for research projects and prototype development) can only be controlled by modifying access to the island but not the object; which other 3DDE provide by default.

Research centering on object security in multi 3DDE is still quite undeveloped. Securing objects in single environments is mainly done through restricting access by authentication and access control lists, while the transfer of objects is mainly centered on discussion about standards [17]. Industry to date is interested more in protecting music and movies, instead of 3D objects in 3DDE. The technology to protect objects is discussed in numerous publications (e.g., watermarking, encryption, and signatures) but not yet adopted to 3DDE. In-world, most 3DDE take precautions, but in case of allowed exports, we have to guarantee, for example, uniqueness, maximum count, or unsophistication. In [25], we describe our current research on the architecture GOMS (Global Object Management System) which incorporates well-known and approved standards to create a secure and trusted environment stretching over multiple 3DDE.

Escape the Prison: The next important step, already part of research and alliances (Open Grid), is to connect worlds and allow (almost) unrestricted exchange of objects and accessibility to all worlds using just one avatar. We covered this subject in [25], but also extend the freedom in other projects, where mobile devices (iPhone) or multiple worlds [26] are used. Here, the major limitation was not the object itself (being mainly a collection of nodes, edges, and surfaces), but included functionality in given programming languages. While constructive details of the object can be automatically transferred in any other format, this is not possible for functionality. Besides keeping multiple implementations of each function within the object [25], we analyze the option to call server-based modules returning the computational results. This would allow for one implementation for all worlds rather than one for each world. Instead of feeling trapped, we do see the next step in the smooth integration into the Web (2.0/3D) to eliminate media breaks and increase acceptance.

4. Conclusion

Is our story worth sharing? Did we achieve more than others? Are these important questions to be answered? Even if the answer to all questions is *no*, we want to go ahead and put our knowledge, our experiences, and our work on the table. Not necessarily to be judged, but to provide input for the claimed knowledge repository we intent to build. We hope that the lesson we learned from out projects will support future projects to be successful and do not fail just because there were known issues not being considered; leading to the abovementioned knowledge repository containing aggregated information from projects in all (virtual) worlds, covering all domains, and all users [5].

Based on discussions with stakeholders (domain experts, technical developers) around the world and our own experiences, we identified important fields for research and development to improve the status of 3DDE in the society. In short: object security, inter-world transfer (objects and avatars), interoperability (with other worlds, software, and web-sites), merging 3DDE with reality (augmented reality), and sharing experiences are crucial to push 3DDE out of the shadow back on the stage. And to conclude the paper: All initiated projects entered unknown terrain, but turned out to be a success; either in the classroom or self-studies of student. We conducted international courses, had student run simulation and could simplify blended learning and presentation of processes. However, and this might be the current drawback of 3DDE, the success was only given if actively promoted, supported, and maintained. And our motivation for MEADS.

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Exploring the Potential Virtual Worlds Platforms for Educational Purposes

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Abstract: The developments of new technologies have allowed the emergence of environments that include representations of some elements, which we can see in real world. These elements are virtual humans, which interact with each other's, virtual physics objects (lands, oceans, and virtual objects), gravity as well as its laws that govern the society. These environments have some peculiars characteristics (synthetic, immersive, presence, interactive, realistic and three-dimensional space) which allowing distinguishes the traditional applications have occupied an important space in the cyber culture and education. To understand their advantages especially when used in education, it makes sense to look for how the social virtual worlds can improve the teaching/learning process and stimulate the Knowledge, including the development of learning to learn autonomy. Our research provides a brief description of Social Virtual worlds, such as Second Life, Active Worlds and Wonderland and makes a comparative analysis between them, based on the matrix developed by Manninen in 2004. Includes a set of measures chosen according the differences and distinctions technical and user interface criteria. Finally, we discuss the potential of these environments for educational purposes. In the future, these worlds may provide a set of services educational including e-learning materials, course module materials, assignments and class sessions, communications between tutors and learners and e-assessment. However most of today's educational institutions will be challenged to encompass the informal and holistic learning scenario

Keywords: Collaborative Environments, virtual worlds social, QEF

Introduction

The Internet has been achieving a notable popularization as a way of communication.With the continuous increasing of the transmission and storage capacity of data, the communication will be more dynamic and more information will be shared. Nowadays, such systems provide to the users a high level of immersion, being a stage for new concepts such as "virtual life". It seems that the only and real world are already not sufficiently, and many people feel the necessity of belonging to different worlds where they can move in space and in the time, advancing and retreating inside a virtual extended attractive space for not to obey to the same rules and laws as the real world.

The real and the virtual worlds get confused in a hybrid fusion of concepts. When analyzing the emergent field of Virtual Worlds, the concept of the "Virtual World" leads us to the existence of many definitions and discussions on this topic. The most used is " a synchronous, persistent network of people, represented by avatars, facilitated by computers" [5].

These worlds allow the creation of spaces through the metaphorical flow of interactions of living things in it "live". The virtual worlds can mean a possibility of extending the process of education, using not only the presence of physical spaces (classrooms), but also the spaces of digital virtual presence (virtual world). The flow of interactions is retained: graphically, by means of the world itself, in the form of movement, evidenced the avatar actions. In this context the present paper aims to contribute to an increasing use of these environments, which we can stimulate the knowledge, including the development of learning to learn autonomy.

In this sense the paper is organized as follows: section 2 describes some social virtual worlds; section 4 makes a comparative analysis between the social virtual world described in section 3, and finally the conclusions where we can observe the advantages in the use of these e-learning environments.

1. Social Virtual World

The Social Virtual World are worlds oriented by socialization and they haven't pre-defined rules. The objectives of members shall live and prosper by using the social practices that they can find in off-line environments, allowing its experiences being more realistic. The users do not necessarily win or play a game, but socialize with others users. The social worlds tend to be much less structured, providing an adjustment of the subject in accordance with reality, basic tools for the construction of the environment and the ability to host activities and events. In general, the social worlds operate more like communities and use elements of games, for instance Second Life, Active worlds, There, Club Penguin, Habbo Hotel, among others [1].

Looking at the different worlds, all have several technologies into a single platform: audio, video, webcam, text and voice chat (VOIP), graphical tools, scripting, web browser and, of course, avatars – the user's projection in the world. Combining these tools and the social aspects, it opens up the way for new perspectives, new ideas that will gradually allow new applications to be used more or less related to real economics.

From the wide range of tools available in the market, we selected those that are most addressed by the academic community, for the following reasons:

- Have a great potential for integrating different technologies, allowing presenting e-learning materials and e-content, narratives based on social interactions, sharing documents and files, hold meetings and events, and provide forums for sharing research findings and meetings with international colleagues.
- Give users the ability to develop the experiences that could be difficult in real world.
- Are safe places for students to learn by doing and they can work in collaborate teams. The ability to interact with one another simultaneously provides students the opportunity to learn concepts not easily learned from a textbook [2].
- the students are encourage to engage in higher level cognitive thinking, such as interpreting, analyzing, discovering

1.1 Active World

Active Worlds (originally known as Alpha World) was officially opened on 27 July 1995, being created by Alpha World [7].

The virtual world Active Worlds (AW) is a hybrid environment, which combines resources of the Internet with 3D environments, and allows the users not only navigate through the world, but also design, implement and extend the environment.

The universe of AW is a feature of online community, with thousands of users distributed by the virtual space, offering a range of possibilities, including making purchases online in 3D virtual space and talk with sellers by chat. The users can be tourists and residents. The tourist don't have the some actions that the residents. The tourists have the right to plan and implement virtual worlds, in certain regions from a database with all kinds of objects and their functions

The browser interface of AW is composed by four windows as we can observe in Figure 1. These provide a set of features that allow the user build the virtual world in different languages, such as English (default), Spanish, Portuguese, French, German, and Finnish.
The interaction between people connected to the world via the Internet is done through conversations, as the chat rooms, where the users can be face-to-face with your caller. It is also possible communicate privately with each other by whispering or sending telegrams. Each person is represented by an avatar, you can choose one to represent it from a wide range of identities, all of them with pre-recorded animations with own express emotions, but just realistic

The AW has a main focus of the communication, but the opportunity it gives to its residents to build something in the world, being owners of the building, allowing the residents to designate levels of privacy and individual control over personal information. The privacy and identity design to both individual users and communities allow a degree of personal autonomy and social.

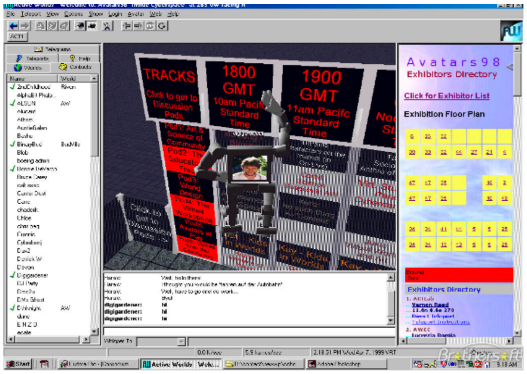

Figure 1 - Browser of Active Worlds (it.pedf.cuni.cz)

Active Worlds has two areas. The first is commercial area where we can showcasing real products and sell them in a virtual store, much like selling in a traditional website. The other is the Active Worlds Educational Universe (AWEDU).The AWEDU, in fact, is a special Active Worlds Browser created specifically to facilitate instructor's capabilities for teaching. The environment is restricted to educational initiatives and provides resources to enable even novices in 3D development the ability to quickly construct and customize a 3D virtual world. This area provides the easiest methods for creating and maintaining individual worlds. Although the interactive opportunities are limited to a pre-defined choice of options, they are easy to employ and allow add to an object or environment

1.2 Second Life

Second Life (SL) [8] is a platform for virtual worlds created by Linden Lab in San Francisco.

The SL is a virtual, three-dimensional environment that simulates some aspects in real life and the social of humans. Depending on the type of use, it can be viewed as a game, a simulator, a v-commerce or a social network.
The SL is a platform based on the 3D Internet where users, called avatars, can communicate with each other through chat and voice. For voice communication, the SL provides a system for the transmission of sound that makes the voice of the avatar is the same user to speak with a microphone connected to the client computer. The sound is transmitted and reproduced from the coordinated avatar in 3D space, thus only the avatars can hear your voice. Another form of interaction is the use of gestures. The gestures animations are able to

communicate the feeling or simulate an action. The Second Life includes a tool that lets users create their own gestures.

In the second life we have some business which advertising the products and services, receive feedback from customers, sell products, have meetings and organize events for updates of products. The SL contains tools for the design and implementation of virtual worlds by the manipulation of geometric primitives. The behavior of objects and avatars can be controlled using the scripting language of the system itself, called the Linden Scripting Language (LSL).

The Second Life has no new concepts on Active World. In both virtual worlds, we appear in a 3D fantasyland as an avatar in the company of others. We can walk, run or fly about, teleport to others spaces, converse with others avatars there. We can have the ability to build their structures, from a library of objects available provided on the server. However, to be guaranteed its permanence, the users must be registered or buy your piece of land, in the case of SL. The ability to own land and then build what you like on it (content) is the key to the awakening of the organizations in the real world moving into the virtual.
Why has Second Life taken a higher success where Active Worlds never quite achieved that threshold?

Perhaps, today there is much greater mutual community awareness than when Active Worlds appeared on the horizon. When Active Worlds was developed the news spread by e-mail, static WebPages. Second Life has appeared at a time when people are more closely interlinked through blogs and various other social networking devices, and a new topic of interest tends to spread more rapidly. For example, a Moodle community has formed, called Sloodle, where we can take advantage of various tools and be in Second Life but interact through Moodle. On the other hand, another reason for the success of Second Life achieves the success is that it's being taken quite seriously by a large number of successful people and entities/companies firmly rooted in the non-virtual world, such as IBM, Nike, Levi's, McDonald's e Coca-Cola and Aveiro University.

1.3 There

There [9] was available to the public October 2003 and has many characteristics of other virtual worlds such as "active worlds" and persistent online games such as "EverQuest." This is a persistent virtual world with objects that can be manipulated, custom (case of avatars) and it has facilities for interaction between users and users and objects.
The users are represented by avatars and they are able to express emotional gestures. The interaction between them is supported by text messages, and audio. The conversation is displayed in a chat through balloons of speech, word for word; instead of complete lines of text appear on instant messaging, as shown in figure 2, the balloons allow users to hear "by chance", observing the conversations around you.

Figure 2- Group of players talking

There virtual world offers a set of tools for scheduling events and training groups, supporting instant messaging (text and audio) and discussion forums. These tools support the organization of complex social interactions, helping to have a "social presence" in the environment.

The interface is divided among a set of Web pages and a 3D virtual environment.

2. Comparative Analysis of Social Virtual Worlds

To improve the understanding of how these applications work, it is necessary to focus on the characteristics of the design used to build the world. The following analysis compares the various features of design in Active Worlds, Second Life and There. Most of the times, the differences and similarities are often difficult to identify, all share the same basic attributes: they are virtual, represents a world or part of it, and they have many participants in simultaneously.

The analysis used was based on Quantitative Evaluation Framework (QEF) method [4]. This framework evaluates the system quality, based on the ISO 9126 standard [6] and measures the quality relatively to a hypothetical ideal system.

To apply the QEF, a set of relevance criteria, should be chosen and validated by the teacher in order to evaluate the system. After selecting the criteria, we grouped into factors according to theirs characteristics, which subsequently will be grouped into dimensions.

This review process was developed in three main phases:

Phase 1 - Identification and validation of criteria

To compare the virtual worlds selected, we started by identifying a set of criteria based on the Manniem's matrix [3]. This set of criteria provides the basis of this whole process and it was chosen due to the impact in the environment. Therefore, these criteria were grouped into 6 main factors: realism in the world, the user's interface and communication, the avatar's characteristics, scalability, communication and security. Each factor is constituted by a sub-set of features. After identifying the factors and the criteria that best characterize objectively the virtual worlds to be studied, we grouped the factors into three dimensions. Each dimension has the following factors:

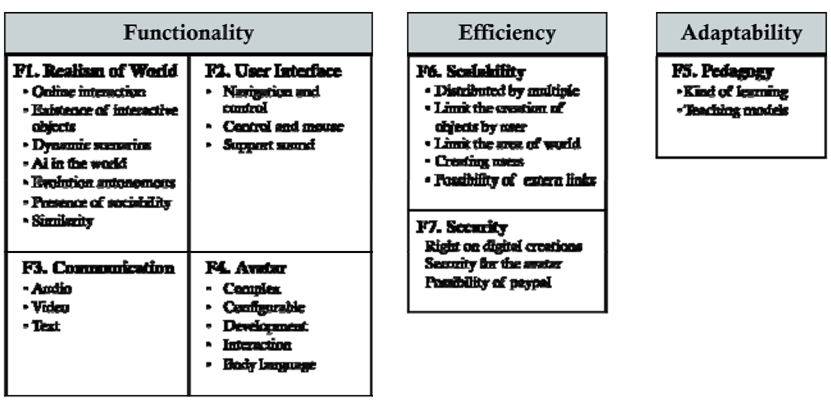

Figure 3. Each dimension with the factors

Phase 2 - Classification of each factor

Once the matrix of comparison was constructed a weight was given to each criteria, and its value depends on its relevance in the virtual world to be analyzed, i.e., it's percentage of compliance with the criteria. As shown in the figure 4, some criteria as been fulfilled with a percentage of 100. In these specific cases, the criteria under study have a maximum of relevance for the dimension that they belong. The platform is ideally for developing education's applications when all criteria have a percentage of 100.

1. REALISM OF WORLD	AW	SL	There	4. AVATAR	AW	SL	There
Online interaction	75	100	75	Complex	75	100	25
Existence of interactive objects	100	100	75	Configurable	100	100	75
Physical models	75	100	75	Development	100	75	75
Speed of dynamic objects and the world	75	100	75	Interaction	75	100	100
Dynamic scenarios	75	0	75	Body language	75	100	100
AI in the world	0	100	0	**5. PEDAGOGY**	**AW**	**SL**	**There**
Evolution autonomous	100	100	75	Kind of learning	75	75	75
Presence of sociability	100	100	100	Teching models	100	100	75
Similarity with the real world	75	100	25	**6. SCALABITILY**	**AW**	**SL**	**There**
				Distributed by multiple servers	25	75	25
2. USER INTERFACE	**AW**	**SL**	**There**	Limiting the creation of objects by user	25	100	25
Navigation and control	75	75	75	Limiting the area of the world	75	75	25
Control and mouse	75	75	75	Creating users	100	100	100
Support sound	100	75	75	Limitation of languages	75	75	25
				Possibility of extern links	75	100	75
3. COMMUNICATION	**AW**	**SL**	**There**	**7. SECURITY**	**AW**	**SL**	**There**
Audio	100	100	100	Right on digital creations	75	100	25
Video	100	100	100	Security for the avatar	75	75	75
Text	100	100	100	Possibility of Paypal	0	100	25

Figure 4 - Matrix for the relevant value assigned to each virtual world

The results have been achieved through an observation of applications in specifics domains (sciences education, e- commerce, entertainment) existing in these platforms of virtual worlds; and developing of small objects and adding objects and spaces to customize the virtual world.

Phase 3 - Evaluation of results

The results were calculated based on the QEF – Quantitative Evaluation Framework [4]. According to QEF the performance of a dimension is obtained through, the factors of each dimension.
First, we calculated the percentage of compliance of each factor (see figure 5). It is calculated by the following formula:

$$\text{Factor}_{n} = \frac{1}{\sum_m pr_m} \times \sum_m (pr_m \times pc_m)$$

m-> number of relevance criteria to the factor in analysis; pr_m -> weight of criteria m (in this 10) and pc_m -> percentage of compliance with the criteria. For Example:

FRealism of world **(AW)**= 1/90 * (10*0,75 + 10*1 + 10*0,75 + 10*0,75 + 10*0,75 + 10*0 + 10*0,75 + 10*1 + 10*0,75) **= 83,3**

Dimension Functionality	AW 87,9 %	SL 91,75 %	There 78,45 %
1. Realism of world	83,3	97	63,8
2. User interface	83,3	75	75
3. Communication	100	100	100
4. Avatar	85	95	75

Figure 5. Percentage of compliance of dimension Functionality

Second, we need calculated the system quality. The system quality is computed by

$$QUALITY = 1 - \frac{D}{\sqrt{n}} \qquad D = \sqrt{\sum_J \left(1 - \frac{DIM_J}{100}\right)^2}$$

For example:

The quality for SL is

$$d = \sqrt{\left(\left(1 - {}^{87.5}/_{100}\right)^2 + \left(1 - {}^{91.8}/_{100}\right)^2 + \left(1 - {}^{89.3}/_{100}\right)^2\right)}$$

$$d = 0{,}184$$

$$Q = 1 - \frac{0{,}184}{\sqrt{(3)}}$$

Therefore, applying the formulas we obtain the following results related to the quality of all virtual worlds as we see in figure 6

DIMENSION	AW	SL	THERE
Adaptability	87,5	87,5	78,5
Functionality	87,9	91,8	47,9
Efficiency	56,3	89,3	64,4
Quality	72,8	**89,4**	64,4

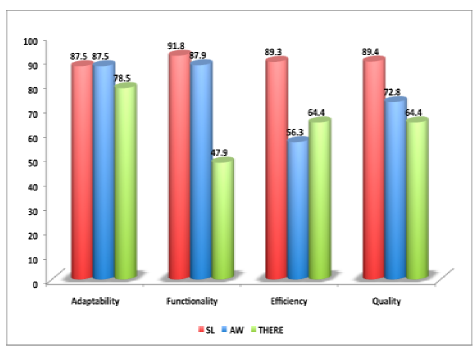

Figure 6- the results of study

3. Conclusions

The present study lists the main virtual world platforms and does a comparative analysis of their potential for educational purposes. The platforms were tested in order to observe if their structure contribute to help educator's functions and if the student becomes a central component, creating their own experiences of learning through exploration. In this case, we analyzed the features and characteristics of platforms, developing small objects, in order to support the allocation of weights to the criteria. The dimension of functionality allowed us to demonstrate that the Second Life offers a greater capacity to develop open learning environments, where the contents are not pre-defined as well the student's actions. The students have the control of the environment. Thus, they become more active in the constructing of their knowledge through the interactions between subject and object. The existence of a large number of interactive objects, the speed of dynamic objects and the world, similarity with the real world, strong communication, are elements that allow the users to manipulate objects, to build and collaborate with each other and to discover new information, and put it in a different, but meaningful, structure. The students and teachers are allowed to:

- Engage in the process of teaching learning, building up more dynamic learning experiences [2].
- Facilitate the understanding of difficult concepts, to comprehend and demonstrate in the real world. The platforms have the potential to be a useful educational tool for teaching and learning by using a constructivist and social approach.

Also, it is possible observe a great adaptability level between the SL and AW, due to some characteristics that facilitate the implementation of different teaching approaches (the possibility of immersion in a 3D environment, simulation, virtual learning community and content production). Since both platforms allow you to connect to external applications, such as Moodle, they facilitate the development of innovative teaching activities.

However, using these tools in educational context requires a shift in thinking and an adjustment in pedagogical methods that will embrace the community. The first hurdle is to accept that an instructor cannot have total control of a learning space while allowing true, open participation from students in a virtual world. We need to learn to embrace more participatory pedagogy if we're to make the most of the technologies that are available to us.

Future work

This study will be used as a basis for identification of problems in the specification of virtual worlds. After that we can develop a virtual world model, whose aim is to improve and simplify the design process of virtual world. The model will use the engineering techniques software.

The main contributions include:

- Rich interaction enables computer-supported variations of the traditional activities (training, entertainment, work, etc.);
- Deeper understanding of the concepts (interaction, behaviour, needs and requirements)

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Implementing a 3D Virtual Classroom Simulation for Teachers' Continuing Professional Development

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Abstract: 3D Virtual Worlds (VWs) are becoming important for education as they provide realistic three-dimensional environments, offer engaging, interactive and immersive experiences, and create new opportunities related to learning and teaching. To this end, it is useful for school teachers to understand these environments and explore their possibilities in enhancing their educational practices. However, in order to achieve this using 3D VWs, teachers should acquire competences that would enable them design and deliver educational activities in the context of 3D VWs, as part of their Continuing Professional Development. To this end, in this paper we present the design and the implementation of a 3D Virtual Classroom Simulation that takes into consideration the instructional strategy of Synectics.

Keywords: 3D Virtual Worlds, Second Life, SLOODLE, Teachers' Continuing Professional Development, Synectics

Introduction

3D Virtual Worlds (VWs) are becoming important for education as they provide realistic three-dimensional environments, offer engaging, interactive and immersive experiences, and create new opportunities related to learning and teaching [11], [12], [14], [18], [21], [25]. To this end, it is useful for school teachers to understand these environments and explore their possibilities in enhancing their educational practices. However, in order to effectively enhance their educational practices using the 3D VWs school teachers should acquire competences, which have been defined in our previous work according to knowledge, skills and attitudes dimensions [16], that would enable them design and deliver educational activities in the context of 3D VWs, as part of their Continuing Professional Development [5]. Moreover, Teachers' Continuing Professional Development involves among others enabling school teachers to relate their previous experiences to new concepts, ideas and/or procedures in order to develop their competences [22], [27].

On the other hand, we should take into account that the possible use of 3D VWs is a major challenge for teachers [9], since they introduce new concepts [10] with which even these teachers who are experienced and keen on using digital technologies are not familiar with.

On the other hand, several researchers [1], [19], [26] argue that 3D VWs are "*empty spaces*" that could become valuable for education if they are designed in such a way so as to support the design and the implementation of educational activities and not only the transfer of educational content in them. Moreover, nowadays school teachers must be capable of not only using digital technologies but also understand their affordances in supporting their students learning. Thus, teachers who have these competences will be able design and implement educational activities supported by digital technologies that not only help their students understand concepts related to the subject but also concepts related to the technology and lead them acquire 21 century competences [24].

Thus, we can claim that there is a need for designing and implementing modules for Teachers' Continuing Professional Development which facilitate among others, teachers learning through the relation of their previous experiences to the new concepts introduced in 3D VWs, acquiring the skills needed to use 3D VWs in their current educational practices and eventually exploring new teaching possibilities offered by this digital technology [27]. To this end, we have designed and implemented a 3D Virtual Classroom Simulation using SLOODLE (Simulation Linked Object Oriented Dynamic Learning Environment) [20]. This 3D Virtual Classroom Simulation is implemented taking into account design considerations formulated by educational activities that derive from the instructional strategy of "Synectics - Making the strange familiar" [15]. The main objective of this approach is to help school teachers through their Continuing Professional Development to (a) explore 3D VWs, (b) understand the concepts related to them and (c) acquire competences for teaching within 3D VWs, by relating their previous teaching experiences to the new opportunities for teaching and learning that derive from 3D VWs educational specific characteristics defined in [10].

1. Background

1.1 Virtual Worlds in Education

VWs are applications that exist more than 20 years, presenting different characteristics and functionalities (e.g. Multi User Dungeons (MUDs) and Object Oriented Multi User Dungeons (MOOs)), but they have been constantly evolving leading to the development of 3D VWs, such as Second Life. This evolution was made possible due to a number of factors such as the evolution of web technologies, the development of standards that allowed interoperability between different web applications and the wide broadband access to the web. Historically, the most important design consideration for a 3D Virtual World has been its ability to constantly "move" between the "real" and the "virtual" world and to provide opportunities for experiences that simulate those of the "real" world, leading to the hypothesis that the experiences presented in a 3D Virtual World could be as "real" as those presented in the "real" world [1].

As with many emerging topics, there is not a single and consistent definition for the 3D VWs that everyone accepts [7], [8], [19]. Thus, based on the literature review, we can identify the basic characteristics and functionalities of 3D VWs: (i) they are facilitated by networked computers, (ii) they are synchronous, (iii) they offer navigational space, (iv) they support multimedia presentation and playback, (v) they provide communication facilities, (vi) they provide the creation and manipulation of avatars, (vii) they allow the creation and management of objects, (viii) they support scripting, (ix) they are persistent, immersive and highly-interactive [1], [2], [3]. Typical examples of widely used 3D VWs are (a) Active Worlds, which is proprietary, features many different user owned virtual environments and presents a virtual environment focused in education namely, Active Worlds Educational Universe (AWEDU), (b) Second Life, which is proprietary, is popular and the most used of all in research studies, is consisted of user generated virtual "islands" and also presents educational tools, such as SLOODLE, (c) OpenSim, which is open source, is relatively new and is a 3D VWs Generator that could be used to create 3D VWs that can be considered as alternatives to Second Life and (d) Edusim, which is open source, is still in an alpha version and is a 3D Virtual World compatible with Interactive Whiteboards.

Acknowledging the 3D VWs characteristics and functionalities that could be related to education, Eshenbenner et al. in [10] state that 3D VWs offer unique learning and teaching opportunities, as they present rich, engaging, immersive, motivating and highly interactive environments, due to the fact that they: (i) recreate the sense of presence, (ii) are immediate, (iii) are adaptable, (iv) offer the possibility to simulate the "real" world, (v) offer the possibility to create new experiences that may not be possible or may be difficult to represent in the "real" world, (vi) could be offered for experimentation and (vii) allow for synchronous communication and collaboration. These can be considered as the key concepts that would be useful to be understood by teachers who want to implement 3D VWs in their educational practices.

In literature, there are a number of studies [3], [6], [8], [13], [14], [17], [18] that have acknowledged these educational specific characteristics and examine the potential of 3D VWs in teaching and learning. Those studies examine whether 3D VWs can be used for: (i) distance learning [8], (ii) personalised learning [6], (iii) project based learning [13], (iv) experiential learning [14], (v) providing real time feedback [17], vi) exploratory learning [6], (vii) collaborative learning [18] and (viii) problem-based learning [3].

Furthermore, there are research studies [11], [12], [14], [17] that focus specifically on teachers' experiences either through using 3D VWs in their teaching activities or through their participation in 3D VWs supported Continuing Professional Development. Table 1 summarises highlights from these studies.

Table 2. Studies highlighting teachers' perspectives about 3D VWs

Study	**Short Description**	**Highlights about the Teachers' Perspectives**
Esteves et al. [11]	Used Second Life in a student-centered learning and teaching approach for computer programming based on a problem-based strategy	"*the pressure felt by teachers in delivering such a course was amplified by the use of Second Life"*
Girvan & Savage [12]	Aimed to define an appropriate pedagogy for teaching through Second Life	*"teachers tend to transfer conventional instructional paradigms as they are and as a result recreate them in 3D VWs settings"*
Jarmon et al. [14]	Aimed to study if Second Life facilitates learning and how can the experiences acquired in it be applied in real life situations	"*at first teachers were not positive in using Second Life, but then acknowledged that they offer new possibilities for teaching and learning"*
Konstantinidis et al. [18]	Aimed to study how Second Life can be used to support collaborative activities	*" teachers could interact and collaborate more with the learners through SL"*
Vasileiou & Paraskeva [25]	Followed a Teachers' Continuing Professional Development approach using Second Life in combination with a role-playing strategy	*"through this approach teachers understood the new and innovative possibilities of using 3D VWs for teaching and learning"*

As it is indicated from the above mentioned studies there are a number of issues, such as the extra pressure applied to teachers who teach within 3D VWs and the lack of understanding of the new possibilities offered by 3D VWs in teaching and learning, that should be considered in order to develop modules in Teachers' Continuing Professional Development programs that aim (a) to help the teachers understand the concepts related to 3D VWs, (b) explore the new possibilities that 3D VWs present for teaching and learning and (c) equip them with useful competences related with teaching in 3D VWs.

On the other hand, the increased interest of exploiting 3D VWs in education, has led to the development of educational tools and applications which aim to integrate existing learning technologies (such as Course Management Systems) in 3D VWs infrastructure (such as Second Life) [3], [4], [7], [19]. A prominent example of those efforts is the SLOODLE (Simulation Linked Object Oriented Dynamic Learning Environment), which enables the integration of Second Life and Moodle [19], [20].

Thus, in order to support teachers understand the concepts related to 3D VWs, explore the new possibilities offered by 3D VWs for teaching and learning and acquire basic competences for teaching within 3D VWs, we propose to use the SLOODLE environment in order to design and implement a simulation of a "traditional" classroom in the unfamiliar context of the 3D VWs, so as to enable teachers achieve the above mentioned objectives within a closed and familiar environment and then extent and apply them in the openness of the 3D Virtual World.

1.2 Application of the instructional strategy of "Synectics - Making the Strange Familiar"

The instructional strategy of "Synectics - Making the Strange Familiar" is defined as "*a strategy for making the students understand and internalize new or difficult concepts and ideas, through the use of analogies between concepts or ideas which are familiar to the students to the new concepts or ideas presented*" [15]. As a result, this instructional strategy is considered as appropriate for (i) exploring and understanding social problems by relating them to familiar situations through the use of metaphors, (ii) problem solving as this instructional strategy offers the opportunity to understand a problem by relating it to previous experiences and apply solutions based on them, (iii) creating a design or a product based on the combination of previous experiences and ideas with the new concepts and/or possibilities presented and (iv) understanding unfamiliar and/or abstract concepts through the identification of their similarities and differences to familiar concepts, ideas and/or objects [15], [23].

Based on the above we consider (a) as the "strange" part of the analogy, the concepts and the competences related with teaching within 3D VWs and (b) as the "familiar" part of the analogy the teachers' experiences in a "traditional" classroom. Thus, we claim that the use of this strategy can (i) facilitate teachers to understand the unfamiliar concepts presented in 3D VWs by exploring the similarities and differences between a "traditional" classroom and a 3D Virtual Classroom, and (ii) enable teachers to design simple educational activities by transferring their previous experiences and ideas using the tools presented in the 3D Virtual Classroom Simulation.

Next, we present the design of the proposed module of Teachers' Continuing Professional Development.

2. Proposed Module of Teachers' Continuing Professional Development Design

The potential participants of this module should be selected school teachers, who are experienced in using digital technologies both in their life and in their educational practices. It is also anticipated that they present high motivation and interest in their continuing professional development and appreciate the potential value of innovative digital technologies for education.

The module consists of seven phases that feature different educational activities. In the first five phases the 3D Virtual Classroom Simulation, will be used in order to demonstrate the second part of the analogy, that is, the "traditional" classroom to 3D Virtual Classroom, whereas in the next two phases the teachers will interact within the 3D Virtual Classroom Simulation exploring the analogy on their own and generating their own analogies, that is, educational activities in a "traditional" classroom to educational activities in a 3D Virtual Classroom.

More precisely, in the Phase 1 (Substantive Input), the educator presents the main concepts related to 3D VWs and triggers a discussion. In Phase2 (Direct Analogy), the educator presents the analogy of a "traditional" classroom to a 3D Virtual Classroom and triggers a discussion on finding the parts where the analogy is connected. In Phase 3 (Personal Analogy), the teachers express how it would have been if they were teaching in a 3D Virtual Classroom and use these expressions to further reinforce the analogy. In Phase 4 (Comparing Analogies), through brainstorming the teachers find and describe the similarities between the two parts of the analogy giving proper justification of their opinions. In Phase 5 (Explaining Differences), through brainstorming the teachers find the differences between the two parts of the analogy and justify their opinions.

The next two phases namely, Phase 6 (Exploration) and Phase 7 (Generating Analogy), aim to address (a) how the concepts of 3D VWs can be highlighted using the 3D Virtual Classroom Simulation in this module and (b) what are the specific tools and functionalities that could be used to support these educational activities. In Table 2, we present the analysis of Phases 6 and 7 to Educational Activities (EA), the 3D VWs concepts related to each Phase, as well as, the mapping to their relevant 3D Virtual Classroom Simulation Tools/Functionalities.

Table 3. Design Considerations for the 3D Virtual Classroom Simulation

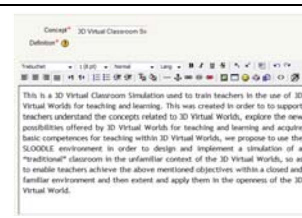
Phase	***Educational Activities (EA)***	***Concepts (C)***	***Tools/Functionalities***
6th Phase: Exploration	**Learn the Basics:** The teachers with the help of the educator create their own Moodle Accounts and Second Life Accounts, select and/or create their Avatars and then enter the 3D Virtual Classroom. There the educator presents some of the basic skills for teaching in Second Life as described in [3]. The teachers try to use the basic functionalities and the educator provides them with immediate and constant feedback. ***(EA_6_1)*** **Explore the 3D Virtual Classroom:** With the help of the educator the teachers explore the 3D Virtual Classroom in order to understand how they can (i) use the tools that are presented in the 3D Virtual Classroom, (ii) manipulate and reconfigure the tools as they like (individually and collaboratively) and (iii) use the communication facilities presented in the 3D Virtual Classroom. The educator provides teachers with immediate and constant feedback. ***(EA_6_2)***	**Recreate the sense of presence**: Use of Avatars linked to Moodle accounts.	**Avatars:** Can be used to participate in the activities.
			Group System: Defines the group of participants and their roles and can be used also to manage a large group of students by dividing them in different sub-groups.
			Access Checker Door: Enrolls the teachers and connects Avatars to Moodle accounts.
		Immediateness: The tools used for the activities should provide immediate feedback.	The tools provide immediate feedback according to the teachers' actions.
		"Real" World Simulations: The 3D Virtual Classroom should resemble a traditional classroom.	**Communal Whiteboard:** Resembles a whiteboard and offers additional functionalities. The teachers can insert slides in texture format using the Upload Image functionality of Second Life.
			Hand Show Chair and Desks: Avatars can sit and raise/lower their hands..
			Access Checker Door: Resembles a door and provides access.
7th Phase: Generating Analogy	**Design and Deliver Simple Educational Activities:** The educator divides the teachers in groups and makes some proposals for activities that could be supported by the 3D Virtual Classroom Simulation. The teachers can always get support from the educator if they face any problems with the use of the functionalities presented in the 3D Virtual Classroom. When, the teachers finish designing their activities, they deliver them to their colleagues. In this way the teachers generate their own analogies (educational activities in a "traditional" classroom to educational activities in a 3D Virtual Classroom). ***(EA_7_1)***	**Adaptable:** All the tools presented in the 3D Virtual Classroom can be reconfigured and manipulated.	All the tools that are presented in the 3D Virtual Classroom can be set as free to be manipulated and reconfigured.
		Simulate experiences that would not be possible in "Real" World: Actions such as the "automatic generation of tools" and the "automatic delivery of virtual objects" could not be easily reproduced in the "Real" World.	**SLOODLE Tool Generator:** Enables the automatic generation of tools from a predefined list.
			SLOODLE Vending Machine: Enables the automatic delivery of any type of virtual objects.

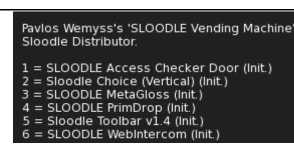
	Comment on the Activities: After completing the previous activity the teachers use the Chat Logger and discuss again the analogy that was previously presented to them, revisiting the similarities and the differences of a "traditional" classroom to a 3D Virtual Classroom. ***(EA_7_2)*** **Comment on the Module:** Finally, the teachers are given the opportunity to comment on the module expressing their opinions about the educational activities that were conducted and about the 3D Virtual Classroom Simulation that they have used in the two last phases of the module. The comments will be made in their Moodle Blogs using the SLOODLE Toolbar to update them. The educator should help the teachers if they face any problems in setting up the SLOODLE Toolbar. ***(EA_7_3)***	**Provide Possibilities for Experimentation:** The 3D Virtual Classroom should enable teachers experiment with the tools presented in it.	All the initialized versions of the tools presented in the 3D Virtual Classroom can be stored in the **SLOODLE Vending Machine.** Thus, the teachers can experiment with the tools and always have their initialized versions available.
		Synchronous Communication and Collaboration: The 3D Virtual Classroom should present different communication and collaboration tools.	**Chat Logger:** Enables teachers to discuss in real time using their Avatars (from SL) or their Moodle Accounts (from Moodle).
			SLOODLE Toolbar: Teachers update their Moodle blogs and use gestures related to the context of a classroom.
			Collaborative Editing: Enables teachers to collaboratively manipulate the tools.

3. The 3D Virtual Classroom Simulation Implementation

Based on the above educational activities we have implemented a 3D Virtual Classroom Simulation that supports the proposed design. In Table 3 we describe the implementation based on the specific steps that were taken.

Table 4. 3D Virtual Classroom Simulation Implementation

Steps	***Description of the Implementation***	***Supported Educational Activities***	***Figures***
Step 1 – Configure Moodle	For the first step a Moodle classroom (Figure 1) was created in which the teachers could create their accounts and then find a link that will lead them to the 3D Virtual Classroom Simulation which is located in Second Life. Moreover, all the Moodle activities, namely Chat, Assignment and Glossary, related to the tools presented in the 3D Virtual Classroom Simulation were created and configured.	**EA_7_1:** This step of the implementation gives the teachers the ability to transfer their own educational content in the 3D Virtual Classroom Simulation. Thus, teachers can insert terms in the glossary, create chat rooms with specified subjects of discussion and give specific assignments to their students.	 Figure 1. Inserting definitions of concepts in the Glossary to be presented in the 3D Virtual Classroom Simulation
Step 2 – Create a Classroom Building	The next step was to build a classroom building that features different rooms related to the tools that are presented in them. Thus, we have built a Presentations Room, a Discussions Room (Figure 2) and an Assignments Room and in front of each one of them we have added information related to the use of each tool (in the form of slides).	**EA_6_2:** The different rooms present different tools, thus teachers can explore the functionalities of tools that are used to support specific activities (namely presentations, discussions and assignments) **EA_7_2:** The teachers can use the Discussions Room in order to discuss the analogy revisiting the similarities and the differences under a new perspective.	 Figure 2. Presentations room in the 3D Virtual Classroom Simulation

Step 3 – Provide Access to the 3D Virtual Classroom Simulation	Our first action was to select and configure the **SLOODLE Access Checker Door** (Figure 3) in order to provide a system that enrolls an Avatar to the 3D Virtual Classroom, provides access to it and also connects it to the users' Moodle account. The next action was to create a group using the **Group System** in order to give the teachers who will participate in the module of Teachers' Continuing Professional Development specific roles (teacher role) and abilities (object reconfigure and manipulation).	**EA_6_1:** The **SLOODLE Access Checker Door** provides a mapping between an Avatar and a teachers' Moodle Account, providing access to them acknowledging them as participants. **EA_6_2:** Having been acknowledged as participants the teachers can explore all the tools/functionalities presented in the 3D Virtual Classroom Simulation. **EA_7_1:** Using the **Group System** the teachers can manipulate and reconfigure the tools as they want to design and deliver their own simple educational activities.	 Figure 3. Providing Access to the 3D Virtual Classroom Simulation
Step 4 – Select and Configure the Tools	Based on the module for Teachers' Continuing Professional Development Design we have selected and configured, tools for supporting Presentations (**Metalabs Whiteboard** (Figure 4), **Hand Show Chairs** and **Desks**), tools for supporting Discussions (**SLOODLE Chat Logger**, **SLOODLE Metagloss** (glossary) and **SLOODLE Toolbar** (classroom gestures)), tools for supporting Blogging (**SLOODLE Toolbar** (Moodle blog update)), tools for Assignments (**SLOODLE PrimDrop**) and tools for Creation and Delivery of virtual objects (**SLOODLE Tool Generator** and **SLOODLE Vending Machine**). What is more, all the tools except for the **SLOODLE Tool Generator** were set as free to reconfigure and manipulate.	**EA_6_2:** All the tools were placed in the different rooms giving the teachers the ability to explore their functionalities in relation to the activities that could be supported. **EA_7_1:** The teachers could use all the aforementioned tools to design and deliver their own simple educational activities. **EA_7_2:** The tools that support Discussions enable teachers to discuss again the analogy after completing the design and the delivery of their educational activities. **EA_7_3:** **SLOODLE Toolbar** blogging features give teachers the opportunity to express their opinions about the module in their Moodle Blogs from within Second Life.	 Figure 4. The teachers use the Metalabs Whiteboard to do presentations while flying and using floating text that moves around their students.
Step 5 – Provide Initialized Versions of the Tools	All the tools that were selected and configured in Step 4, were stored in the **SLOODLE Vending Machine** as their initialized versions. (Figure 5).	**EA_7_1:** While teachers are designing their own simple educational activities they could always have the initialized versions of the tools available in case something goes wrong.	 Figure 5. Selecting the Initialized versions of the Tools

4. Conclusions

Recent studies on exploiting 3D Virtual Worlds in Education have indicated that this new digital technology has characteristics that could be used to enhance educational practices. On the other hand, teachers are expected to develop and participate in engaging and interactive educational activities that enhance the learning process and also provide their students with 21st century skills. Thus investigating the use of 3D Virtual Worlds in educational practices appears as attractive. However, the concepts presented in them may seem unfamiliar even to teachers who are experienced in using digital technologies. In this paper we have presented the design and the implementation of a 3D Virtual Classroom

Simulation based on design considerations derived from educational activities designed following the “Synectics – Making the Strange Familiar” instructional strategy. Thus, the next step is to design and conduct an experiment that will validate the applicability of the above proposal in (a) helping teachers understand the concepts of 3D VWs, (b) explore the new possibilities that 3D VWs present for teaching and learning and (c) acquire competences for teaching within 3D VWs but also extract valuable conclusions by comparing our teacher's perspectives to those mentioned in Table 1.

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Workshop

The 4th International Workshop of Modeling, Management and Generation of Problems/Questions in Technology-Enhanced Learning

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Preface

Solving problems/questions is one of the most indispensable and important components in the teaching and learning process. Problems/questions with adequate quality in various testing conditions are believed to enable teachers to assess individual students' capability and readiness of transfer in specific domain knowledge. Despite this, there are still many areas in need of systematic investigation to promote knowledge and skills on problems/questions-centered learning approach, including learning by problem solving and/or generation. For instance: what criteria constitute as adequate test item quality (in addition to frequently cited psychometric index like item difficulty, discrimination index); how to best assess learner's capability with appropriate quality level within constrains (e.g., an optimal number of items, time limitation, etc.); any feasible metadata heuristics and/or techniques for problems/questions selection; any promising alternative strategies for compiling a sufficient amount of number of problems/questions; any scaffolding techniques for question-generation implementation and instructional diffusion and so on.

In ICCE2006 and 2007, and 2009, we held a series of workshops where we paid special attention to "questions/problems" in technology-enhanced learning. This is the 4th workshop focusing on the same topic. This continuous workshop will provide a good and timely opportunity to present and share the results and issues about "problems/questions" in ICCE community.

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Question and Problem Generation – State of The Art

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Abstract: Currently, there are two communities which focus on question and problem generation. The first one has been starting from 2006 and runs workshops at the ICCE conference, whereas the second one has been established since 2008 and has been hosted at AIED2009 and ITS2010. Through these two communities, numerous approaches to generating questions and problems have been devised. The goals of this paper are to summarize the state of the art in this research area.
Keywords: question/problem generation, applications

Introduction

Currently, researchers from multiple disciplines have been showing their common interest in question and problem generation (QPG). The natural language processing community is interested in the methods of how to extract questions from a natural language text. The intelligent tutoring systems community deals with generating both questions and problems which are adaptive to the knowledge state of individual students. Researchers from the education community investigate mainly the question of how and whether questions may improve the learning process of students. In this paper, we summarize the state of the art of QPG. Our discussion will focus on the applicability of QPG in educational systems. The paper distinguishes between question and problem generation. We will answer the following questions: 1) Why is QPG useful? 2) Which methodologies can be applied to generate questions/problems and how automatic question/problem generation can be deployed in educational systems?

1. What is Question and Problem Generation?

Question generation (QG) has been defined in [1] as a task of generating questions from some forms of input, e.g., from a deep semantic representation or a raw text. Most of current works in question generation concentrate on text-to-question and tutorial dialogue. Dale and White [4] distinguished between question generation from paragraphs and question generation from a sentence. Generating questions from paragraph is more challenging than from a sentence, because a paragraph contains causal relations between sentences (e.g., pronouns), which need to be elicited and annotated explicitly.

Similarly, problem generation is achieved by composing necessary information from a structured or unstructured database of domain specific knowledge and transforming the composition into a well-formed natural language text. The main topics in the most literatures of the problem generation are how to model domain knowledge and how to automatically generate problem components, such as given conditions, goal, and solution to the goal, based on the domain knowledge.

2. Question Generation

2.1 Question Classification

Before questions should be generated either from a text or from a structured database, the type of possible questions should be determined. Thus, question taxonomy is required to build a model for question extraction. An additional use of question taxonomy is for evaluating generated questions [5]. The most coarse question classification has been proposed by Kalady and colleagues [6]. The authors distinguished between factoid and definitional questions. Factoid questions are usually generated from elementary sentences of an input document and have short fact- based answers. On the contrary, definitional questions have a descriptive answer that exists within several sentences of an input document and can only be answered after the whole document has been read (or processed). An example of a definitional question is "*What is a volcano*?" A possible answer for this question may require more than one sentence. A more fine-grained question classification, which is widely used in existing automatic question generation systems, includes the following question types: *how, who, what, which, when, where and why* [7, 8]. In addition, *Yes-No* questions [6, 9] and quantitative questions [10] such as *how much/many, how old, what percentage of* have also been exploited for extracting questions. Researchers grouped question types *who, what, when, where* into the class of shallow questions, and *why, how, what-if* are considered deep ones [1]. Several complex question taxonomies have been developed in the area of education (e.g., in medical examination, engineering, and trial questioning) such as Socratic questions, the Bloom's taxonomy, and the Lehnert's and Graesser's taxonomy [5]. Rarely, these question taxonomies can be found in question generation systems. Boyer and colleagues [11] explained that a general question taxonomy does not meet the requirements of all application areas and of specific tutors.

2.2 Approaches to Automatic Question Generation

The problem of question generation can be illustrated using the following sample sentence:
"The 18th ICCE will be held between November 29 and December 3, 2010 at Putrajaya, Malaysia." Possible questions are: *1) when will the 18th ICCE be held? and 2) where will the 18th ICCE be held?*
According to Becker and colleagues [12], the process of question generation has to involve in the following issues: 1) Target concept identification: which topics in the input sentence are important? 2) Question type determination: which question types are relevant? 3) Question formation: how questions can be constructed grammatical correctly? The first and second issues are usually solved by most QG systems in the similar manner using the following different techniques of natural language processing (NLP):
<u>Parsing:</u> The input sentence is analyzed in functional constituents (e.g., the noun phrase, verb phrase, adverb, preposition) according to the grammar of the language being used.
<u>Simplifying sentence:</u> Complex sentences can be simplified using text compression techniques [13]. Given a complex sentence, text compression techniques produce a single shortened version that conveys the main information in the input. Hailman and Smith [14] argued that text compression is not sufficient to generate high quality questions, because a complex sentence often conveys multiple pieces of information. As an alternative, the authors suggested a method to extract appositives, subordinate clauses, and other constructions from complex sentences using *semantic entailment* and *presupposition*.
<u>Anaphor resolution:</u> This technique replaces pronouns in a sentence by a concrete noun [6].
<u>Semantic role labeling:</u> The goal is to annotate each constituent of the input sentence with a semantic role in relation to the verb (also called the predicate) in the sentence. Semantic roles

can be classified into e.g., agent, patient, instruments and adjuncts (locative, manner, temporal). For instance, the sample sentence can be annotated with semantic roles using the Illinois Labeler [15], where A1, VERB, AM-MOD, AM-TMP, AM-LOC represent semantic roles: *[(thing held **A1**) The 18th ICCE] [(General modifier **AM-MOD**) will] be [(**Verb**: hold) held] [(temporal: **AM-TMP**) between November 29 and December 3, 2010] at [(location: **AM-LOC**) Putrajaya, Malaysia].*

Named entity recognizing: The parsed constituents of the input sentence are assigned to unique entities (e.g., PER (person), LOC (location) or ORG (organization)). For instance, the sample sentence above will be tagged as followed using the Illinois named entity recognizer [16]: *The 18th [**ORG** ICCE] will be held between November 29 and December 3, 2010 at [**LOC** Putrajaya], [**LOC** Malaysia].*

The results of the semantic role labeler and the named entity recognizer mainly contribute to solve the second issue, namely determining appropriate question types for the identified target concepts. For instance, if the entity in a proper noun phrase, then "*who/whom*" is suggested as appropriate question types for entity of type PERSON or ORGANIZATION, and "*where/which*" for LOCATION; if the entity is of type NO ENTITY, then the question type "*what*" is suggested [6, 17]. Besides the methods of determining question types based on the named entity recognizer and the semantic role labeler, other types of question can be identified using information of the parse tree, e.g., a prepositional phrase is a candidate for question [6]: *The dog is asleep on his bed => On what is the dog asleep?* And an adverb phrase can also be the target for a "How"-question: *The meeting went well => How did the meeting go?*

Where most QG systems share common techniques on the first and second step of the process of question generation, their main difference can be identified when handling the third issue, namely constructing questions in grammatically correct natural language expression. Many QG systems applied the transformation-based approach to generate well-formulated questions [6, 8, 10, 18, 19]. In principle, transformation-based question generation systems work through several steps: 1) delete the identified target concept, 2) a determined question key word is placed on the first position of the question, 3) convert the verb into a grammatically correct form considering auxiliary and model verbs. For example, the QG system of Varga and Le [19] uses a set of transformation rules for question formation. For subject-verb-object clauses whose subject has been identified as a target concept, a "*Which Verb Object*" template is selected and matched against the clause. "*Which*" replaces the target concept in the selected clause. For key concepts that are in the object position of a subject-verb-object, the verb phrase is adjusted (using auxiliary verb).

Table 1: Evaluation results of existing question generation systems

System	Question type	Evaluation Results
[6]	Yes-No, Who, Whom, Which, Where, What, How	Recall=0.68; Precision=0.46
[8]	Yes-No, Who, Which, Where, What, When, How, Why	Recall=0.32;Precision=0.49
[19]	Who, Whose, Whom, Which, What, When, Where, Why, How many	Relevance[1]=2.45(2.85); Syntactic Correctness & Fluency=2.85(3.1)
[17]	Who, When, What, Where, why, How	Low acceptance, no data avail.
[10]	Yes-No, Who, When, Which, What, Why, How many/much	Satisfactory results, no data avail.
[21]	Question templates for informational text	79.9% plausible questions[2]
[23]	Question templates for narrative text	71.3 % plausible questions

The second approach, which is also widely employed in QG systems is template-based [20, 21, 22]. The template-based approach relies on the idea that a question template can capture a class of questions, which are context specific. Chen and colleagues [21] developed the

[1] The evaluation criteria *Relevance* and *Syntactic correctness and fluency* are rated by from 1 to 4, with 1 being the best score. Values outside and inside in the brackets indicate ratings of the 1st and 2nd human.

[2] The evaluation results are calculated as the average of the plausibility percentage of three different question types: 86.7% (condition), 65.9% (temporal information), 87% (modality).

templates "*what would happen if* <X>" for conditional text, "*when would <X>*" and "*what happens <temporal-expression>*" for temporal context, and "*why <auxiliary-verb> <X>*" for linguistic modality, "*where <X>*" maps to semantic roles annotated by a semantic role labeler. These templates are specific for informational text. For another type of text, e.g., narrative text, Mostow and Chen [23] developed another set of question templates. Another technique to define question templates is using regular expressions [20]. Sneiders [22] developed question templates whose answers can be queried from a structured database. For example, the template "*When does <performer> perform in <place>?*" has two entity slots, which represent the relationship *performer-perform-place* in the conceptual model of the database. Thus, this question template can only be used for this specific entity relationship. For other relationship types, new templates need to be defined. Hence, the template-based approach is mostly suitable for applications with a special purpose. A disadvantage of this approach is that developing high-quality templates requires a lot of human involvement. Table 1 summarizes the evaluation results of different existing question generation systems. We notice that the template-based systems [21, 23] achieve considerable results, whereas the transformation-based ones [6, 10, 19] need more improvement.

2.1 Direction for Question Generation in Educational Systems

From the technical point of view, automatic question generation can be achieved using a variety of natural language processing techniques which have gained wide acceptance. Currently, high quality shallow questions can be generated from sentences [1]. Deep questions, which capture causal structures, can also be modeled using current natural language processing techniques, if causal relations within the input text can be annotated adequately. However, successful deployment of question generation in educational systems is rarely found in literature. Researchers rather focus on the techniques of automatic question generation than the strategies of deploying question generation into educational systems. A similar picture has been identified by Mostow and Chen [23] especially in the settings of training reading comprehension: most existing works in this field rather randomly choose sentences in a text to generate questions, than pose questions in an educational strategic manner.

Research on question generation with focus on educational systems needs to develop further. Several research questions can be raised: If the intent of the questions is to facilitate learning, which question taxonomy should be deployed? Given a student model in an intelligent tutoring system, which question type is appropriate to pose the next questions to the student? Apart from generating questions from an input text, questions may also be generated from other source of data (e.g., Wikipedia) to remind the student to additional information if necessary. The question is when and how additional data should be deployed? Another area of deploying question generation in educational systems may be using model questions to help students improve the skill of creating questions, e.g., in the legal context.

3 Problem Generation

3.1 Classification of Problem Generation

Problem consists of problem sentence, which describes given conditions in natural language, and its solution sentences, which represents the goal and its solution. In problem-solving process, problem sentences change their structures variously to the goal structure, which characterizes the different aspects of the problem. Problem structures in problem-solving process are modeled as Figure 1, which is a revised version of problem-solving process proposed in [25] [3]. Surface structure describes given conditions of the problem, such as objects, attributes, and relations between them. Surface structure is transformed into the formulated structure and applied domain knowledge to derive the goal structure. Domain knowledge represents operations to change the objects and attributes. The knowledge includes conceptual knowledge of objects and attributes and numerical knowledge among them. Types of necessary knowledge are different according to the domain. The change of formulated structure to the goal structure with the domain knowledge corresponds to the solution structure. Natural language descriptions of the solution structure become solution sentences.

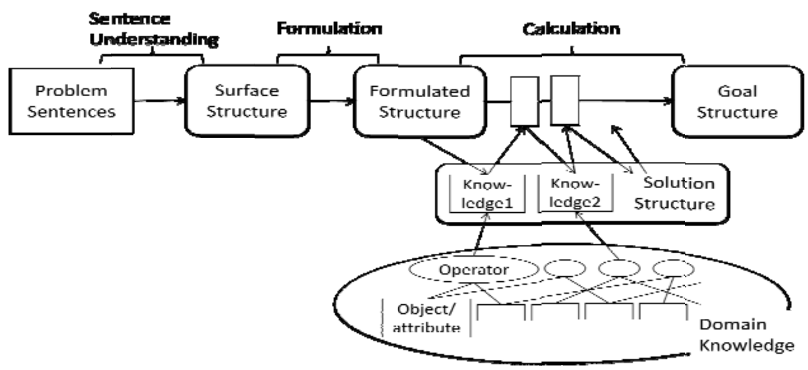

Figure 1: Model of Problem-Solving Process (Revised version of [25])

Problem generation is to generate particular structure/s of problem by given structure/s. It is classified as the following two categories: 1) To derive solution structure/solution sentences from problem sentence/surface structure; 2) To generate problem sentence/surface structure that satisfies given solution structure/domain knowledge. In the first category, the challenging issue is to model domain knowledge and method for finding the solution structure from given formulated structure automatically. Determination of validate surface structure that satisfies certain solution structure or domain knowledge is the main focus in the second category.

The difference of problem generation approach of the system depends on the types of problems that they generate. For the problems whose goals are to find one of the answers that satisfy given constraints, solution structures are not so important. In addition, they may have plural goals and to prepare all solution structures is not a realistic task. For this type of problems, second problem generation category, which focuses on preparing meaningful surface structure, is often applied. For problems that have one or only a few answers, it is important to select appropriate domain knowledge to derive the goal structure. For such problems, the first problem generation category is often observed. Details of these approaches are shown in Section 3.2 and Section 3.3, respectively.

3.2 Approaches to Derive Solution Structure as Problem Generation

Solution Structure is derived by applying domain knowledge to the formulated structure. The varieties of problems that can be generated by the system are determined by the size of its domain knowledge. Many systems are developed for different domains (Table 2). Most systems focus on the domain whose problem-solution process is clearly described. In these domains, goal structure can be generated by changing given objects and attributes to the required one based on the domain knowledge. Therefore, the domain knowledge is represented as operations/relations among all possible objects, attributes, and their values.

[3] Hirashima and colleagues [34] defined only numerical constraint as domain knowledge, since they focus on physics. We revised their figure so as to apply to the general problem-solving process.

Table 2: Targets of existing problem generation systems for deriving solution structure

System	Target domain
[26]	Mechanics
[27]	Chemistry
[28, 29]	Arithmetic

Hirashima and colleagues [26] proposed phenomenon structure as domain knowledge in mechanics. Phenomenon structure describes phenomenon as operational relations and attributes that relate to the phenomenon. For example, the phenomenon "*block falling by the gravity*" is represented as operational relation "the law of gravitation $F=m*g$" and attributes "mass of block *block(mass(m))*", "acceleration of gravity *block(gravity-acceleration(g))*", and "gravitation for block *block(gravitation(F))*". If the goal of the problem is to derive the gravitation of the block and mass of block is given as $m1$ and acceleration of gravity is given by g, the system is able to derive the gravitation $m1*g$ by applying this operational relation. In this approach, the phenomenon structure takes the role of the rule for changing the attributes of objects. Ishima and colleagues [27] also applied this concept into the chemistry. It prepares knowledge on material, knowledge on phenomenon and numerical relation knowledge related to them. Since it models the chemical world from various aspects, it is able to derive the solution structure of various types of problems, e.g. problems that ask the value of attribute.

Matsuura and colleagues [28] modeled attributes of objects and their numerical relations statically as one directed graph. It consists of two types of nodes; *index of variable* that represents attributes of the objects and *relation of variable* that indicates numerical relations between the attributes. Links connect these two types of nodes. When the surface structure is provided, given values are assigned to corresponding *index of variable* initial state and *index of variable* of required value is set as a goal. To derive the solution structure is to find the path from the initial state to the goal by replacing unknown values in *index of variables* using *relations of variable*. Kojiri and colleagues [29] introduced solution network to represent the relations of problem and sub-problem. The solution network connects templates of problems based on the inclusive relations. The solution structure is determined by following the solution network, from the problem that has required attribute as its goal until its given attributes are all derived.

3.3 Approaches to Derive Surface Structure as Problem Generation

Surface structure defines situations of problem in which specific domain knowledge can be applied. Plural surface structures exist for the same set of domain knowledge. As described in [30], the difficulty of the problem is changed based on the types of objects appeared in the problem. Therefore, to generate surface structure is regarded as finding appropriate objects and attributes. Table 3 introduces some systems that focus on generating the surface structure/problem sentence from given domain knowledge.

Table 3: Targets of existing problem generation systems for deriving surface structure

System	Target domain
[31]	SQL database query language
[32]	Real-life problem for self-assessment
[33]	Arithmetic

Martin and Mitrovic [31] applied problem generation mechanism into SQL database query language learning system. In the system, some constraints are described using the wildcard or variable. For example, in the constraint that checks "*WHERE clause in student solution contains name of table or attribute*", variables that represents *name written by student*, *table name*, and *attribute name* are used. Problem generation of this system is to prepare constraints whose variables are changed to available values. In order to set available values for each attribute, *instantiation constraint* is introduced. It restricts the value of the literals and checks if instantiated values are available. Example of the instantiation constraints is to ensure the literal in WHERE clause in student solution is valid attribute name of the table. Similarly, Le and Menzel [32] applied the constraint-based approach in the real-life problem[4]. It also embeds the function to check if the generated surface structure does not violate the hard constraints.

Kojima and colleagues [33] constructed problem generation system based on the differences between two problems called *episode*. Episode is formed by differences of two problems selected by the user; *base problem* and an example of *new problem*. Episode is regarded as a rule for changing the surface structure of the problem from one to another. New problem can be generated by applying episode to the existing problem. Generated problems are available if episode is applied to the correct type of problem.

3.4 Direction for Problem Generation in Educational Systems

There are three categories in introducing problems into the educational systems: 1) Problems are generated dynamically according to the teaching strategy in the educational system; 2) Problems are utilized by problem selection function in the educational system based on their metadata; 3) Problem generation framework is introduced into the educational system which supports the learner's problem generation activity.

As the first category, Le and Menzel [32] introduces the evaluation phase of learner's skills and personal characteristics in *the problem generation cycle*. Hirashima and colleagues [25] designed the system based on the concept: "*problems that simplify the original difficult problem is one of the most promising method to realize the help for a learner to solve a problem him/herself* " *[34]*. The system determines the solution structure of the new problem by simplifying that of the original one according to the learner's answer and generates three types of simplified problems[5].

For the second category, almost no practical system is proposed which embeds function for selecting generated problems. One reason is that most systems focus on generating only a specific part of the problem. For example, most systems do not consider steps of translating surface structure to the problem sentence or that of translating solution structure to the solution sentence. The other reason is that generated problems do not have metadata that represent their characteristics. In order to solve the second problem, Hirashima [30] proposed the metadata editor by which author is able to describe the metadata of problems that consist of objects, attributes, and values easily. However, the method for employing the metadata into adaptive support was not discussed.

Third category is one of the focusing topics in this area. Kojima and colleagues [33] introduced episode, which describes rule for changing the original problem to the new problem, to encourage learners to derive various types of problems in their problem

[4] The example of the problem is "*to arrange the family members around a table in the way that satisfy the important condition*", with conditions and attributes of family members, e.g. the interests, aversions and the favor of other family members, are provided.

[5] (I) Formulation partialized problem which simplifies the surface structure, (II) solution partialized problem which partitions solution structure, (III) solution specialized problem which specializes constraint structure.

generation activities. Yamamoto and colleagues [35] integrated the domain knowledge in physics into the system for supporting problem modification activities. In this system, learners make validate question sentence and also solve the problem that they generated. The system gives feedback for both generated question sentence and derived solution structure. Ishima and colleagues [27] also refer to the possibility of introducing the system into the learner's problem generation activity.

4 Conclusions

As introduced in this paper, many systems for QPG were developed. In the technical point of view, many systems are succeeded with their novel approaches. However, they are not widely accepted yet as a part of practical educational systems. To solve this situation, the way of deciding surface structure of questions/problems according to the strategies or the way of selecting already generated questions/problems are common topics for QPG.

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Question Generation to Prompt Internal Self-Conversation for Meta-Learning: Taking Presentation-Based Learning As an Example

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Abstract: Meta-cognition plays an important role in acquiring and transferring expertise. Although we recognize the necessity of building a learning scheme for developing meta-cognitive skills, little knowledge for it has been acquired. We try to accumulate knowledge of meta-learning support system development in presentation based meta-learning scheme. Many researchers try to develop meta-learning support systems but their design principles are not necessarily described explicitly. Consequently, the know-how of developing meta-learning support system cannot be accumulated. Therefore, we adopt design model based approach to confront the problem. In our learning scheme, we provide a presentation task in specific learning area to a learner, who thinks he/she had already learned that specific topic. In this learning scheme, we intend to give the learner a chance to reflect his/her own learning processes. In this paper, we propose a question generation function to encourage learners' reflection for meta-learning based on a design model.

Keywords: Meta-Learning, Model Based Approach, Guidance Information, Presentation

1. Introduction

Many researchers in educational psychology field pointed out the importance of meta-cognition to enhance transferal to other learning domain [2][4], and research on computer supported system to enhance meta-cognitive skill is also investigated by many researchers based on the shared recognition [5][6][8].

On the other hand, design principles of meta-learning support systems developed are not necessarily clarified because of the lack of conceptualizations for characterizing them. Consequently, the know-how of developing meta-learning support system cannot be accumulated. Therefore, we adopt design model based development approach to confront the problem by conceptualizing the know-how to improve meta-cognitive skills clarified in educational psychology field. Therefore, the design model based on our conceptualization itself is meaningful as well as the concrete system development [5].

Furthermore, our research goal is to enhance learning of learning-method by stimulating learner's reflection on his/ her own learning processes. To achieve this goal, we give a task to make a presentation material on a specific topic [10].

It is pointed out in educational psychology field that an emphasis on meta-cognition needs to accompany domain-specific instruction in each of the disciplines, but not generic-instruction in general context because the type of monitoring required will vary [1]. In history, for example, the student might be asking himself as internal self-conversation, "who wrote this document, and how does that affect the interpretation of events," whereas in physics the student might be monitoring her understanding of the underlying physical principle at work [1].

In our research, we systematize such domain-specific learning methods as learning skill ontology. The learner in presentation task describes his/ her intention of presentation as a teaching plan based on it. Therefore, learner's learning-context is reified, and the learner can get the opportunity to analyze how the good learning processes should be performed in his/ her learning context.

Guidance (question generation) function that we consider in this paper is embodied computer based meta-cognitively aware instruction. The system intervenes to enhance learner's analysis on his/ her learning activity more actively, and plays a role of giving stimulation to facilitate learner's reflection on his/ her own learning processes. We confirmed the function could enhance meta-cognitively aware learning in our presentation based learning scheme [13].

In this paper, we'll mainly discuss two issues: (1) conceptualizations and design model based on them to build meta-cognition support systems and (2) learning scheme based on the model that embeds guidance function to prompt internal-self conversation for meta-learning. Concrete system and its experimental issues are described in [12].

2. Design Model Based on Conceptualizations

Design model that must be a basis of implemented support functions in each system is not always clarified. Thus, the targets that each implemented function intended to support are not clarified. This prevents us from accumulating and sharing the knowledge for building learning support systems. Therefore, we adopt the model-based approach in order to develop our system.

By making the concepts as a basis of learning system design explicit and building learning systems based on them, we can accumulate the knowledge for building sophisticated learning support systems.

We propose five concepts that we specified from the viewpoint of system development.

We explain to avoid misunderstanding: we don't argue the know-how described in this section are new from the cognitive science viewpoint but we conceptualize from the viewpoint of system development as a basis of functional design for facilitating meta-cognitive learning. We explain the meaning of each concept in the following.

SHIFT means that stagger the time of developing learning skills after performing problem-solving processes. By introducing Okamoto's survey on reflection [9], we'll explain the meaning of SHIFT in detail.

He pointed out that there are two kinds of reflection, i.e., on-going monitoring and reflective monitoring.

- On-going monitoring means controlling cognitive processes IN a problem-solving.
- Reflective monitoring means modifying cognitive processes AFTER solving the problem.

The learner in on-going monitoring simultaneously performs three kinds of different level cognitive activities, e.g., solve a math problem expressed in words, monitor the problem-solving processes and generalize the knowledge to transfer other problems. The reasons why performing these processes simultaneously is difficult for most learners are two folds: first is that they tend to exhaust their limited cognitive capacity by performing these processes and second is that they cannot be aware of when and what meta-cognition they have to perform and how to perform it.

SHIFT means the strategy that enhances the reflective monitoring by staggering the time of performing the meta-cognitive activities AFTER problem-solving processes.

Furthermore, it is needed to give appropriate stimulation to encourage their meta-cognition. This stimulation can be interpreted that it gets the meta-cognitive task as easy as cognitive task by changing internal self-conversation task to usual conversation task. Thus, we conceptualize LIFT as making the learner be aware of learning skill acquisition as a principle for the system development in this research.

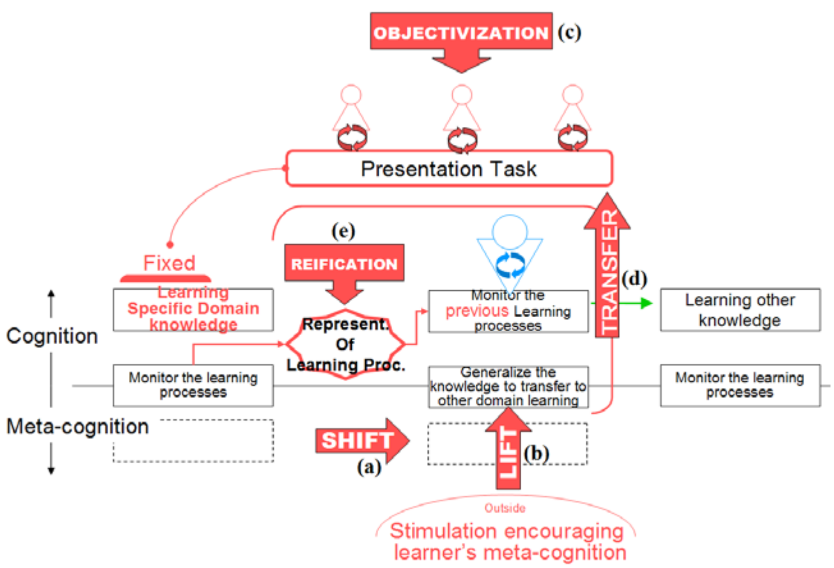
We think that how we can realize the SHIFT and LIFT is the key issue for developing meta-cognitive skills.

REIFICATION means that giving appropriate language for the subject of meta-cognition. By OBJECTIVIZATION, we intend making the internal self-conversation processes objective by discussing with others. TRANSLATE means changing the learning skill acquisition task to a problem-solving task that includes same task structure of learning skill acquisition task.

By introducing these conceptualizations, we can build a system design model shown as fig. 1 for the development of a learning system that facilitates meta-cognitive skill development. It contributes to clarifying why presentation task is suitable for facilitating meta-cognitive learning. In the figure, we are noncommittal about the boundary between cognition and meta-cognition since there are some opinions and not important for our discussion in this paper.

We presuppose a learner who has already learned a specific topic (UML). We give the learner the task of producing readily comprehensible presentation material for other learners whose academic ability is similar to that of the presenter. This task setting is important for the learner to focus on meta-cognitive learning: if the learner must perform both learning and making presentations, the learner cannot allocate sufficient cognitive capacity to perform the meta-cognitive activities. This task setting corresponds to the SHIFT (fig. 1(a)). It staggers the time of performing monitoring and generalizing processes AFTER performing learning. In preparing presentation materials, the learner monitors the previous own learning processes and asks herself queries to validate them. This stimulation corresponds to the LIFT (fig. 1(b)). It lifts monitoring and generalizing processes to the cognitive level. Then, she discusses with others whether the presentation material is easy to understand or not. This corresponds to OBJECTIVIZATION (fig. 1(c)). TRANSLATE means that it changes the learning skill acquisition task to the presentation task where the learner can be easy to be aware of learning skill acquisition (fig. 1(d)). REIFICATION (fig. 1(e)) provides terms for representing learning processes and plays an important role to realize appropriate LIFT and OBJECTIVIZATION.

Building the system design model based on the conceptualizations from the viewpoint of



system development contributes to deepening understanding of each learning scheme that aims to support meta-cognitive learning and to clarifying commonalities and/or differences among them.

3. Overview of the System

Based on the conceptualizations described in section 2, we can design support functions to enhance meta-learning. In this section, we'll explain the overview of our system based on these conceptualizations.

a. Structure of the System

Figure 2 shows a structure of our learning environment to support learner's meta-learning processes. The system is composed of three parts: Hozo (fig. 2(a)), which is an ontology building environment developed at Osaka University, meta-learning material authoring environment (fig. 2(b)) and presentation based meta-learning environment (fig. 2(c)). A scenario for using this environment is as follows.

(1) Building ontologies in Hozo

Ontology Engineer (OE) and educational psychologist build

- general level learning skill ontology.

OE and Domain Expert build,

- domain-specific learning skill ontology,
- domain ontology of learning target field and
- annotate hypertexts using ontologies built.

(2) Authoring a meta-learning material in authoring environment

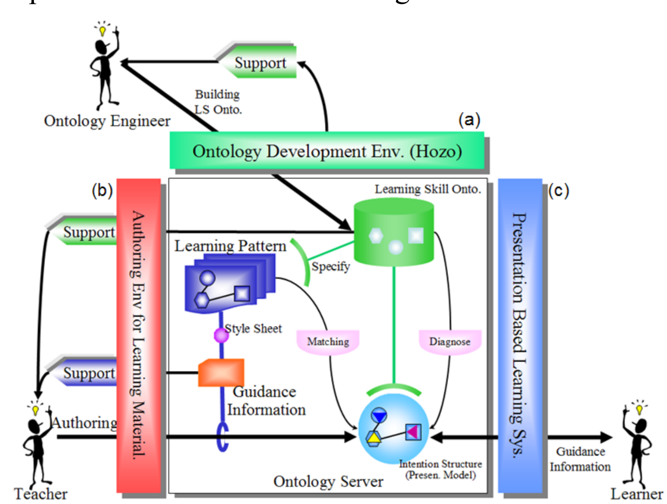
Teacher performs following activities:

- setting a presentation task for facilitating meta-learning activity,
- making a presentation material and its intention structure which plays a role of a teaching model, and
- identifying required teaching activities (learning topics) that must be embedded into presentation by a learner

(3) Presentation learning at presentation design phase

A learner, in our presentation based meta-learning support environment makes,

- intention structure of presentation (will be shown as Fig. 3) by referring domain-specific learning ontology, and
- presentation material according to the intention structure to satisfy requirements of given presentation subject.



Then the system provides

- guidance information (questions) to facilitate learner's reflection on his/ her own learning processes by referring learning skill ontology and the intention structure that the teacher made. The information is given by the learner's request to move to the following collaborative meta-learning phase. The learner's request is interpreted as a declaration that he/ she thought the presentation satisfies the presentation subject.

The learner reconsiders

- whether the presentation satisfies the requirements by referring guidance information that suggests the learning topics might be embedded.

(4) Presentation learning at collaborative meta-learning phase

A learner in collaborative meta-learning support environment performs,

- collaborative meta-learning with learning partners by referring interaction logs between the learner and the system.

Then the system provides

- information for the viewpoint to discuss their learning methods.

Ordinary learners tend to focus on the aspects on visual quality, impact of the presentation material and so on rather than validity of contents and their sequence structure (learning logic), when they discuss presentation material. Thus, we provide an environment that facilitates learning communication on learning logic, i.e., what should be learned and how to learn them, in the specific learning domain.

4. Question Generation Function Design

In this section, we explain what information the system should provide as questions to facilitate meta-learning activity.

a. Domain-Specific Learning Method

In our research, we focus on the meta-learning in technology domain, especially in software development domain as a concrete example.

In general, novice learners of object-oriented software development method tend to stop learning by memorizing only shallow knowledge such as how to depict diagrams or typical design patterns. Needless to say, memorizing how to depict diagrams is not essential in learning principles in software design.

We use DP which is a catalogue of software design model as a sophisticated learning material for enhancing learning of software design principles. Learners, however, cannot always understand them deeply even if they use DP as a learning material. They, therefore, cannot apply learned DPs to solve problems facing to them and build good design models by themselves even if they finished their learning.

The essential reason why they finish learning only by memorizing DPs is that they do not have domain-specific learning methods in the software design field.

In learning DP as well as software development methods, it is essential for the learner to ask himself to answer the important questions of designing software model: “Which functions might be extended?,” ”Which classes do we need to modify due to the respective functional extension?,” and “Which classes are not needed to modify even in a functional extension?,” and so on.

b. Intention Structure Reflects Learning Context

It is important for the system to understand learner’s learning context so that the system supports learners to acquire domain-specific learning methods in his learning context. In our learning scheme, we set an assumption that intention structure of presentation reflects learner’s learning context in his learning.

Let’s take a concrete example of this by referring to fig. 3.

In our system, it requires learners to describe intention (teaching) structures in making presentation materials. Figure 3(a) and 3(b) show intention structures of presentations that the teacher and the learner designed, respectively. Here, each node in the structure represents a learning (educational) goal, e.g., "make the learners understand the Iterator Pattern," and it is gradually detailed until feasible activities, e.g. "make the learners consider what functions might be extended."

Educational goals connected vertically represent that the learner intends relatively upper one is achieved by performing relatively lower ones.

Figure 3(a) is an intention structure that the teacher designed when he/ she sets the presentation task, i.e., "make the learners understand DP using the Iterator pattern as an example." In the figure, for example, the learning goal of "make the learners understand advantages of using Iterator pattern" is detailed as its sub-learning goals that "make the learner consider what functions might be extended," "make the learner consider which classes we need to modify due to each functional extension," and "explain advantages of using Iterator pattern."

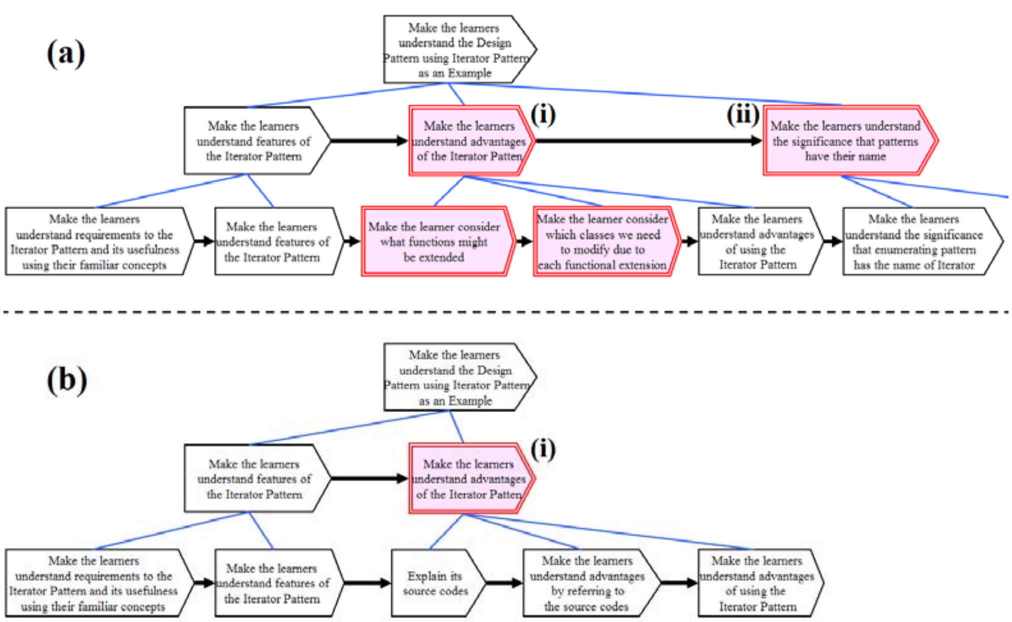
The educational activities double lined in fig. 3(i) are the ones that the teacher identified as required domain-specific educational activities.

The intention structure that the learner designed (fig. 3(b)) doesn't include the educational goals that the teacher identified. In our research, we interpret this meaning from the viewpoint of meta-cognitively aware instruction as "the learner does not recognize the important domain-specific learning activities (even if the learner had performed in learning)" or "the learner doesn't have the learning activities as learning-operators (thus, he/ she cannot perform them)."

c. *Ontology Based Guidance Function*

Guidance information is provided to the learner when she intends to move to the following collaborative learning phase. It gives queries on domain-specific learning activity based on the diagnosis of learner's intention structure by referring domain-specific learning skill ontology and the intention structure that the teacher constructed.

Below is an example guidance messages to prompt her reflection on her own learning



methods..
(1) Do following learning activities need to be embedded into your presentation to achieve the learning goal of "make the learners understand DP using Iterator pattern as an example?" If you think you need, choose "embed into the presentation" by right-mouse clicking.
(2) Do you have sufficient understanding of performing following teaching activities? Check items you had already understood."

- Make the learners consider what functions might be extended
- Make the learners consider which classes we need to modify due to each functional extension
- Make the learners consider which classes we do not need to modify even in a functional extension
- Make the learners understand the significance that each pattern has its own name

All of these learning activities are the ones that are defined in domain-specific learning skill ontology. Learning activities that the teacher identified to perform in the presentation are preferentially-shown high in the list.

It requires the learner to examine importance of their learning activities whether she should embed into his/ her presentation.

This can be interpreted as a stimulation to facilitate the learner's reflection on his/ her own learning processes. Furthermore, the checking activity is interpreted as declaration of (a) the change of the learner's understanding on "the importance of performing learning activities that he/ she couldn't be aware of in learning time" or (b) starting learning processes to understand it that the learner did not perform.

Therefore, the learner has to judge whether each query-item (teaching activity) should be embedded into his/ her presentation by referring these useful information capturing his/ her learning contexts. This encourages learner's internal self-conversation on domain specific learning activities.

Declaration of (b) cannot be directly interpreted as the learner's will for acquiring the learning operator (meta-learning), however, performing the learning activity is the necessary condition to acquire it as the learning operator.

The guidance information plays a meaningful role to enhance learner's acquisition of learning operators and gives a precious opportunity to acquire them, since the learner performs based on the understanding of significance of each learning operator to achieve presentation subject.

For educational activities that the learners judged as less important but the teacher requires, the teacher's presentation slide is shown in order to give an opportunity for the learner to reconsider the validity of his/ her judgment.

The interaction history in this phase will be shown as the learning material to facilitate learning communication in collaborative learning phase.

5. Related Works

In this section, based on our design model proposed in this paper, we can clearly address our research by comparing with other related works that focus on facilitating meta-cognitive skill development.

In the research on problem posing [7][8], they transfer learning skill acquisition task to problem posing task: it includes SHIFT and TRANSLATE principles. In performing problem posing task, learner has to remind his own problem solving processes: it includes LIFT principle. Furthermore, secondary effects occur since posed problem has to be solved by other learners: it includes OBJECTIVIZATION principle. It doesn't include REIFICATION principle. In this learning scheme, it is a problem that learners might not be able to follow this task transfer.

Consequently, the system design model based on the conceptualizations plays a role of clarifying commonalities and/ or differences among related learning schemes.

6. Concluding Remarks

We aim to build a novel learning scheme to encourage meta-learning through presentation task. In this paper, we mainly address two issues: (1) conceptualizations and design model based on them to develop meta-cognition support systems and (2) and (2) learning scheme based on the model that embeds guidance function to prompt internal-self conversation for meta-learning. We'll carefully address the empirical issues [12] and our model-based approach for the system development in othe paper.

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An Approach for Evaluating Question-posing Ability in a Web-based Collaborative Learning

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Abstract: With the rapid development of e-learning environment, question-posing learning activity has become an important instruction mode for both teaching and learning. Although previous research has demonstrated the benefits for both instructors and students in the question-posing learning activity, this learning approach still has some difficulties. One of the major difficulties is the lack of a practical approach to assist teachers in evaluating the question-posing ability of all learners. To cope with this problem, the present study develops an approach to measure the question-posing ability of individual students in a web-based collaborative learning. As a result, the proposed approach could not only improve the learning performance of individual students, but advance students' attitudes towards question-posing learning activity in a web-based collaborative learning environment.

Keywords: Collaborative learning; Teaching/learning strategies, Question-Posing

Introduction

With the rapid development of e-learning, web-based collaborative learning systems is gaining popularity as a promising learning environment [5][7].

1.1 Review of question-posing

Essentially, the use of questions as a learning activity has been recognized as a useful strategy to improve text retention and comprehension [1][6]. Prior studies suggested that engaging in the process of question-posing may be conducive to students' cognitive growth [1][6]. According to [7], question-posing learning activity was the most difficult task for young students, and high achievement students were tended to pose more questions. Although several studies [2][7] have demonstrated the benefit and effectiveness of question-posing in a web-based learning environment. However, very few attempts have been made at evaluating student's question-posing ability in a web-based collaborative learning environment. This point deserves explicit emphasis because it could provide students' learning status for teachers as well as further enhance learning and reflective thinking.

1.2 Research problems

The aim of present study is to develop and implement a web-based collaborative learning system, called Question-Posing Indicators Service (QPIS) System, designed to assist teachers in evaluating the question-posing ability of individual students, and enhance the reflective thinking and quality of learning activity among instructor, student, and peers. In view of the above, this research would try to answer the following research questions:

- Is there significant improvement in learning performance after using the QPIS system?
- How does using the QPIS system affect learner's learning attitudes?

In the following sections, an overview of the proposed system is presented. Second, findings for research questions are presented. Finally, we discuss implications of our findings for future research.

Overview of the proposed system

2.2 System architecture

The proposed system was designed by providing three modules: question-posing module, tool module, and assessment module. With respect to teacher interface, an instructor can use the assessment module (i.e., expert assessment) to evaluate students' question-posing contents. Additionally, about the student interface, students can use the question-posing module to pose a question, use the tool module to search self or peers' question-posing contents, and evaluate their and peers' posed questions contents. Then, each module is specifically described as follows.

2.3 Modules of proposed system

2.2.1 Question-Posing module

The function of the question-posing module is to pose a question according to individual's knowledge. As shown in Figure 1, student was chosen a type of question, and then the construction area will show the related fields. After finishing a question-posing, students have to give an assessment (i.e., self assessment) of the question they have constructed.

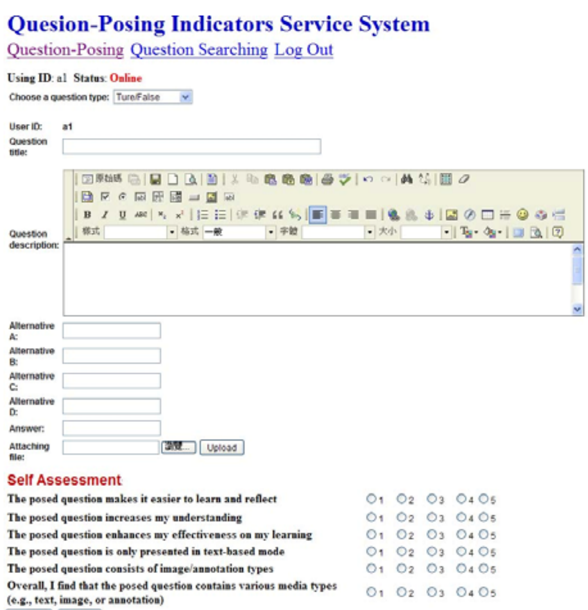

Figure 1. Screenshot of the question-posing function by selected types of multiple-choice question.

2.2.2 Tool module

The proposed system provides a tool module for students to search posed question and give comments of peers. About search function, student could search by keywords from an internal database, or selected a learner's ID to search.

2.2.3 Assessment module

The primary objective of the knowledge assessment function is to assist teacher in evaluating the knowledge contribution of individual students. With respect to how to evaluate a specific question-posing ability value, this study adapts the content usefulness instrument developed and tested by [4] and content richness criteria developed by [3] to measure. Each question created by learners is scored on a 5-point Likert scale, which is represented by explicit descriptions for easy understanding instead of just a number score.

Moreover, for the purpose of understanding learners' question-posing ability, the present study develops four sub-modules to evaluate the indicators of question-posing ability. They are question type analysis agent as well as self, peer, and expert assessment modules.

2.2.3.1 Indicators of question-posing ability

Question-posing ability was calculated by the scoring mechanism according to the above knowledge assessment modules. Both definitions and formulations of the proposed indicators involve various rules of evaluating in the QPIS system. More details concerning definitions and formulations of the question-posing ability indicators are presented as follow:

- t_j: the j-th question-posing score in the expert assessment set $t=\{t_j \mid j=1...n\}$, where n is the cardinality of the score set.
- s_j: the j-th question-posing score in the self assessment set $s=\{ s_j \mid j=1...n \}$, where n is the cardinality of the score set.
- p_j: the j-th question-posing average score in the peer assessment set $p=\{ p_j \mid j=1...n \}$, where n is the cardinality of the score set.
- t_w: the weight of expert assessment.
- s_w: the weight of self assessment.
- p_w: the weight of peer assessment.
- q_w: the weight of question types, where $w=\{1, 2, 3, 4\}$, q_1: true/false, q_2: multiple-choice, q_3: matching, q_4: short-answer.
- I: indicators of a student's question-posing ability represented as

$$I = \sum_{j=1}^{n} \frac{(t_j \times t_w + s_j \times s_w + p_j \times p_w)}{(t_w + s_w + p_w)} \times q_w$$, where $j=1...n$.

- μ_I: the average of the numerical set of all students' indicator scores I.
- σ_I: the standard deviation of the numerical set of all students' indicator scores I.
- $z(I)$: the standard score function of I, where $z(I) = \dfrac{I - \mu_I}{\sigma_I}$.
- $T(I)$: To assist teacher in simply understanding the score of question-posing ability, the study attempts to transform the indicators from z score to T score normalized by the standard normal function.

3. Experiment

3.1 Participants

The participants from the same department of two classes were divided into two groups, namely experimental group and control group, respectively. The two groups consisted of a total of 100 freshmen, majoring in the Department of Information and Management, who were taking a Basic Programming Design course. Control group students were conducted the traditional teaching approach (i.e., without the QPIS system), while experimental group students were provided the QPIS system for teaching and learning. All participants have similar educational backgrounds and intelligences. To increase the reliability of the experiment, all participants learn with the same contents of Basic Programming Design materials (introducing java general techniques, objects and equality, and exception handling), which are given by the instructor.

3.2 Experimental tools and materials

Experimental group students were required to pose questions on reflective thinking according to their learning during and after class. The learning materials were provided by the instructor, and the instruction tools was used J2SE SDK 5.0 and UltraEdit v13.10 for students to learn and create their works. After finishing their works, learners were asked to pose questions based on their reflection in the QPIS system.

3.3 Procedures

The experiment was conducted over eight weeks period. After eight weeks, experimental group students were asked to answer a feedback questionnaire for measuring attitudes towards the use of QPIS system, and a post-test for testing their knowledge of the course for both experimental and control groups. Moreover, the system logs and contents of question-posing were also extracted for analysis. A total of 50 responses (100%) were collected.

4. Results

4.1 The changes in the students' pre- and post-test scores after participating in the Basic Programming Design course

In this research, the pre-test scores represent entry behavior of learning, and the post-test scores represent the learning performance. Before the experiment, to measure if there was difference between groups in terms of learners' prior knowledge of Basic Programming Design concepts, an independent sample t-test was conducted for pre-test scores. The result indicated that no significant difference was found between groups ($t=0.32$, $P=0.75>0.05$). In other words, this implied the participants of both groups did not differ in their initial prior knowledge.

After learning the course, the study administrated a post-test to examine whether there was difference in both groups. As shown in Table 1 and Table 2, both groups were significant differences in paired t-test. These imply that both teaching strategies could assist students in learning.

Moreover, we attempted to further use a t-test to examine whether the use of QPIS system of experimental group could really enhance the students' learning performance more than the control group. The analysis results indicated that there was a significant difference in students' post-test performance between the two groups, as shown in Table 3 ($t=4.169$, $P<0.05$).

Table 1. Results of paired t-test on pre- and post-tests of experimental group

Measure	N	Pre-test		Post-test		t value
		Mean	SD	Mean	SD	
Knowledge of the course	50	34.00	14.14214	65.90	10.62775	-18.119^{*}

* *P<0.05*

Table 2. Results of paired t-test on pre- and post-tests of control group

Measure	N	Pre-test		Post-test		t value
		Mean	SD	Mean	SD	
Knowledge of the course	50	33.10	13.80956	56.80	11.19220	-16.606*

* *P<0.05*

Table 3. Results of t-test on post-test between experimental and control groups

Variable	Post-test		t-test
	Mean	SD	
Experimental group	65.90	10.62775	4.169*
Control group	56.80	11.19220	

4.2 Results of questionnaire analysis

With respect to perceived usefulness listed in Table 4 (Cronbach's alpha=0.890). On average, students reported moderate learning attitudes toward the usefulness of QPIS system. They indicated the use of QPIS system saves their time and accomplishes tasks more quickly. When asked about the learning aspect of QPIS system, students agreed to the statement that using QPIS system enhances their effectiveness on the question-posing; they also agreed that using QPIS system improves the quality of question-posing. Regarding the perception of peer assessments, students strongly agreed that peers fairly evaluate the posed questions contents. On the other hand, regarding the perceived ease of use (see Table 5), students noted when using the QPIS system is not occur in confused and make errors frequently. Overall, they thought using the QPIS system is easy to use.

Table 4. Perceived usefulness of the QPIS system

#	Question	SA	A	U	D	SD	Mean score	Std. dev.
1	Using QPIS system saves me time.	7 (14.00%)	19 (38.00%)	16 (32.00%)	8 (16.00%)	0 (0.00%)	3.50	0.93
2	QPIS system enables me to accomplish tasks more quickly.	7 (14.00%)	17 (34.00%)	17 (34.00%)	8 (16.00%)	1 (2.00%)	3.42	0.99
3	Using QPIS system enhances my effectiveness on the question-posing.	7 (14.00%)	25 (50.00%)	18 (36.00%)	0 (0.00%)	0 (0.00%)	3.78	0.68
4	Using QPIS system improves the quality of question-posing.	8 (16.00%)	24 (48.00%)	18 (36.00%)	0 (0.00%)	0 (0.00%)	3.80	0.70
5	Using QPIS system makes it easier to do my learning.	6 (12.00%)	20 (40.00%)	19 (38.00%)	5 (10.00%)	0 (0.00%)	3.54	0.84
6	I think peer assessment was objective for me.	27 (54.00%)	18 (36.00%)	5 (10.00%)	0 (0.00%)	0 (0.00%)	4.44	0.67
7	Overall, I find the QPIS system useful in my learning.	15 (30.00%)	22 (44.00%)	8 (16.00%)	5 (10.00%)	0 (0.00%)	3.94	0.93

Note: SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree.

Table 5. Perceived ease of use of the QPIS system

#	Question	SA	A	U	D	SD	Mean score	Std. dev.
1	I was not often become confused when I use the QPIS system.	22 (44.00%)	20 (40.00%)	7 (14.00%)	1 (2.00%)	0 (0.00%)	4.26	0.78
2	I was not make errors frequently when using the QPIS system.	23 (46.00%)	20 (40.00%)	5 (10.00%)	2 (4.00%)	0 (0.00%)	4.28	0.81
3	I find it easy to get the QPIS system to do what I want it to do.	20 (40.00%)	21 (42.00%)	8 (16.00%)	1 (2.00%)	0 (0.00%)	4.20	0.78
4	It is easy for me to understand how to perform tasks while using the	10 (20.00%)	22 (44.00%)	18 (36.00%)	0 (0.00%)	0 (0.00%)	3.84	0.74

	QPIS system.							
5	Overall, I find the QPIS system is easy to use.	17 (34.00%)	22 (44.00%)	11 (22.00%)	0 (0.00%)	0 (0.00%)	4.12	0.75

Note: SA: Strongly Agree, A: Agree, U: Undecided, D: Disagree, SD: Strongly Disagree.

5. Discussion and conclusion

The present study developed the QPIS system to be applied in a web-based collaborative learning environment and to assist teacher in evaluating and understanding the individual's question-posing ability. Additionally, this study provides evidence consistent with prior research [2] that question-posing ability can serve as both learning and assessment tools in higher education by encouraging students to carry out active learning, constructive criticism and knowledge sharing. As a result, students could improve their learning outcomes after using the QPIS system.

Moreover, contrary to [7], our study was found different results. They pointed out that younger learners felt difficult in question-posing learning activity. In fact, the good qualities of question-posing need more reflective thinking and mature ideal, but younger learners do not have fully knowledge and ideals. In this study, the experimental evidence supports above view.

Finally, the result of the questionnaire survey showed there are positive attitudes toward using the QPIS system as a question-posing learning environment. Although most students agreed the perceived usefulness and ease of use of the proposed system, it still has few students dissatisfied. Few students noted by using QPIS system with question-posing was spent their time and was not an easy task. The problem might be improved by providing user-friendly interface or more rewards as incentives.

In conclusion, we believe that this research can provide valuable insights to teachers and researchers about the trajectory of question-posing ability in a web-based collaborative learning.

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Analysis of Learners' Activity in a Question-Posing Learning Support System by Association Rule Mining

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Abstract: Many support systems for learner-centered question-posing learning have been developed. Some effectiveness in using such systems have been reported. However, most researches have indicated a single factor or combined two factors as the effectiveness of question-posing learning. In this paper, association rule mining was used for analyzing the effectiveness in using a question-posing learning support system. The effectiveness of the combination of more than two factors was investigated. From the analysis, it was revealed that making high-quality question-items related to increasing comprehension of learning materials even though learners posed, answered and/or assessed not many questions.

Keywords: Question-posing learning, Learning support system, Data mining, Association rule mining

1. Introduction

Question-posing is higher cognitive activity than question-answering and has positive effect on the learners' problem solving skills [1]. Recently, question-posing learning activity includes question-posing, question-answering, question-assessing and some discussion. These activities improve the learners' comprehension [2]. Additionally, many Web-based learning support systems have been developed and collaborative learning in a distributed asynchronous environment has been supported [3]. According to abovementioned background, many question-posing learning support systems, such as "MONSAKUN [4]", "QPPA [2]" and "Concerto [5][6]", have been developed.

In this study, the learners' activities in Concerto III were analyzed and the learning effectiveness in using the system was identified. The effectiveness of posing questions has been discussed in many precedent studies. Effects of other learning activities, though they are considered to be important, have not been reported enough. The positive effectiveness of making high-quality question-items have been reported [7]. The question-items consist of question-stem, the answer and the explanation. The high-quality question-items define as "the question-item where there are few mistakes, such as wrong answer and misspelling". Also, the positive effectiveness of assessing many questions have been published [8]. Thus, making questions, making high-quality question-items and/or assessing questions have positive effect on learning. However, most precedent researches have indicated a single factor or combined two factors as the effectiveness of question-posing learning activities. Akahori [3] has suggested that the factor of effectiveness is not only one, but complicated especially when the subject of an experiment is a human beings.

In this paper, the learning effectiveness in using a question-posing learning system was analyzed with "association rule mining". The effectiveness of the combination of more than two factors could be found by this analysis. The results indicated that making high-quality question-items related to increasing comprehension of learning materials even though learners posed, answered and/or assessed not many questions.

2. Related Work

a. The Learners' Activity Analysis in a Question-posing Learning Support System

In the early research about a question-posing learning support system, the qualitative analysis, such as one of the questionnaire to which the learners who used the system responded, has been conducted. One example of the results is as follows:

- Learners' interactive skills were improved by creating questions and group-review of posed questions. Learners' comprehension of learning materials was also improved. Learners were motivated to learn. Therefore, the posing and review activity had significantly positive effect on learning. [9]

There are some reports about the positive effectiveness of question-posing activity by analyzing the questionnaire. (e.g. [2][10][11][12][13])

Recently, the quantitative analysis, such as one of logs stored in the system, has been carried out. The pre- and post-test score have been used in many researches. These scores have been used to show that learners' comprehension was increased in the comparison of "before" and "after" using the system. One instance of the analysis is as follows:

- Students were divided into two groups by the pre-test score, and students in each group were also divided into two groups by the number of posed questions. Then, the pre- and post-test score were compared between the groups. The results indicated that our system improved the problem solving ability of the students which the pre-test score was low and the number of posed questions was high. [4]

There are some researches conducted the similar analysis. (e.g. [9][14][15][16][17])
The effectiveness of question-posing activity varies according to the condition of experiment. Abovementioned researches have indicated at most combined two factors (e.g. the students which the pre-test score was low and the number of posed questions was high) as the effectiveness of question-posing activity.

b. Data Mining Methods

Generally, learners' activity logs are stored in the database for LMS (Learning Management System) included a question-posing learning support system [18]. Data mining techniques are frequently used to analyze learners' activity, learning effectiveness and/or other perspective. There are various mining techniques, such as association rule mining [19], decision tree, SVM (Support Vector Machine), clustering and many more. Many insights are revealed by these techniques. However, it may be difficult for the analysts to interpret if the findings are too much. Therefore, we used "association rule mining" because the number of findings can be controlled by the definition of threshold level.

3. Outline of Association Rule Mining

Association rule mining has received a lot of attention in recent years [18]. An association rule [19] is an implication of the form "A => B", where A and B disjoint subsets of U (a universal set). The sets of items A and B called LHS (left-hand-side) and RHS (right-hand-side). The quality of an association rule is defined by its *confidence* and *support*. *Confidence* of a rule is the conditional probability of B given A. *Support* of a rule is an estimate of the probability of itemsets in the union of A and B. The correlation between A and B in the rule may be strong if the value of *confidence* is high. However, the rule may not be persuasive if the value of *support* is low. Thus, evaluation of rules needs to consider both these values.

4. Experiment of using Concerto III

a. Outline of Concerto III

In this study, the data stored in Concerto III [7] was analyzed. Concerto III is a Web-based learning support system and provides the following functions:

- Question-posing: learners can make a question in the form of a multiple-choice or story question and pose it to the system. They can use figures on question-making and revise the posed question if necessary.
- Question-answering and Question-assessing: learners can answer the posed question and assess it. They can assess it in terms of its originality, difficulty and/or quality on the five point Lickert scale (1-5) and additional comments. The assessment is done at the same time when the learners answer the question. As for the assessment of the quality, the scale is as follows: (1) Contradiction exists in the question. He/She can not answer the question (e.g., no answers for the question). (2) He/She can answer the question, but there exist some errors in the answer or explanation. (3) There exist no errors in the question, answer and explanation, but I want the question-poser to explain the question and answer in more details. (4) There exist no errors in the question, answer and explanation. The question-poser explains the question very well. However, there are incorrect characters in the question, answer or explanation. (5) The question is perfect.
- Discussion: Learners can discuss the posed question with others. The system provides BBS (Bulletin Board System) for each question.

b. Outline of the Experiment

Concerto III has been applied to a university course "Introduction to computer systems". The course was offered by the department of information education at Tokyo Gakugei University in the 2008 and 2009 academic year. A pre-test has been carried out before the application of Concerto III. The content of pre-test is what learners have already learned in the course. A post-test has also carried out after the application. The content of post-test is what learners learned in the course. Table 1 shows the usage results of Concerto III. Table 2 shows an example of question-item posed by a learner.

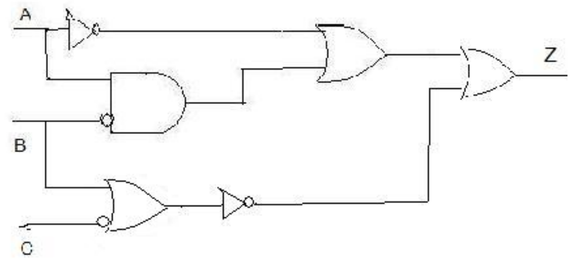
Table 1. Usage results of Concerto III.

Year	2008	2009
Duration of application	6 weeks	7 weeks
No. of user registration	94	77
Total No. of login	1384	611
Total No. of question-posing	273	94
Total No. of question-answering	3815	1340
Total No. of question-assessing	2561	697
Total No. of submitted the comments in the BBS	23	9

5. Extraction of Association Rules

a. Data Sets

Table 2. Example of question-item posed by a learner.

Question: Given that the logical circuit using MIL symbol, express this same circuit using Boolean algebra. Then, simplify the Boolean expression.	
Answer: Z = not A + not B	
Explanation: Z = notA + A * notB + not(B + notC) = (notA + A) (notA + notB) + notB * C = notA + notB + notB * C = notA + notB (1 + C) = notA + notB	

In this analysis, learners' activity logs were stored in Concerto III and the pre- and post-test score were used. Table 3 shows the recorded activities and their explanations. There were some learners who were absent from the pre- or post-test. The data of these learners were not used in the following analysis. The assessed data were collected through the Web page of the system. It might be desirable that the quality was evaluated by the instructors for the accuracy, but was done by the learners in this practice. This instead realized the collaborative learning. The evaluation by the instructors is one of the future works.

Table 3. The system logs and its explanation.

Log	Explanation
Login	A learner logged in to the system
Pose	A learner posed a question
Answer	A learner answered a pose question
Assess	A learner assessed a posed question
Submit	A learner submitted a comment to the BBS
Quality	The quality of a learner's posed question

b. Methods

The analysis began with calculation of the number of each learner's question-posing, question-answering and so on. Table 4 shows part of the calculated data. For example, learner L_1 posed 4 questions, answered 30 questions and his/her score of pre-test was 6 and the post-test is 62.

Table 4. The summary of users' information.

Learner	No. of question-posing	No. of question-answering	…	Pre-test score	Post-test score
L_1	4	30	…	6	62
L_2	6	218	…	5	73
…	…	…	…	…	…
L_n	3	65	…	7	48
Average	2.93	41	…	-	-

Then, we classified the calculated data as H (High-group) and L (Low-group). Table 5 shows part of the classified data. For instance, the learner which the number of question-posing was higher than average value belongs to the high-group. As for the pre- and post-test score, each learner's T-score was calculated and classified as "increased" or "decreased". The learner which his/her T-score of post-test was higher than one of pre-test belongs to the "increased" group. "Increased" defines that learner's comprehension of learning materials was increased in the comparison of pre-test and post-test. As for the classified and normalized data shown in Table 5, the data in 2008 and 2009 was combined. There were 119 learner's data in the combined data.

After completing the classification process, mining association rules was carried out. We used the software "R 2.9.1 [20]" (for statistical processing), the package "arules [21]" (for mining association rules) and the apriori algorithm [22]. The minimum value of *support* and *confidence* was set up to control the number of extractable rule. The minimum *support* was 0.20. This means that there are 24 or more learners who satisfy the condition LHS of a rule. The minimum *confidence* was the proportion which satisfy the condition RHS unconditionally. This is because the rule which the value of *confidence* is higher than the minimum *confidence* is significant in the principle of this mining. "T-score = increased" or "T-score = decreased" was selected as the condition RHS because our goal of this study was to identify the learning effectiveness.

Table 5. The summary of the classified groups.
("1" means that the learner belongs to the group)

Learner	No. of question-posing		No. of question-answering		…	T-score	
	H	L	H	L		increased	decreased
L_1	1	0	0	1	…	0	1
L_2	1	0	1	0	…	1	0
…	…	…	…	…	…	…	…
L_n	0	1	1	0	…	0	1

c. Results

Table 6 and Table 7 contain the extracted rules in this mining. 24 rules related to "T-score = increased" and 20 rules related to "T-score = decreased" were extracted. The rules were numbered in order of *confidence* and *support*. For example, Rule I_1 means that T-score of the learner was increased and the learner satisfied the following three conditions:

- The number of logging into the system was lower than the average value.

Table 6. Rules related to increase of T-score.

Rule No.	LHS	RHS	*Support*	*Confidence*
I_1	Login=L, Submit=L, Quality=H	T-score=increased	0.210	0.595
I_2	Login=L, Quality=H	T-score=increased	0.218	0.577
I_3	Pose=L, Submit=L, Quality=H	T-score=increased	0.260	0.574
I_4	Submit=L, Quality=H	T-score=increased	0.327	0.573
I_5	Pose=L, Quality=H	T-score=increased	0.268	0.542
I_6	Answer=L, Submit=L, Quality=H	T-score=increased	0.226	0.540
I_7	Pose=L, Assess=L, Quality=H	T-score=increased	0.201	0.533
I_8	Pose=L, Answer=L, Quality=H	T-score=increased	0.210	0.531
I_9	Assess=L, Submit=L, Quality=H	T-score=increased	0.218	0.530
I_{10}	Quality=H	T-score=increased	0.344	0.512
I_{11}	Submit=L	T-score=increased	0.428	0.490
I_{12}	Login=L, Answer=L, Submit=L	T-score=increased	0.243	0.483
I_{13}	Answer=L, Quality=H	T-score=increased	0.226	0.482
I_{14}	Pose=L, Answer=L, Submit=L	T-score=increased	0.260	0.476
I_{15}	Login=L, Answer=L	T-score=increased	0.243	0.475
I_{16}	Login=L	T-score=increased	0.294	0.472
I_{17}	Assess=L, Quality=H	T-score=increased	0.218	0.472
I_{18}	Answer=L, Submit=L	T-score=increased	0.277	0.4714

I_{19}	Login=L, Submit=L	T-score=increased	0.277	0.4714
I_{20}	Pose=L, Assess=L, Submit=L	T-score=increased	0.344	0.4712
I_{21}	Pose=L, Submit=L	T-score=increased	0.201	0.470
I_{22}	Answer=L, Assess=L, Quality=H	T-score=increased	0.302	0.467
I_{23}	Assess=L, Submit=L	T-score=increased	0.302	0.467
I_{24}		T-score=increased	0.462	0.462

Table 7. Rules related to decrease of T-score.

Rule No.	LHS	RHS	*Support*	*Confidence*
D_1	Pose=L, Quality=L	T-score=decreased	0.201	0.685
D_2	Submit=L, Quality=L	T-score=decreased	0.201	0.666
D_3	Quality=L	T-score=decreased	0.210	0.641
D_4	Answer=L, Assess=L	T-score=decreased	0.352	0.575
D_5	Login=L, Pose=L, Assess=L	T-score=decreased	0.285	0.5666
D_6	Assess=L	T-score=decreased	0.394	0.5662
D_7	Answer=L	T-score=decreased	0.369	0.564
D_8	Pose=L, Answer=L, Assess=L	T-score=decreased	0.294	0.555
D_9	Login=H	T-score=decreased	0.210	0.555
D_{10}	Login=L, Assess=L	T-score=decreased	0.294	0.546
D_{11}	Login=L, Pose=L, Submit=L	T-score=decreased	0.294	0.546
D_{12}	Login=L, Pose=L	T-score=decreased	0.310	0.544
D_{13}	Pose=L, Answer=L	T-score=decreased	0.310	0.544
D_{14}	Answer=L, Assess=L, Submit=L	T-score=decreased	0.310	0.544
D_{15}	Login=L, Pose=L, Answer=L	T-score=decreased	0.260	0.543
D_{16}	Pose=L	T-score=decreased	0.428	0.542
D_{17}	Login=L, Answer=L, Assess=L	T-score=decreased	0.268	0.542
D_{18}	Pose=L, Assess=L	T-score=decreased	0.327	0.541
D_{19}	Login=L, Assess=L, Submit=L	T-score=decreased	0.285	0.539
D_{20}		T-score=decreased	0.537	0.537

- The number of submitted comments to the BBS was lower than the average value.
- The quality of his/her posed question was higher than the average value.

Then, *Support* of the rule was 0.210 and *Confidence* was 0.595.

6. Discussion

a. Interpretation of Extracted Rules

The rules I_1 to I_{10} include the condition “Quality = H”. According to this, we can guess that posing high-quality question-items relates to the increase of T-score. Moreover, “Quality = H” and other conditions, such as “Login = L”, “Submit = L”, “Pose = L”, “Answer = L” or “Assess = L”, were combined. The *Confidence* of these combined rules are higher than one of the single condition “Quality = H”. On the other hand, the rules D_1 to D_3 include the condition “Quality = L”. According to this, we can guess that posing low-quality question-items relates to the decrease of T-score. There were some rules consisted of the single condition, such as “Pose = L”, “Answer = L” or “Assess = L”.

b. Comparison of This Study and the Precedent Researches

In this section, the results of this research are compared to the results of the precedent researches. In all of these researches, the learners were undergraduate students. The subjects were “Introduction to computer systems” [7][8] and “Information processing” [9]. Web-based learning support systems were provided and the learners' comprehension of learning materials have been investigated.

(1) The effectiveness of question-posing

Takagi et al. [9] has suggested that there were some effectiveness of question-posing by investigating the questionnaire. They also reported that the number of question-posing did not influence on the examination score. Another study [7] has conducted that the examination score of learners who posed many questions were more increased than those who not. We can not identify the influence because "Pose = H" is not listed in Table 6 and 7. However, we can guess that one factor which the number of question-posing is lower than the average value related to another factor which the examination score is decreased.

(2) The effectiveness of posing a high-quality question-item

Hirai et al. [7] have reported that the examination score of learners who posed high-quality question-items were more increased than those who not. As for this, we confirm after the fact because the rule satisfied the condition "if Quality = H then T-score = increased" was extracted in Table 6.

(3) The effectiveness of question-assessing

Hirai et al. [8] have indicated that the examination score of learners who assessed many questions were more increased than those who not. We can not identify whether the number of question-assessing influence on the examination score because "Assess = H" is not listed in Table 6 and 7. However, we can guess that one factor which the number of question-assessing is lower than the average value related to another factor which the examination score is decreased.

c. The Effectiveness in Using a Question-posing Learning Support System

In section 6.1, we described that there were rules consisted of the single condition, such as "Pose = L", "Answer = L" or "Assess = L" in LHS of Table 7. In other words, these rules related to the decrease of T-score. However, when these factors and one factor "Quality = H" are combined, the rule relates to the increase of T-score. The following are some examples of this phenomenon:

- (Pose = L) and (Quality = H) => (T-score = increase) …rule I_7
- (Answer = L) and (Quality = H) => (T-score = increase) …rule I_{13}
- (Assess = L) and (Quality = H) => (T-score = increase) …rule I_{17}

In short, the result suggested that making high-quality question-items had positive effect on learning even though learners posed, answered and/or assessed not many questions.

d. Hypothesis on increasing comprehension by making high-quality question-items

Learners may check question-items to upgrade when making the question. As for checking questions, Yu et al. [2] have reported that peer-assessing learning activities encourage participants to gauge objectively and critically the adequacy and correctness of posted questions. Then, learners presumably add details to their existing cognition, explore and correct their misconceptions, and/or re-organize their current knowledge structures by online interaction and open communication with peers pertaining to the question and the correct answer. This report describes peer-assessing activities. We hypothesized that learners may do these activities during making the question. Therefore, we considered that making high-quality question-items caused increasing comprehension.

7. Conclusion

In this paper, the learners' activities have been analyzed by association rule mining. The combined factors as the effectiveness of question-posing learning have been clearly identified. The interpretation of extracted rules have indicated that posing high-quality question-items related to increasing comprehension of learning materials even though learners posed, answered, and/or assessed not many questions. Some support depending on the interpretation of extracted rules will be developed in the future.

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Effects of Online Scaffolded Student Question-Generation on Science Learning

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Abstract: In this paper, the effects of scaffolded student question-generation (immediate and delayed) on students' performance in academic achievement and question-generation were examined. A total of 78 fifth-graders from four classes participated in the study for 13 weeks. An online question generation system was adopted to assist the learning process. A quasi-experimental research design was adopted. Results of ANCOVA found no statistically significant differences among different treatment groups in neither of the observed variables. Explanations for the unexpected results and suggestions for classroom implementations and future studies are provided.

Keywords: student question-generation, scaffolds, online learning activities, science learning

1. Introduction

Constructivists emphasize the notion that knowledge cannot be given to learners; instead, learning is most likely to occur in contexts where individuals are allowed to reflect and build their knowledge based on learning experiences [1]. Student-generated questions in essence reflect the ideas of constructivism. Based on their understanding of the learning materials, learners are given opportunities to highlight the contents they deem important, relevant and interesting [2], and transfer the information in the form of questions and answers. As a result, the student-generated questions approach to learning encourages students to reflect on what they learn and what it means in terms of their past learning experiences, current and future learning [3].

Despite the generally positive effects supporting the student-generated questions strategy [4], researchers found that a considerable proportion of students do not experience question-generation during their formal schooling [5-7]. Moreover, more than half solicited students viewed the student-generated questions as difficult or very difficult [8]. Thus, how to better support students to be adept and feeling equipped at generating questions will be a topic of importance.

Questioning guided by a set of question stems developed by King (1990) was found to promote peer interaction and learning in cooperative groups by enhancing the levels of posed questions and elaborated responses [9]. In light of this, and that existing studies comparing the effects of supporting strategies is limited, the study aimed to examine the effects of scaffolded student question-generation on student learning. Furthermore, according to Ertmer and Simons (2006), providing metacognitive support too early may interfere with student learning by adding difficulty to the task [10]. Some researchers further suggested metacognitive scaffolds to be introduced later in the process [11]. However, this presumption still lacks solid experimental studies for empirical confirmation. As such, the effects of delayed scaffolded student question-generation on student learning were also examined. Finally, in addition to the outcome variable of most concern to teachers (i.e., academic achievement), if and how would the scaffolds affect the task at hand (generating questions) was examined in the study.

To sum up, this study attempted to answer the following two questions:

1. How does scaffolded student question-generation (immediate and delayed scaffolds), as compared to no scaffolds, influence students' academic achievement in science?
2. How does scaffolded student question-generation (immediate and delayed scaffolds), as compared to no scaffolds, influence student's abilities in generating questions?

2. Methods

a. Participants, Learning Context and Experimental Procedures

To ensure enough group size, four 5th grade classes (N=78) of one elementary school in urban Taiwan were invited to participate. To minimize the scheduling and administrative problems that might be evoked by randomly assigning students to different groups, intact classes were used and randomly assigned to one of three experimental conditions except one class (which were randomly assigned to different treatment groups).

The online student question generation activity, implemented on *Question Authoring & Reasoning Knowledge System* (QuARKS), was introduced as supporting students' regular science learning. As science at the same grade level was taught by the same teacher at the participating school, instructional contents covered in each week were kept identical. Also, students in this participating school started taking computer classes since they were in 3th grade, and thus possessed fundamental skills of computer operations.

This study lasted for 13 weeks. As a routine, students of each treatment group head to a computer lab during regularly scheduled 40-minute morning study sessions one time per week to engage in this activity. Except for the first two sessions allocated for training and pre-treatment assessment, three sessions for the midterm, post-treatment assessment and final exam, respectively, students worked individually to generate short-answer questions in accordance with covered instructional topics for eight weeks. A training session was arranged at the beginning of the study to help students become familiar with good question-generation practices and the adopted computer system. Feedback to student performance in question-generation was done by the participating teacher by intentionally selecting three pieces of students' work as exemplary of good question-generation practice each week.

b. Different Treatment Groups

Three treatment conditions were set up. In Treatment A (no scaffold), no guides were provided for students' reference to support question-generation. In Treatment B (immediate scaffold), a set of guides were provided at the very beginning of their question-generation activity. In Treatment C (delayed scaffold), no scaffolds were provided until the group generated questions for two weeks.

Guides which were included in this study and provided to Treatments B and C were based on the question stems developed by King (1990) and Tung (2005) [9, 12]. Three science teachers from the participating school were invited to assess its relative appropriateness and usefulness for the subject matter (science) and participants (elementary schoolers). As a result of the expert validity assessment, fourteen question stems were included (e.g., can you write in your own words…? explain why…what was the main idea…? can you provide an example of what you mean…? how is…related to…that we studied earlier? how are …and…similar? what is the difference between…and…? can you group by characteristics such as…? what conclusions can you draw about…? how does…affect…?, etc.). In addition to question stems as scaffolds to students assigned to scaffolded question-generation groups (Treatment groups B and C), examples on using each of the question stems (based on science contents from the prior semester) were also provided and made online accessible to students assigned to scaffolded groups (see Figure 1 as an example). Students who were given scaffolds were requested to generate questions based on these prompts.

Import Stem	Generic Question-Stems	Sample Questions
Import this stem	What do you think might occur if ..... ?	What do you think might occur if a mammal was developed outside of its mother's body? What dangers would there be for the baby's survival?
Import this stem	What information do we already have about..... ? How does it apply to .... ?	What information do we already have about reptiles versus mammals? How do these differences apply to body temperature?
Import this stem	Are there any differences between. ... and.. .. ?	Are there any differences between learned and instinctive behavior ? Explain.
Import this stem	.... appears to be a problem because .... What are some possible solutions?	The untimely death of a mother appears to be a problem because of her role as nurturer ad teacher. What are some possible solutions for the baby's survival if she should die prematurely.
Import this stem	The author(s) states that " ...." Explain why this statement is true or false.	The author(s) states that 'Mammals are the only animals that have hair or fur." Explain why this statement is true or false.
Import this stem	Compare. ... .and/with ....in regards to.. .... Explain your answer.	Compare incisors and canines with premolars and molars in regards to eating. Explain your answer.
Import this stem	What do you think causes…?	What do you think causes the shrinking of glaciers in the Arctic Circle?
Import this stem	How does … effect …?	How does elevation affect temperature?
Import this stem	What is the meaning of …?	What is the meaning of photosynthesis?
Import this stem	How are … and …different?	How are assimilation and accommodation different?
Import this stem	Why is … important?	Why is conserving water important?
Import this stem	Explain how…	Explain how can we conserve energy?
	Close	

Figure 1 Scaffolded student question-generation (question stems with samples questions)

c. Measures

Students' performance in science was measured by the average scores of mid-term and final exams, which were centrally administered at the participating school. Difficulty index for the majority of test items for the mid-term was between .71 and .91 and.52 and .79 for the final exam with Cronbach α all reached the level of .90.

For measuring students' performance in generating questions, each question students generated at the last question-generation activity (8^{th} activity) were analyzed, scored and summed up against a defined scheme. Mainly, each question was graded along four dimensions: fluency, elaboration, originality and cognitive level. *Fluency* (0-3) assesses the correctness of spelling, clarity of sentence, the logic, and relevancy of the constructed question. *Elaboration* (0-2) gauges the interconnectedness between current covered topic/unit and prior topics/units and examples not from covered materials. *Originality* (0-2) taps on the uniqueness of the question as compared to their peers (including demonstrating innovative ideas and embedding new materials for graphical display or expression of covered content). *Cognitive Level* (0-3) evaluates the cognitive levels demanded of responders: *fact*, *comprehension* or *integration*. *Comprehension* indicates that students used their own words to define or describe learned content whereas *fact* stressed the verbatim nature of questions from the learned materials. *Integration* evidences a link has been built across topics/units and explanation has been provided to build connections. To ensure the reliability of this scoring procedure, the analysis work was done collectively by one of the author and a science teacher. Any inconsistencies between the raters were discussed and resolved.

3. Results

Descriptive statistics on student performance in science achievement and question-generation is listed in Table 1. Data on students' performance in academic achievement were analyzed using analysis of covariance (ANCOVA) with students' scores in science in the prior semester as covariate. The assumption of homogeneity of regression was satisfied, F (2, 72) = 1.76, $p>.05$, before proceed. Results from ANVOVA revealed that there were no statistically significant differences among three groups, F (2, 74) = 1.78, $p > .05$. This indicated that scaffolds (immediate or delayed), as compared to no scaffolds, did not affect students' academic achievement differently.

Data on students' performance in question-generation were analyzed using ANCOVA with students' scores at the 1st question-generation activity as covariate. The assumption of homogeneity of regression was satisfied, F (2, 72) = 46， $p >.05$, before proceed. Results showed no statistically significant differences among three groups in students' performance in question-generation, F (2, 74) = .045, $p>.05$.

Table 1. Descriptive statistics on student performance

		SQG* (n=27)	Immediate Scaffolded SQG* (n=26)	Delayed Scaffolded SQG* (n=25)	Total
Science achievement					
	In the prior semester, M (SD)	90.11 (6.65)	90.27 (6.02)	89.56 (7.33)	89.99 (6.6)
	Average midterm, final, M (SD)	85.07(10.46)	85.29(6.24)	81.68(11.9)	81.68 (9.82)
	Adjusted M	84.93	84.96	82.18	
SQG					
	1st QG	4.93(3.40)	8.46(5.56)	3.88 (4.42)	5.76 (4.89)
	8th QG	9.07 (6.28)	11.81(7.23)	8.60 (6.26)	9.83 (6.67)
	Adjusted M	9.60	10.12	9.78	

*SQG: Student Question-Generation

4. Discussion and Conclusions

The present study found no evidence supporting the research hypothesis that scaffolds (introduced immediately or later) in the question-generation process enhanced student performance in science achievement and question- generation. Explanations are provided for the unexpected findings. First, the non-significant result on academic achievement might be due to the overall low cognitive-level type of questions in the midterm and final exams. Further item analysis done on the midterm found that 68% test items were knowledge level and the rest on comprehension level (32%). While 14% of the items in the final exam could be categorized as application (4%), analysis (4%), synthesis (4%) and evaluation (2%), a predominate percentage of test items were still on knowledge (64%) and comprehension (22%). Those items might not allow the deep cognitive-level processing induced during the scaffolded question-generation, as substantiated in King (1990) [9], to manifest its superior effects on learning. On the other hand, the non-significant result in students' performance in question-generation may be because with continuous practice with question-generation for more than two months, students learned from their own experience and the repetitive feedback given by instructors, which lead to no difference in the end.

Though ANCOVA found no differential effects in students' performance in question-generation, a look at the descriptive statistics directed attention to the immediate effects scaffolds had on the task. With guides provided at the 1st question-generation session, students in the scaffolded group performed much better (M = 8.46) than the other two groups (no scaffold, M = 4.93; delayed scaffolds, M = 3.88). In other words, the elevated performance in question-generation of the immediate scaffolded group at the first session, as compare to the no scaffolds and delayed scaffolds, pointed to its immediate effects.

One important implication that can be drawn from this is that instructors concerned about students' initial performance could consider the inclusion of scaffolds at the onset for immediate support. A word of warning, however, is in place.

The set of question stems used in the study was based on a compilation of the work of King (1990) and Tung (2005) [9, 12], followed by instructors' validity assessment, interested instructors as well as researchers are advised to re-assess its relevancy and applicability before including them into specific context. Finally, given the grade and age level of participants in this study and the applied context (science), future studies with other age groups and contents will be needed to warrant its generalizability.

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Statistical Learning-based Approach for Automatic Generation System of Multiple-choice Cloze Questions

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Abstract: In this paper, we propose an automatic generation system of multiple-choice cloze questions from English texts. Empirical knowledge is necessary to produce appropriate questions, so machine learning is introduced to acquire knowledge from existing questions. To generate the questions from texts automatically, the system (1) extracts appropriate sentences for questions from texts based on Preference Learning, (2) estimates a blank part based on Conditional Random Field, and (3) generates distracters based on statistical patterns of existing questions.

Keywords: automatic question generation, multiple-choice cloze question

1. Introduction

Since English expressions vary according to the genres, it is important for students to study questions that are generated from sentences of the target genre. Although various questions are prepared, it is still not enough to satisfy various genres which students want to learn. On the other hand, most of the existing questions have been produced by experts based on their heuristic knowledge. Therefore, it is difficult to define the generation knowledge of multiple-choice cloze questions for individual genres.

In this paper, we propose a system for the automatic generation of multiple-choice cloze questions from texts. For generating questions from texts, system 1) selects sentences that are appropriate to form questions, 2) determines blank part which is target knowledge to ask, and 3) generates distracters that characterize difficulties of questions. The generation knowledge for each generation stage can be observed by the existing questions. Therefore, in our approach, characteristics of existing questions for each generation stage are extracted based on statistical learning. Then, by applying extracted characteristics to the inputted text, the system selects the sentence, determines words for blank part, and selects words from various dictionaries as distracters.

2. Approach

Various automatic generation systems of multiple-choice cloze questions have been proposed [1] [2]. One of the problems of these researches is that systems do not validate whether given sentences are “appropriate” as multiple-choice cloze questions. In our approach, sentences that are similar to sentences in existing questions are extracted in an “appropriate” order as questions using Preference Learning. Preference Learning is a method for classifying samples by Preference calculated according to similarity among samples. Existing questions are defined as positive samples, and words and Part-of-speech (POS) tags of existing sentences are learned. Based on the approach, sentences whose words and grammatical patterns are similar to the existing questions are selected as appropriate sentences.

An appropriate blank part of each sentence depends on the structure of this sentence. In our approach, the system estimates a blank part using Conditional Random Field (CRF). CRF is a framework for building discriminative probabilistic models to segment and label sequence data [3]. From existing questions, sequences of words and POS tags, and position of blank parts in the sequence are learned based on CRF. According to this approach, various word classes are determined as the blank part.

Generating distracters is also an important issue in the automatic generation of multiple-choice cloze questions. Relations between a correct choice and its distracters in existing questions have been investigated statistically and methods for generating each type of distracters are defined. The methods include searching appropriate types of words from WordNet or a lexicon of conjugations of verb. The candidates of distracters and their adjacent words are searched through the web for the purpose of finding inappropriate candidates that can form a correct sentence. Based on the search results, the candidates that are often seen in the documents on the web are eliminated.

3. Prototype System

Figure 1 and Figure 2 are the interface of our system[6]. The system is constructed as a web-based system, which is implemented by PHP and AJAX. Currently, learning data are 1560 questions from TOEIC workbooks. Therefore, questions that have similar characteristics to TOEIC questions are generated.

The user inserts the text from which he/she wants to generate questions in the entire text area in Figure 1. After pushing the generation button, the system automatically generates questions and displays list of questions as shown in Figure 2. The questions are ordered by the appropriateness of the sentences, namely the question appearing at the top is generated from the most appropriate sentence.

Figure 9. The interface of the system

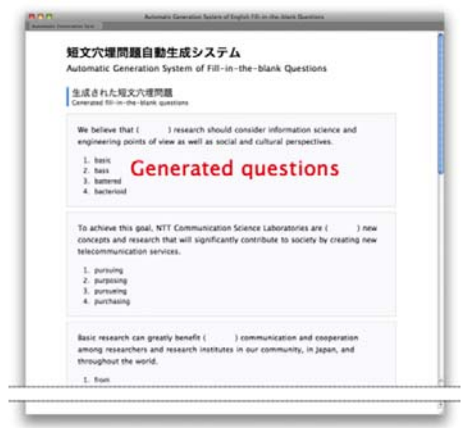

Figure 10. A screenshot on generated questions

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An Implementation of Learning Environment for Problem-Changing Exercise

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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 the problems. As an implementation 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. In this paper, we introduce the implemented learning environment.

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

Introduction

An implementation of interactive environment for learning by problem-changing has been described in this paper. Several researchers have already suggested that problem-changing exercise where a learner is required to pose a new problem by changing the provided problem is a promising method to promote them to be aware of the difference between the problems and characteristics of themselves [1, 2]. However, because there are usually several ways to change the original problem, it is often very difficult to give effective feedback for the problem-changing. In order to make "problem-changing exercise" as more common and useful learning method, we have investigated interactive learning environment with a function of automatic assessment of learner's problem changes [3]. In this environment, the learner poses new problems by changing given problems. After the problem-posing, the learner is required to compare the new problems with the given problems or the solutions of the problems. Through an experimental use of the environment, we have confirmed that this exercise is a promising method to support a learner to understand the relations between problems.

2. Implementation of Learning Environment for Problem-Changing Exercise

Figure 1 shows the interface of learning environment for problem-changing exercise. At first, a learner is given a problem and is required to solve it. The problem is described by configuration of physical objects and their attributes. The next task of the learner is, then, to make a new problem from the original problem by changing the configuration or attributes. After that, the learner is required to solve the new problem. The system shows both of the problems and their solution methods, like shown in Figure 1. The learner is promoted to compare them and reflect the problem-change and the differences in the two problems and their solutions.

Figure 2 shows examples of problem-changing operations in this environment. In the original problems shown in Figure 1, there is no outer force on the block without gravity. In Figure 2(a), "outer force" is selected from the list of physical parts and put on the right side of the block with drag&drop operation. This means that the block is received the outer force in the new problem. A part in the physical configuration can be deleted by dragging it in the picture and dropping it on the garbage. In Figure 2(b), an outer force is deleted in the physical configuration. By clicking the right button of the mouse on an object, a list of attributes that the learner can set on the object is shown. In Figure 2(c), the learner chose friction as an attribute to change. The learner is allowed to change the attribute value in the small window. In this case, the value is zero in the original problem. By changing the new problem again, the learner continuously carries out the problem-changing exercise.

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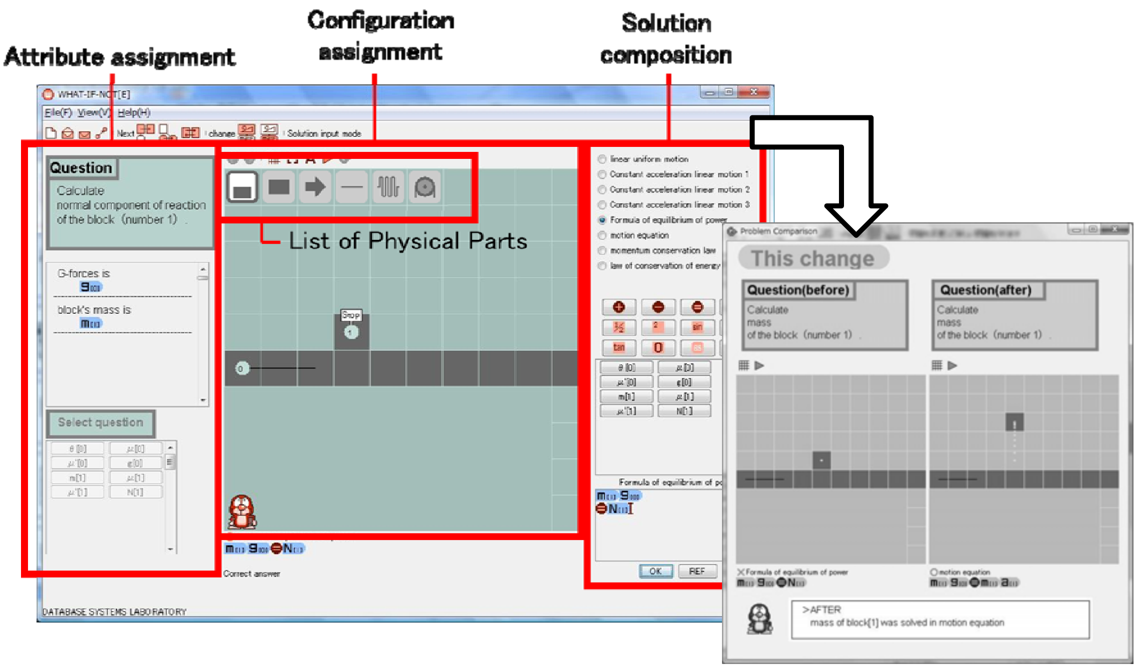
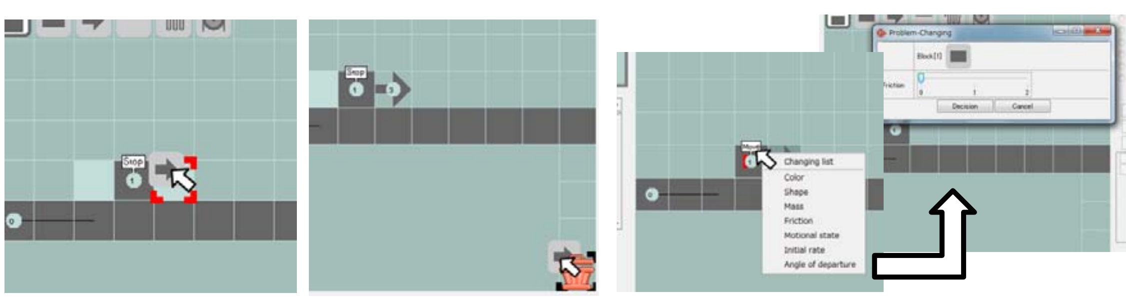


Figure 1. Interface of Learning Environment of Problem-Changing Exercise.



(a) Addition of Physical Component. **(b) Deletion of Physical** **(c) Change of Attribute Value.**

Figure 2. Operations of Problem-Changing.

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An Implementation of Interactive Environment for Learning by Question-Posing

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Abstract. In this paper, we describe an implementation of 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. We have also implemented authoring module of the question-posing exercises.
.

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

1. Introduction

Several investigations have already suggested that question-posing is one of the promising learning as well as problem-solving activities. In learning by question-posing, assessment and feedback for the questions & answers posed by learners are important issues. We have investigated the function of automatic assessment of questions & answers posed by learners in technology-enhanced learning [1]. In this paper, we will introduce an implementation of interactive learning environment for learning by question-posing composed of learning module and authoring module.

2. Module for Learning by 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.

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. Here, the learner should generate the correct question as: '*what has many kinds of interesting animals?'*

3. Authoring Module

If 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. As for clue words, authors can select adequate ones from the list of nouns derived from the original sentences.

In Figure 3, 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.

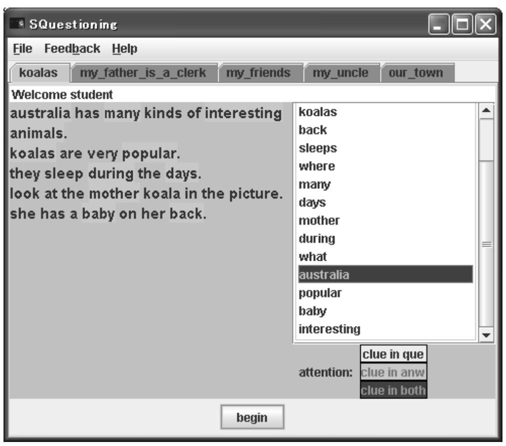

Figure 1. Selection of a clue word.

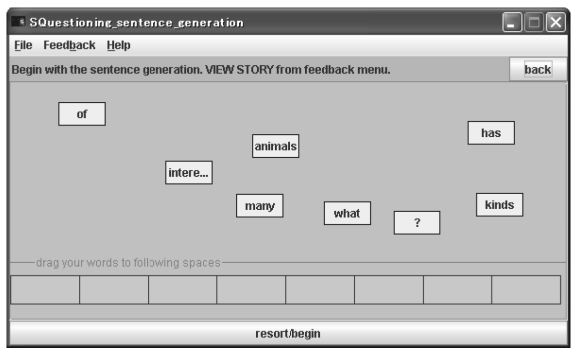

Figure 2. Words as components of a sentence.

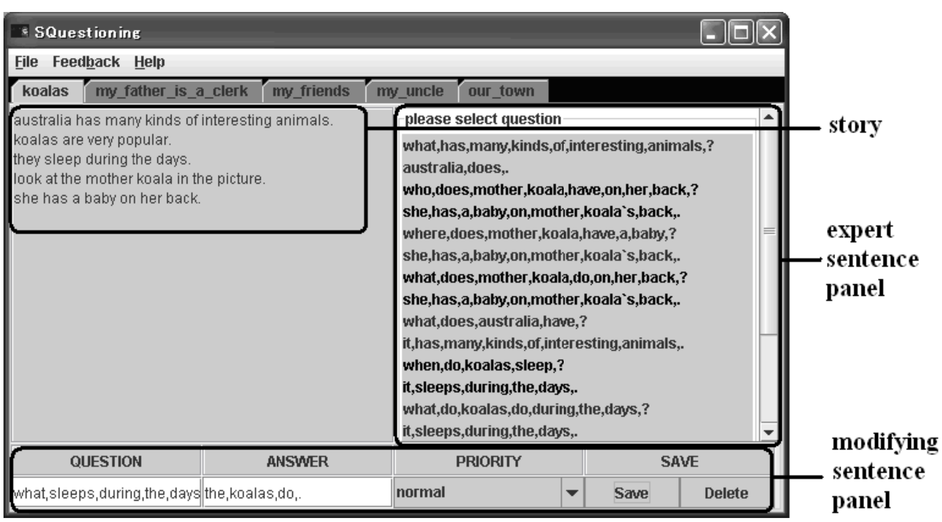

Figure 3. Sentences Modification Function.

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Workshop

International Workshop on Models, Methods, and Technologies for Learning with Web Resources

Workshop organizers

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Shinobu Hasegawa, Japan Institute of Science and Technology, Japan
Hiroyuki Mitsuhara, University of Tokushima, Japan
Peter Brusilovsky, University of Pittsburgh, USA

Program committees

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Preface

The emergence of the Web has brought about a lot of opportunities to learn with huge number of Web resources, and has led to development of new learning environments. Also Web resources useful for learning or education have been increasing. Such Web resources have a potential for giving learners wider, deeper, and better knowledge more than conventional learning/educational environments. On the other hand, most of the resources do not provide learners with well-structured contents although there exist some resources like Wikipedia that provides semi-structured contents. In order to properly learn these resources, the learners are required to navigate and restructure the contents of the resources. However, it is not so easy for them to accomplish such navigational learning. In order to resolve it, we need to create cognitive models, methods, or technologies for promoting learning with ill or semi-structured Web resources, which is one of essential and challenging issues in the area of ICCE.

This aim of this workshop is to share views of learning with the Web resources to discuss learning technologies useful for promoting it. We accepted 5 papers for this workshop. These papers will be helpful for sharing the latest knowledge in the theme of this workshop, “Learning with Web Resources”, and draw the future directions.

Beutelspacher, et al., in their paper, present the current situation of blended learning at German universities by the example of the Heinrich-Heine-University Duesseldorf. Kawasaki and Kashihara, in their paper, propose self-directed reconstruction of learning scenario as a promising solution to the issue of the knowledge unstableness in self-directed navigational learning. Li and Hasegawa, in their paper, propose a multi-layer map model which provides learners with the structure of resources explicitly and to share the suitable resources via map representations. Hosoi, et al., in their paper, describe fundamental support functions and a reflection support function for effective report writing. Ota and Kashihara, in their paper, propose a collective knowledge mining method that can extract these useful pages and links from learning histories gathered from the group of learners.

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Blended Learning in Academic Teaching Present State and Opportunities at the Heinrich-Heine-University Duesseldorf

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Abstract: Blended learning is increasingly becoming an important topic in Germany. For this reason, we present the current situation at German universities by the example of the Heinrich-Heine-University Duesseldorf. In this study we show different ways to provide blended learning platforms and their advantages and disadvantages. By closer examination of the given projects and inquiries of their administration, we have found many innovative approaches and we give future prospects of the possibilities of those blended learning approaches.

Keywords: Blended Learning, University, Germany, Collaborative Learning, Web 2.0

Introduction

"With the emergence of Internet technologies, there has been an explosion of non-traditional learning opportunities during the past few years" [10]. The further development and simplification of these new technologies force universities to offer more innovative and elaborated blended learning methods while simultaneously giving them a chance to do so. In the following study we look at the current state of blended learning at German universities by the example of the Heinrich-Heine-University Duesseldorf (HHU). For a common base the necessary concepts are defined first and then an overview of the available tools is given. Then we present selected examples, by which we show the different methods, possibilities and requirements of blended learning platforms.

1. PresentState and Definition of Terms

In the following segment we take a closer look at our definition of blended learning and the most common tools.

1.1 Blended Learning

A pure eLearning approach has not been adopted sufficiently at German universities. [11] suspect the reasons for this is in the lack of acceptance of both learners and teachers. Also the high financial and human effort and the fact that some learning contents are not suitable for eLearning could be reasons.

Because of those reasons the trend at schools and universities changes to "blended learning". Blended or hybrid learning is based on the mixing of eLearning and traditional classroom learning [4].

Blended learning is often defined differently. To avoid confusion and misunderstanding we define blended learning in this paper as follows:

- The online course must not stand alone. The online courses need to reference to a classroom course.
- Some kind of multimedia must be involved (videos, pictures, animations).

- There must be an interaction between the student and the online course.

1.2 Current State at German Universities

There are a lot of programs who support the use of blended learning systems in higher education institutions. In Germany we find many ways to implement blended learning projects [3]. A substantial amount of blended learning projects at German universities arose in the 1990s. Because of the spread of computers and the internet, the start-up from many advancement training programs took this development [9].

The use of new media in university life will be a quality assurance or, ideally, increase the quality of teaching. Since the introduction of Bachelor and Master Courses in Germany, the learner has a more rigid schedule. Through the use of blended learning, students will be able to take parts of their learning stuff outside of the classroom. The student can access his or her own courses from any location at any time [15].

2. Blended Learning Tools

For our further work, it is important to identify the different methods of blended learning used at the HHU. In this section we explain the possibilities of the methods. We can identify two different groups of blended learning: Self-paced learning and collaborative learning [2].

2.1 Self-paced Learning Tools

In self-paced learning scenarios the student learns independently and without communication with other students or the teacher. At the HHU the following self-paced learning methods are used:

- Lecture recordings
- Online tests
- Video glossaries
- Problem-based learning courses

Lecture recordings allow the students to watch (missed) lectures whenever they want. In addition, more complex content can be repeated, for example to prepare for an exam. It is a cost and time efficient way of online learning [13]. With online tests, the knowledge of the students will be intensified, in addition to the identification of knowledge gaps and problems. These tests can be realized either as multiple choice, gap text, or free-text questions. It is important that the students receive feedback after the test and are able to see their progress [14]. To deepen the knowledge, video glossaries can be used. Those glossaries show selected topics with animations or filmed scenes. After students have acquired these basics, they must also be able to apply this in a problem-oriented way. Here it is important to find concrete and realistic examples.

2.2 Collaborative Learning Tools

Collaborative learning allows the student to exchange with fellow learners or teachers. At the HHU the following collaborative learning methods are used:

- Online forums
- Weblogs

- Wikis
- Social networks
- Social bookmarking

Most of those collaborative learning scenarios are based on Web 2.0 services. In online forums the students can discuss about the content taught in class and ask questions. Each participant can answer the questions. The complete discussion can be viewed at any time from any place. The public inquiry can be compared to a question in the classroom [14]. It is also conceivable that the students create their own tasks that need to be solved by their fellow students. Blogs are often used as diaries for the private sector, but also gain importance in eLearning. Blogs, which are used for teaching and learning, are called Edublogs [1]. Edublogs are suitable for presenting points of view or research progress and results [12]. The comment feature allows all participants to discuss on blog content. Wikis can especially be used for collaborative content creation. There is room for discussion and anyone can to link and embed a variety of sources [16]. With social networking services (e.g. Facebook) students have the opportunity to create a network of friends and fellow students. It can be used as a platform for problems or ideas. Moreover, such a network is useful for course marketing. Social bookmarking services are applications where students can store bookmarks. These bookmarks can be tagged, which will help other students to search for relevant documents. This is particularly important in the preparation of homework and exams.

3. Study at the HHU Duesseldorf

In the following segment we will introduce our study at the HHU by showing our approach and list the most significant examples.

3.1 Heinrich-Heine-University Duesseldorf (HHU)

As we are going to have a closer look at the HHU Duesseldorf, a brief introduction of the institution should be presented at this point.

Initially the university was founded as the Medical Academy Duesseldorf in the year 1907. Its tasks were the training of medical interns, training in specialized subjects, educational courses, and the promotion of practical medicine. The academy had no rector constitution and could not train students, however this changed in the year 1935 as the academy received the right to award doctorates. The name Heinrich-Heine-University was given to it as recently as 1988, after 23 years of dispute over its' name, by the Senate [5]. Today it consists of five faculties: The faculty of arts, mathematics and natural sciences, the medical faculty, the faculty of economics, and the faculty of law. During the summer term of 2010 15,482 students attended the university. 5,570 of these attended the Faculty of Arts, 4,909 Mathematics and Natural Sciences, 2,719 the Medical Faculty, 1,289 the Faculty of Law and 819 the Faculty of Economics [6]. In 2008, 2,294 people worked at the HHU, 1,475 of those were scientific staff [8].

3.2 HeinEcomp

A project that should be mentioned, as it plays a vital role in eLearning and blended learning at the HHU, is "HeinEcomp". It is a project to promote eLearning and eTeaching and it is funded by North Rhine-Westphalia's Ministry of Innovation, Science, Research and Technology (MIWFT)[7].Its goals are to intensify the use of eLearning and blended learning in academic teaching and to create the necessary basis for this, as well as the training of students and teachers and the development of learning platforms. To reach these goals HeinEcomp supports many eLearning projects per term financially and organizes a great number of eLearning-courses for teachers. Furthermore, they maintain monthly network-meetings for everyone interested in eLearning [6].

3.3 Method

For our study we screened the extensive offer of blended learning platforms of the HHU and picked out the most significant examples. These examples were examined in detail by using the systems and looking at the context they are applied in. In addition, we conducted interviews with the administration staff of the platforms, to get further information. This information ranged from user behavior or the size and maintenance of the system to the specific content. Overall, six employees from different platforms were interviewed in July 2010. The interviews were conducted mostly by e-mail. It is in the nature of non-standardized expert interviews that the results are mainly qualitative and do not include much quantitative data.

3.4 Significant Examples

After intensive screening we identified the following examples from the extensive offer of blended learning platforms of the HHU as the most significant ones.

3.4.1 English Morphosyntax goes Web 2.0

The project "English Morphosyntax goes Web 2.0" came up from the idea to provide as many as possible teaching materials for the students. Additional incentive for the implementation of the project was HeineComp, which finally supported the construction of the platform financially and with technical knowhow. The basis for the blended learning platform are the Web 2.0 services www.blogger.com (blog service), www.slideshare.net (presentation service), and www.zshare.net (video-hosting service). English Morphosyntax goes Web 2.0 was built in the fall semester of 2009 to 2010 and currently contains records of meetings, lectures and other course related material, such as presentations. In addition, students have the opportunity to post comments. Basically, the learning platform of the Department of English Language and Linguistics is freely accessible to everyone at the HHU and not just the students of the relevant subject area.

3.4.2 E-DaF

The next learning platform we look at is E-DaF. DaF (Deutsch alsFremdsprache = German as a foreign language) are courses that teach students German and trains teachers of German. The E-DaF is interesting for foreign students and German students as well. The tasks are divided into reading comprehension, grammar, listening comprehension, and text production. The tasks are marked with different colors that represent the difficulty of the assorted tasks and are supplemented with audio and video files. The platform was created by members of the university language center and can be used by everyone on the internet. The exercises are not only studied and discussed at home but also in the classroom.

3.4.3 InfoCenter

The platform InfoCenter was created by the staff of the department of Information Science and is open to every student of information science. Students from different areas of the department helped to build the courses. The goal was to unite as many different methods as possible to a suitable learning platform, so that every student could choose his favourite tool for working outside the class. Time and location-independent communication between the students is ensured through various collaborative services. First, there is a Facebook group where students can exchange information about current events or problems. Second, there is a wiki where information about important topics can be collected. In a blog, students can write about current research or experiences (for example internships). To facilitate the literature search, the social bookmarking service Bibsonomy is used. As on many other learning platforms the standard blended learning platform ILIAS (http://www.ilias.de) is used. Here, the students can check their knowledge with multiple-choice tests with immediate feedback.

A special feature of this learning platform is the interactive lecture videos. The filmed lecture is supplemented with additional information and an interactive table of contents. These functions are integrated into a Flash video and allow the students to look exactly at the topic that they are interested in. Furthermore, additional information such as full texts is available via links.

3.4.4 Toxicon

The blended learning platform Toxicon was built in order to fill the lack of knowledge networking within a newly established, interdisciplinary degree program, so that the understanding of the toxicology could be improved in the Masters Course. The platform is in use since June 2010 and is only accessible for students of HHU. The current version comprises a wiki, which includes images and texts. It serves as a knowledge store and also expands the content of teaching. An enlargement of the wiki to podcasts and videos is planned. Toxicon works with ILIAS.Internet-based teaching materials can be created and published. Next, there is the possibility to create virtual communication and cooperation between group systems. ILIAS also offers the opportunity to integrate test systems, such as online exams.

3.4.5 Casus

Casus is a standard blended learning platform used by 15 faculties around Germany. At the HHU it is used by the Medical Faculty to accompany and complement special courses. With over 1,200 case studies implemented, Casus follows the cognitive constructivist approach of eLearning to procure strategies to solving problems. The system is in regular use at the HHU since 2005 and contains at the moment 40 case studies in 10 different courses. Cases can be created by the lecturers of courses themselves, if they do not want to use an existing one. This takes about 20-40 hours per case. The administration of the whole system takes around 10-20 hours of additional work of data processing a week for the administrators. The system is capable of handling texts, hyperlinks, graphics, photos, videos, and seven types of question/answer-elements and only students can access those parts of the system they take courses in. The only way of communication is from the tutor to the students (via email to one or all of them) and in the form of a commentary function from students and tutors. No other collaborative elements are incorporated.

3.4.6 KreuzMich

Finally we will take a look at KreuzMich, a web-based blended learning platform of the Medical Faculty that has some special characteristics which distinct it from all of the other examples we chose for this study. First of all it is the only platform that is not maintained by the institute or the HHU, but by the students themselves. That means an alternating group of students was and is responsible for setting up the platform and feeding it with new information without getting any funding at all. Secondly it is the only platform that contains content from most of the courses of the institute, not only from some or one of them. This is owed to the fact that a great part of the exams, including the state examination, for earning your medical degree are in form of multiple choice tests. KreuzMich constantly collects relevant questions for all exams and offers the possibility to solve them online. The students, which have to be students of the Medical Faculty to use it, instantly get feedback whether they answer a question correctly or not and their total progress is recorded. This was the base for the system that has been around since the end of the 90s and has become a great success. According to the current administrators around 90% of the medical students at the HHU use it exclusively to learn for the exams. Since June 2008 there have been 7,8 Mil. answered questions in the system. During examination periods there are up to 100 answered questions per minute. Since it has become such a great success, the maintaining team started to expand the function volume of the platform by incorporating different social tools. For example the collaborative writing of more elaborated answers to questions as a kind of wiki-entry (including a history and a possibility to discuss it in form of comments) , the possibility of sharing links to questions with friends or doing the online exams in collaboration. From all the examples above KreuzMich is the most cared for platform we have seen, as the workforce working on it is not depending on funding, but on people having fun working on it and with it.

3.5 Interpretation and Discussion

Some of the platforms used are freely available, while others are only for the students of the respective disciplines. The blended learning offered at the HHU is very up to date and constantly evolving. The offers include conventional eLearning methods, such as multiple choice tests and collaborative services, wikis, blogs and social networks. Most of the offers use multimedia content. Most systems are maintained by a small number of administrators that are joined a growing number of teachers adding or adapting content for their courses. Almost all platforms support collaborative work of their users: Some by adding “traditional” Web 2.0 techniques, such as wikis or collaboratively editable blogs, others, such as KreuzMich, directly in the eLearning-platforms themselves. Thus, the amount of collaboratively generated content varies very much: From simple comments about the offered online lectures (e.g. Casus) across to the editing of one partial offer of a platform (e.g. the wiki in InfoCenter or Toxicon) to platforms that get all their additional information that way (e.g. KreuzMich).

Most offers are funded by institutions themselves or HeinEcomp, while others, such as KreuzMich get no funding at all, which is one reason, why some projects have to rely much more on user generated content than others.

Finally it can be said that platforms that are relevant to a large number of students and are especially used for tests preparation, are most successful. This becomes evident in KreuzMich.

4. Conclusion

The study has shown that there are good, innovative projects in blended learning, which give students the opportunity to learn independently and focused. During our study two possibilities to create blended learning platforms have emerged.

1. On the one hand there is the possibility to buy external solutions with already prepared content that can be adapted with relatively little effort to meet the requirements of the courses. The advantages of this method are the usability and the possibility of external support. Disadvantages are the high costs and the low flexibility in adapting to the needs of the different courses.
2. The second option is to build a new platform from scratch. The difficulty is to find appropriate methods and to combine them in a useful way. In addition, this method requires a great deal of time and money, as all content must be generated and structured. The clear advantage of this approach is the high degree of flexibility. The system and the content can be adjusted to the requirements and needs of the student.

Both approaches can produce good blended learning platforms. Here it is necessary to weigh the pros and cons. To keep the time and cost involved in content creation as low as possible, it is useful to include various Web 2.0 services. In this way, students can participate in content generation. This is especially useful if the platform can be accessed by a large number of students, as seen in KreuzMich.

Furthermore, it seems very important to improve the networking and communication between the administrators of the platforms. In this way, content and technology can be exchanged and thus enhance usability for a larger number of people. Thus, some of the interviews showed that already existing platforms could be used for other departments or faculties as well. An important step in this direction is the work of HeinEcomp.In summary, it can be said that German universities are on a good way, but they still need future development.

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Self-Directed Reconstruction of Learning Scenario forNavigational Learning

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Abstract: After navigational learning on the Web, learners often reach an unstable understanding of knowledge learned since it is difficult for them to properly recall and reproduce the process of how they have constructed their knowledge. Our approach to the knowledge unstableness is to encourage them to reconstruct their learning scenario in a self-directed way, which represents a sequence of constructing their knowledge. Such scenario reconstruction enables them to reflect on their knowledge construction process. This paper demonstrates an interactive learning scenario builder, iLSB for short, that helps learners reconstruct their own learning scenario. We also discuss the future direction.

Keywords: Learner-reconstructed Scenario, Self-directed Learning, Reflection, Hyperspace

Introduction

In recent years, Web resources fruitful for learning/education have increased, which bring about a lot of opportunities for learners to learn in a self-directed way [1]. Such self-directed learning requires them to search for resources that are suitable for their learning goal. It also involves navigating the Web pages to construct knowledge [2][3]. Such navigation with knowledge construction is called navigational learning.

The navigational learning process does not always follow the scenario the authors of the resources provide. The learners would often self-regulate their navigational learning process to construct their own learning scenario. On the other hand, the navigational learning process often results in an unstable understanding of knowledge constructed. In other words, learners cannot always reproduce their constructed knowledge after the navigational learning process, and cannot fully grasp relationships among pieces of the constructed knowledge. This gives evidence that the constructed knowledge is not stable. We call this issue knowledge unstableness. In order to resolve it, the learners are required to reflect on the knowledge construction process to stabilize the constructed knowledge [2].

This paper addresses the issue of knowledge unstableness occurring from self-directed learning in hyperspace provided by hypertext-based resources on the Web. One promising approach to this issue is to enable learners to reconstruct a learning scenario in a self-directed way, which represents a sequence of knowledge construction process carried out in hyperspace. Self-directed reconstruction of the learning scenario could activate reflection on their knowledge construction process in hyperspace [2].

However, it would be not so easy for the learners to reconstruct the learning scenario [4]. In this paper, we describe an interactive learning scenario builder, iLSB for short. iLSB assists learners in reconstructing a learning scenario from learning history generated with Interactive History (IH for short), which we have developed for scaffolding self-directed knowledge construction process in hyperspace [5]. iLSB automatically generates the learning scenario with the learning history, and then helps the learners edit it. In addition, iLSB presents information on the Web related to the learning scenario, which assists the learners in reinforcing the scenario with the related information. Such learning scenario reconstruction enables learners to stabilize their knowledge constructed from their self-directed learning in hyperspace.

1. Learning Scenario Reconstruction

1.1 Navigational Learning in Hyperspace

Before discussing the learning scenario reconstruction, let us first consider self-directed learning process in hyperspace.

Hypertext-based resources on the Web generally provide learners with hyperspace where they can navigate the Web pages in a self-directed way. The self-directed navigation involves constructing knowledge for achieving a learning goal, in which the learners would make semantic relationships among the contents learned at the navigated pages [4][6]. They could also carry out the knowledge construction process in an individual way, in which the constructed knowledge could be individualized. Such navigation with knowledge construction is called navigational learning.

Self-directed navigational learning process, on the other hand, often finishes with incomplete knowledge [7]. It is also hard for learners to become aware of the knowledge incompleteness, which we have addressed in our previous work [8][9]. Even if they constructed their own knowledge from hyperspace, in addition, understanding of the constructed knowledge tends to be unstable. In other words, the learners could not always reproduce the constructed knowledge, and also could not fully grasp relationships among pieces of the constructed knowledge. How to resolve the knowledge unstableness is the main issue addressed in this paper.

1.2 Learner-Reconstructed Learning Scenario

Self-directed navigational learning with hypertext-based resources does not always follow the scenario the authors provide [4]. Learners would construct a learning scenario as they navigate and construct their own knowledge in the hyperspace. The learning scenario represents the sequence of learning in hyperspace for achieving the learning goal. In this work, we focus on the learner-constructed scenario. When learners learn in hyperspace, they always browse the pages in a linear order to implicitly construct their learning scenario and their knowledge. Their knowledge would result in a structural form not in a linear form. In order to review or reuse the knowledge constructed after the learning process, it is necessary for the learners to recall the learner-constructed scenario for reproducing their knowledge structure since the scenario includes the context of how they have constructed their knowledge. However it is not so easy for them to recall it only from their knowledge structure. That is the main reason why they could not reproduce the constructed knowledge and why the constructed knowledge could be unstable.

One promising approach to resolving the knowledge unstableness is to encourage learners to reconstruct the learner-constructed scenario from the constructed knowledge. Such learning scenario reconstruction involves sequencing the constructed knowledge, which represents the knowledge construction process carried out in hyperspace. Such sequencing allows the learners to reconsider and raise awareness of the relationships among pieces of the constructed knowledge and to have a clear overview of it, which would activate their reflection on the knowledge construction process. Such reflection is useful for them to stabilize understanding of the constructed knowledge. The learner-reconstructed learning scenario could be also useful for the learners to reproduce and review their knowledge after self-directed learning.

However, it is difficult for learners to recall the knowledge construction process by taking a look at the constructed knowledge as learning results and to sequence their constructed knowledge. We have accordingly developed iLSB that helps learners reconstruct their own learning scenario.

2. Framework for learning scenario reconstruction

2.1 Learning phases

Let us here explain the framework for iLSB.iLSB assumes a model of self-directed learning as shown in Figure 1, which consists of the following two phases: knowledge construction in hyperspace, and learning scenario reconstruction.

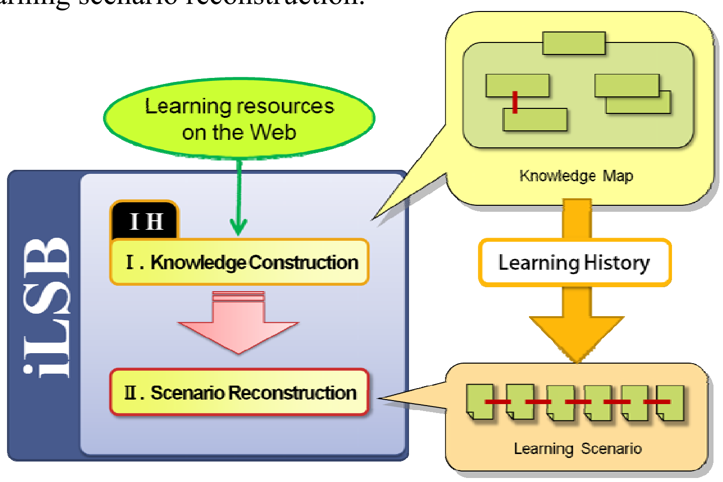


Figure 1. Framework of Learning in iLSB

Learners can have fruitful opportunities to reflect on their knowledge in the process of the learning scenario reconstruction phase, which contribute to the knowledge stabilization.
In the following, let us explain each phase in iLSB.

2.2 Knowledge Construction Phase

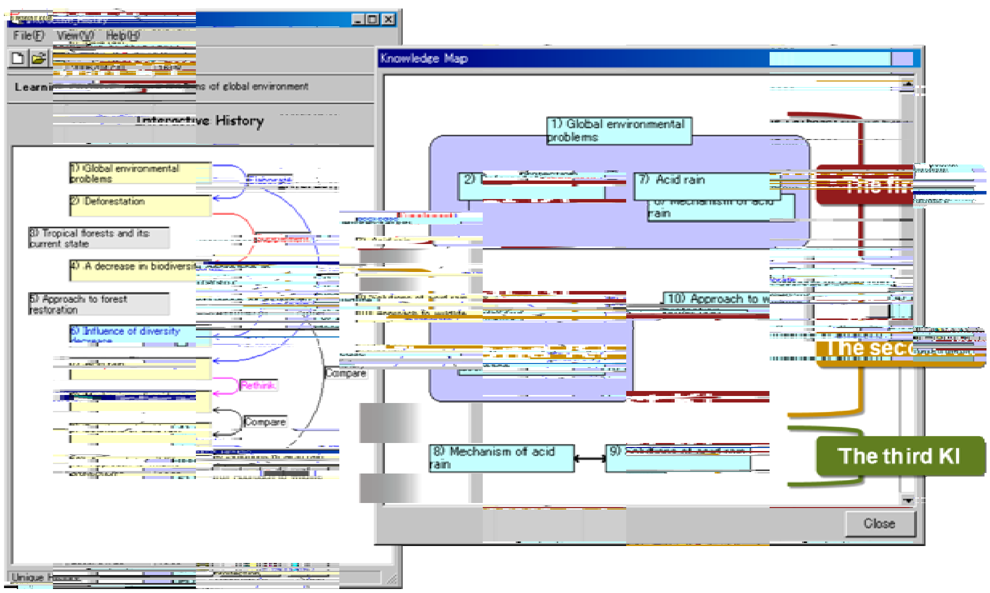
In navigational learning process, learners generally start navigating the pages for achieving a learning goal. The movement between the various pages is often driven by a local goal called navigation goal to search for the page that fulfills it. Such navigation goal is also regarded as a sub goal of the learning goal. The navigational learning process includes producing and achieving a number of navigation goals.

We currently classify navigation goals into six: Supplement, Elaborate, Compare, Justify, Rethink, and Apply. For instance, a learner may search for the meaning of an unknown term to supplement what he/she has learned at the current page or look for elaboration of the description given at the current page. We refer to the process of fulfilling a navigation goal as primary navigation process. This is represented as a link from the starting page where the navigation goal arises to the terminal page where it is fulfilled. Navigation goal signifies how to develop or improve the domain knowledge learned at the starting page.

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

In order to scaffold such knowledge construction process, we have developed IH. In the knowledge construction phase, learners are expected to learn hypertext-based resources with IH [5]. As shown in Figure 2, IH enables them to annotate a navigation history, which includes the pages sequenced in order of time they have visited, with primary navigation processes carried out. Figure 2(a) shows an example of annotated navigation history. IH monitors learners' navigation in the Web browser to generate the navigation history in the annotated navigation history window. Each node corresponds to the page visited. The learners can annotate the navigation history with the primary navigation processes that they have carried out. They can also take a note about the contents learned at the starting or terminal pages, which could be copied and pasted from the corresponding portions of the pages. The note is linked to the node in the annotated navigation history.

When the annotated navigation history includes more primary navigation processes, the learners have more difficulty in understanding the semantic relationships among the pages included in these primary navigation processes and in constructing their knowledge. When the primary navigation processes are overlapped each other, in particular, it is hard to understand the relationships among the pages included. In order to reduce such difficulty, IH second generates a knowledge map by transforming primary navigation processes into visual representation. (See [5] for detailed generation mechanism.)



(a) Annotated Navigation History (b) Knowledge Map

Figure 2. User Interface of IH

Figure 2(b) shows an example of knowledge map. The knowledge map is generated from the annotated navigation history shown in Figure 2(a), which is obtained from the learning goal of learning problems of global environment. Viewing this map, for example, the learner can visually understand that he/she elaborated the contents of Global environmental problems by referring to Deforestation and Acid rain, and so on. The knowledge map generally consists of several islands including some primary navigation processes. We call them Knowledge Islands (KIs). The knowledge map shown in Figure 2(b) consists of three KIs.

Although IH enables the learners to reflect on what and how they have constructed so far in hyperspace, it is still hard for them to reproduce the constructed knowledge with IH after the navigational learning process.

2.3 Learning Scenario Reconstruction phase

Figure 3 shows the user interface of iLSB, which consists of scenario editor, page viewer, and note editor.

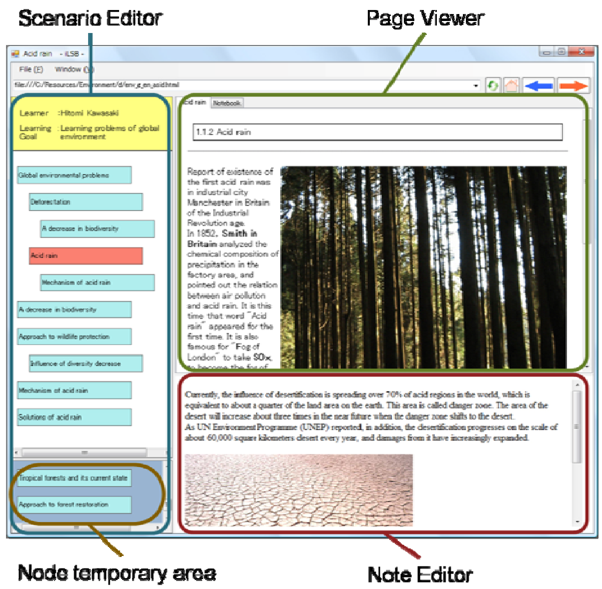


Figure 3. User Interface of iLSB

In the learning scenario reconstruction phase, the learners are expected to reconstruct the learning scenario by themselves. However, it is not so easy for them to execute the scenario reconstruction from scratch. In this phase, iLSB first automatically generates a sequence of the nodes included in the knowledge map as shown in the scenario editor in Figure 3, which represents a learning scenario. Referring to and reconfirming the contents of any node in the scenario with the page viewer and the note they have taken with IH by means of the note editor, the learners can alter the sequence of the nodes and change the titles to edit the scenario. Moreover the learners can remove the node from scenario editor as needed. Such removed nodes are stored in the node temporary area below the scenario editor, which can be restored. They can also edit the notes corresponding to the nodes. Such edit operations would activate their reflection particularly on the relationships among the nodes that are viewed as the components of their knowledge. Reconstructing the learning scenario, in this way, the learners can reflect on their navigational learning process and constructed knowledge.

The notes corresponding to the nodes are automatically sequenced according to the learning scenario as a notebook, which can be viewed in the page viewer. The notebook contains the titles and contents of the nodes. Each title in the notebook is given a caption number according to the hierarchical level of the corresponding node. Reconstructing the learning scenario with such notebook, the learners can recall their knowledge construction process and knowledge itself more easily.

Following these phases, learners would be able to recall/reconstruct the order of their self-directed navigational learning process and the relationships among pieces of knowledge learned, and resolve the issue of knowledge unstableness. They could be accordingly expected not only to stabilize their understanding of their knowledge constructed, but also to refine their knowledge, which is indicated by the knowledge map in IH, in accordance with refinement of the learning scenario. Such knowledge refinement would result in reinforcing relationships among their knowledge components.

2.4 Automatic Generation

Let us here demonstrate iLSB with an example.The learning scenario is first automatically generated from the knowledge map as follows. The sequence of the nodes is created according to each KI included in the knowledge map. Each primary navigation process in the KI is also sequenced according to the navigation goal as shown in Figure 4.

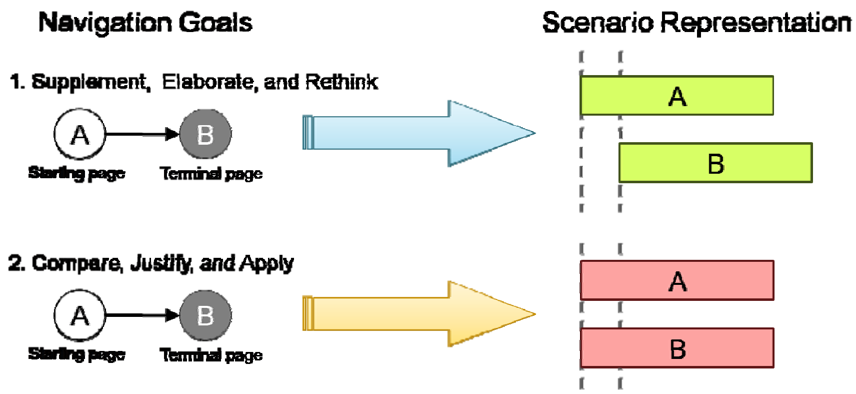


Figure 4. Scenario Representation for Primary Navigation Processes

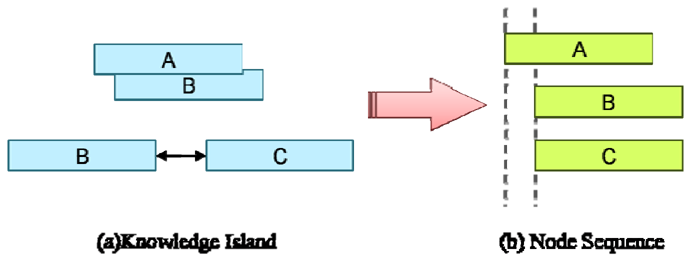


Figure 5. Automatic Sequencing of Nodes

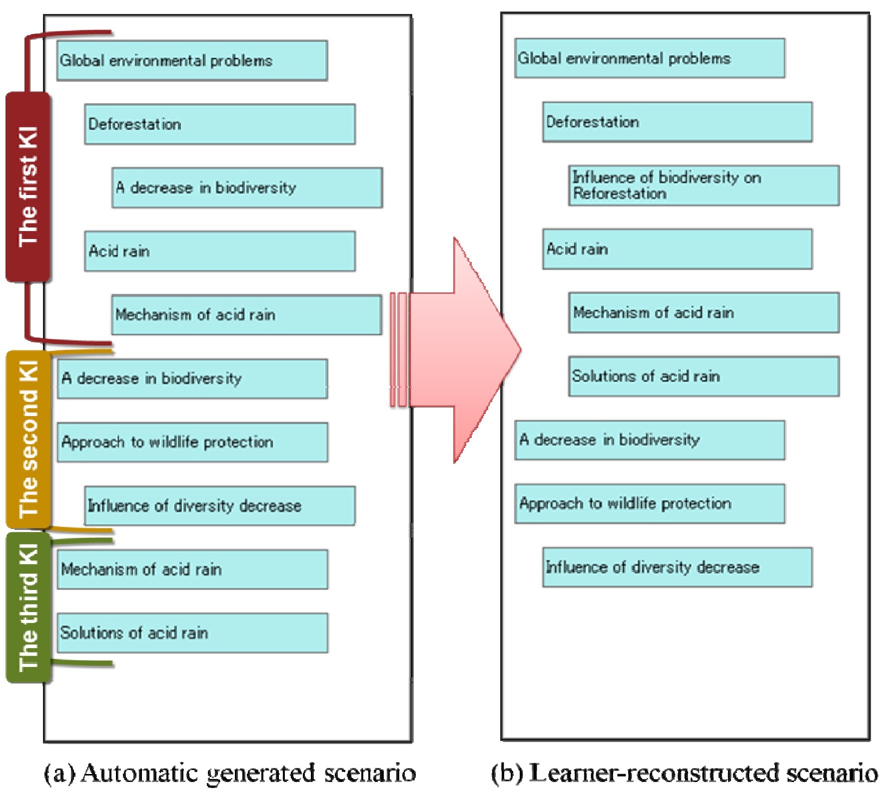


Figure 6. Learning Scenario Reconstruction

For example, the KI shown in Figure 5(a) consists of two primary navigation processes whose navigation goals are Rethink and Compare. In this case, iLSB generates the sequence of nodes as shown in Figure 5 (b).

Figure 6(a) shows the learning scenario automatically generated from the knowledge map shown in Figure 2(b), which is represented as the sequential and hierarchical relationships between nodes. The sequence of the nodes is created from three KIs in the knowledge map. The sequence of the first five nodes from the node of Global environmental problems to the node of Mechanism of acid rain is created from the first KI in the map. The sequence of the second three nodes from the node of A decrease in biodiversity to the node of Influence of diversity is also created from the second KI in the map. The sequence of the last two nodes is created from the third KI.

Each node in the scenario has a link to the corresponding page, which can be viewed in the page viewer. It also has a link to the corresponding note taken in the knowledge construction phase since the note is important for the learner to recall the contents learned.

2.5 Scenario Reconstruction

The automatic generated scenario is next reconstructed by learners. iLSB allows the learners to alter the sequence of the nodes, to change the titles and to remove the nodes. Dragging any node in the sequence, the learners can move and drop it at any place and any hierarchical level (four levels at the maximum) in the sequence. The hierarchical level allows the learners to represent their scenario contexts in a simple way. As explained in 2.3, the learner can also edit the notes/notebook with reconstructing.

Figure 6(b) shows the learning scenario reconstructed from Figure 6(a). In this case, the learner places the final node of Solution of acid rain next to the node of Mechanism of acid rain that is below the node of Acid rain. Following this operation, he/she also deletes the second to the last node, which is Mechanism of acid rain. In addition, he/she changes the title of the third node A decrease in biodiversity into Influence of biodiversity on Deforestation. The node of A decrease in biodiversity appears twice in the automatic generated scenario. This means it has been learned in the two different contexts. In this example, the third node has been learned as the influence of biodiversity on deforestation.

The scenario reconstruction, in this way, allows the learner to make the sequence of the nodes much better than the one before editing. Such edit operations would activate their reflection particularly on the relationships among the nodes that are viewed as the components of their knowledge. iLSB also allow them to save and reproduce the reconstructed learning scenario for afterward recalling the knowledge construction process.

2.6 Future Direction

Let us here discuss the future direction of iLSB. We will particularly focus on improving the functionality of iLSB. We have already conducted a case study with iLSB. The results suggest that learner-reconstructed learning scenario is so effective for reflection on knowledge constructed in hyperspace. But, we found that the learner-reconstructed learning scenario iniLSB was not sufficient for representing the sequence of the knowledge construction process.In particular, the learning scenario could not currently represent the semantic relationships among the nodes and the contents learned in each node.

In order for learners to understand the learning scenario generated with iLSB to reproduce their knowledge, it needs to represent the following four elements at least: (1) the sequence of nodes, (2) node segments, (3) contents learned in the nodes, and (4) semantic relationships among the nodes. As described in 2.3 the learning scenario generated with iLSB has a sequence of nodes, each of which has its own title. The node sequence is also segmented with hierarchical relationships between nodes, which is indicated by means of indent. The learners could understand the sequence and segments of knowledge construction process from the node sequence. As for the contents learned in the nodes, on the other hand, the learners could use the node titles as cues to reflect on the contents learned. However, they would often have difficulties in the reflection process. Furthermore, the hierarchical relationships between nodes do not indicate the semantics. The learners would accordingly need to reflect on how they combined the contents learned among the nodes.

In order to resolve these problems, we plan to refine the functionality of iLSB. We will first attach some keywords, which are included in the Web pages corresponding to the contents learned, to the nodes. These keywords could help them reflect on the contents learned. Second, we will use navigational goals generated with IH to represent the semantic relationships among the nodes in the learning scenario. Such semantic relationships could allow them to reflect on their knowledge construction process. These two functions would contribute to the knowledge stabilization.

3. Conclusion

This paper has proposed self-directed reconstruction of learning scenario as a promising solution to the issue of the knowledge unstableness in self-directed navigational learning. The scenario reconstruction involves sequencing the knowledge construction process in hyperspace, which could activate learners' reflection on their constructed knowledge. Such reflection contributes to stabilizing the constructed knowledge.

This paper has also demonstrated an interactive learning scenario builder, iLSB for short, which enables learners to reconstruct a learning scenario with automatic scenario generation. iLSB accordingly allows them to stabilize their knowledge with less cognitive efforts. In future, we will ascertain whether the learning scenario generated with iLSB contributes to reproducing knowledge constructed, and will refine iLSB according to the results.

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Multi-layer Map-oriented Learning Environment for Self-directed/ Community-based Learning

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Abstract: The main topic addressed in this paper is how to combine self-directed learning and community-based learning using Web-based learning resources. In this paper, we proposed a multi-layer map model which provides learners with the structure of resources explicitly and to share the suitable resources via map representations. We also describe a learning environment, based on the model proposed and Topic Maps standard, enables not only individual learners can easily organize related learning resources as personal topic maps but also they can share the community topic map which merges the personal topic maps created by community members.
Keywords: Web-based Learning, Topic Maps, Self-directed Learning, Community-based Learning

Introduction

There is currently enormous number of information serving as learning resources on the Web. Therefore, it has become possible to overcome the restrictions of time and place for self-directed learning. Such learning has been demonstrated to enhance the learning process [8], but often requires learners not only to navigate Web pages to construct their knowledge but also to control the navigation and knowledge construction processes [5]. As a result, Web-based self-directed learning has become an important research issues in the recent decade. On the other hand, community-based learning also attracts much attention along with the fast development of the Web technology, in which learners have informal community-centered communications [2]. However, it is difficult for the learners to get feedback to their learning process from community-based learning without suitable communication platform. In order to solve this problem, we propose a multi-layer map-oriented learning environment based on Topic Maps which relates the actual Web contents to semantic structure. The key ideas of our approach are: (1) the learners make their personal topic maps by conducting self-directed learning; (2) they make communications through the maps collected from community members as community-based learning. In this paper, we describe the design of the learning environment which constitutes multi-layer maps and combines self-directed and community-based learning seamlessly.

1. Issue Addressed

1.1 Self-directed Learning

On the Web, learners can navigate a vast amount of Web-based learningresources to achieve their learning goals. Such resources usually provide them with hyperspace so that they can navigate in a self-directed way by following links among the pages as shown in Figure 1. Especially, it is expected to encourage their information literacy by selecting suitable resources, each of which usually has different credibility and standpoint about the similar topic.

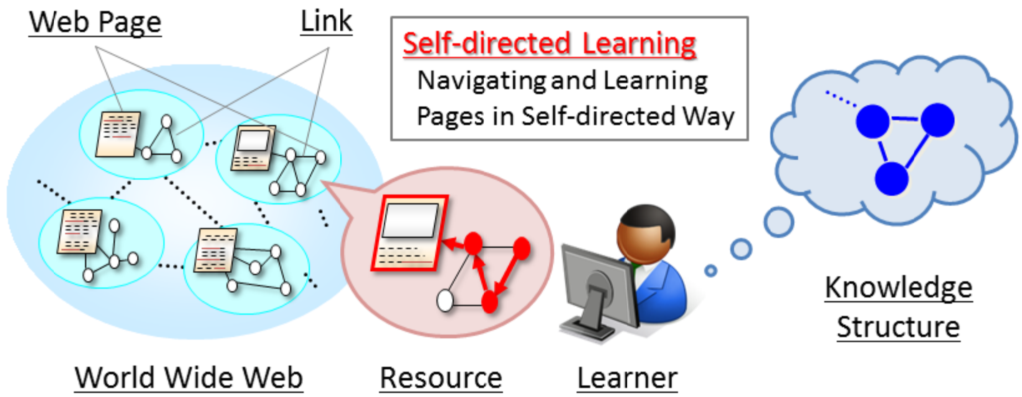

Figure 1 Self-directed Learning

1.2 Community-based Learning

In this paper, community-based learning means a process of communication by the community members with the similar learning goals for the purpose of encouraging each self-directed learning activity. Such process involves not only sharing resources but also performing peer-review for knowledge learnt. Ordinarily, it is not so easy for self-directed learners to get adequate supports since their learning resources and processes are varied from learner to learner. However, community-based learning makes it possible to conduct informal communication as feedbacks for the individual self-directed learning processes.

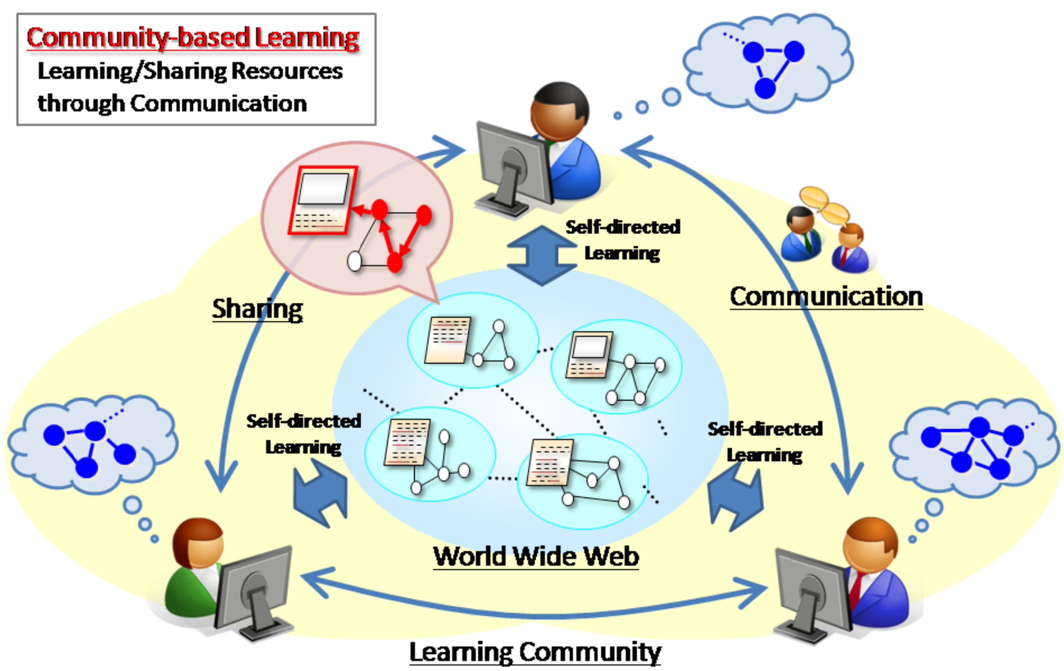

Figure 2 Community-based Learning

1.3 Difficulties in Self-directed and Community-based Learning.

First of all, the large amount of available information on the Web makes it very difficult for learners to locate suitable resources about particular topics of interest. Traditional search engines only order list of pages ranked according to a particular matching algorithm. The learners therefore often have to click into certain Web pages to find out whether they are fit or not to achieve their learning goals, and may miss the chance of learning after two or three useless clicks since it could be a time-consuming job as previous step of self-directed learning. If the learners finally successfully locate sufficient learning resources from several URLs as learning hyperspace; moreover, they have to organize these resources and to construct their knowledge structures by navigating the hyperspace. Beginners at self-directed learning sometimes lose sight of their learning goal because of the complexity of the hyperspace. Such navigation problems are major issues, and have been discussed regarding the developments of educational hypermedia/hypertext system [1]. From an aspect of community-based learning, it is difficult to pass learning achievements and get feedbacks with each member of community who has the similar interests about the certain topics.

2. Approach

2.1 Topic Maps

Topic maps are a new ISO standard for describing knowledge structures and associating them with information resources [4]. While it is possible to represent immensely complex structures using topic maps, the basic concepts of the model—Topics, Associations, and Occurrences (TAO)—are easily grasped[7].

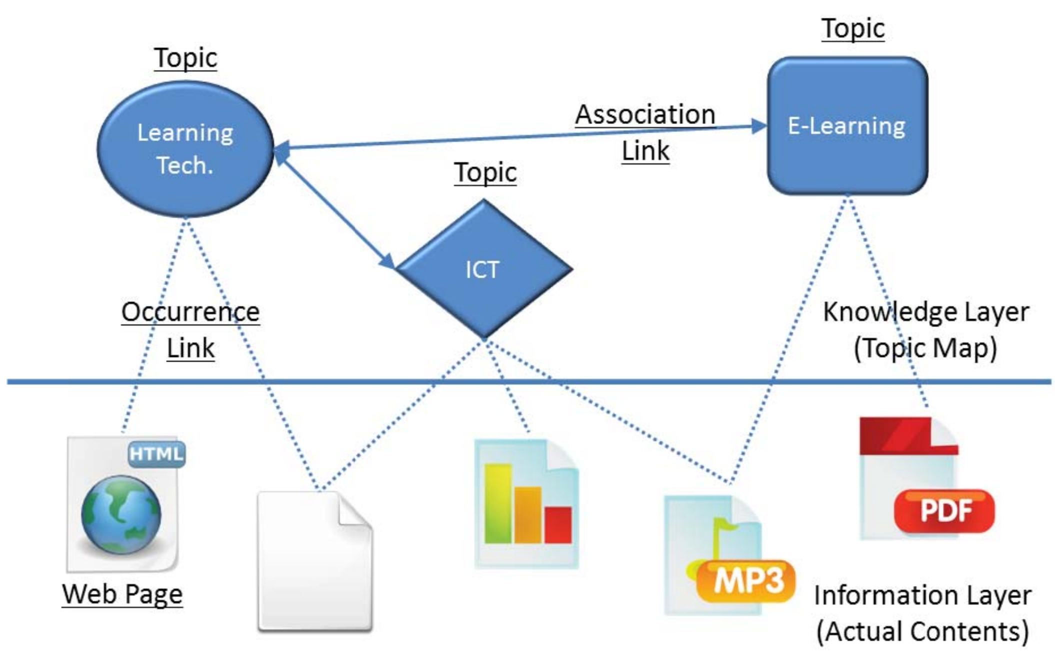

Figure 3 Basic Concept of Topic Maps

Figure 3 illustrate how the three key concepts relate in the Topic Map standard. Topics represent concepts of a certain field to the learners' interests. Association links represent hyper-graph relationships between topics. Occurrence links represent actual Web contents relevant to a particular topic.
Topic maps can be used to qualify the content and/or data contained in information objects as topics to enable navigation tools and to link topics together with multiple, concurrent views on sets of information objects.

2.2 Multi-layer Map Model

Multi-layer Map Model is the core of the learning environment proposed which is intended to perform as a GUI for self-directed and community-based learning. Figure 4 shows the four layers model with different functions yet dependent on the services provided by their nearest layers. The model provides the community members with communication basis via superposed map representations. It mainly focuses on visualizing the structure of learning contents in term of resource maps, and then enables learners to edit or reconstruct personal maps according to their learning processes. Moreover, this model includes community map where the personal maps are merged, viewed and used by other community members that have the similar interests. The following sections will describe the basic concept of each layer respectively.

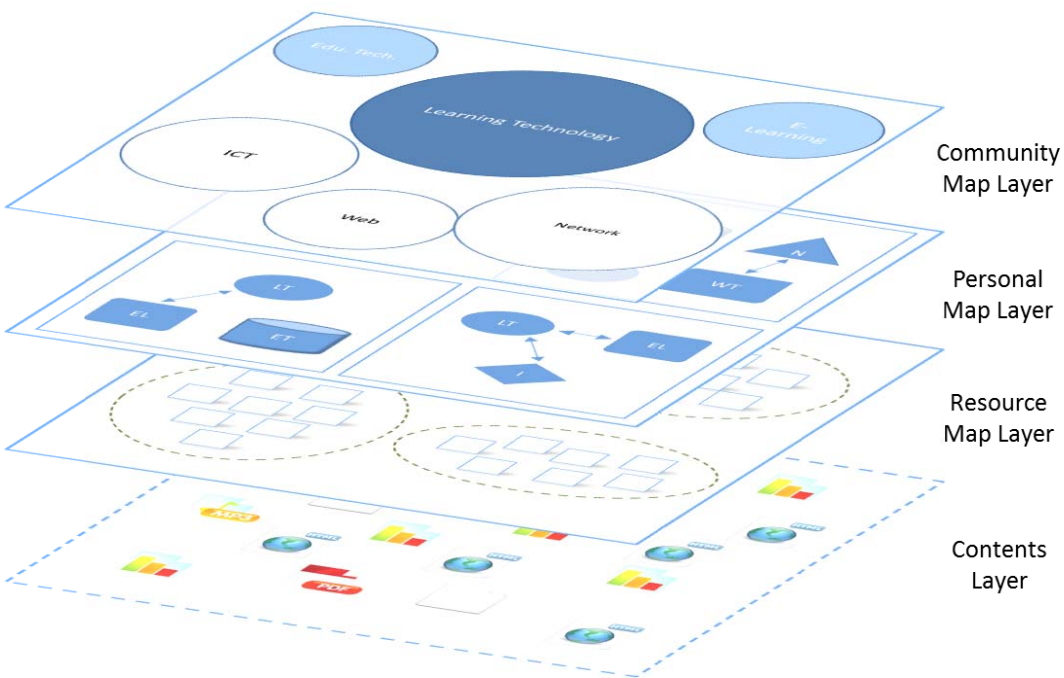

Figure 4 Multi-layer Map Model

3. Design for Multi-Layer Map

3.1 Contents Layer and Resource Map Layer

Contents layer is the lowest layer of this model. It means the actual Web contents such as Web pages, documents, and media files of the Web-based learning resources. This is just a conceptual layer for the model.

Resource map layer is the place to visualize structures of the Web contents by the learning resources in one-to-one manner as shown in Figure 5. This map provides the learners with an overall perspective of the resources used by the community members. Every node used by community members is cashed crawling contents information and labeled with typical words such as title of the Web page occurred. The learning behaviors on the environment, like searching for resources, selecting real contents, and taking memo, are conducted at this layer.

3.2 Personal Map layer

Personal map layer is aimed to support learners' self-directed learning. It helps the learners to edit and reconstruct their personal topic maps based on the spatial maps created at the resource map layer. At this layer, learners are capable of defining topics, adding/deleting occurrence links between topics and contents, making the structure among topics by association links, and navigating resources.

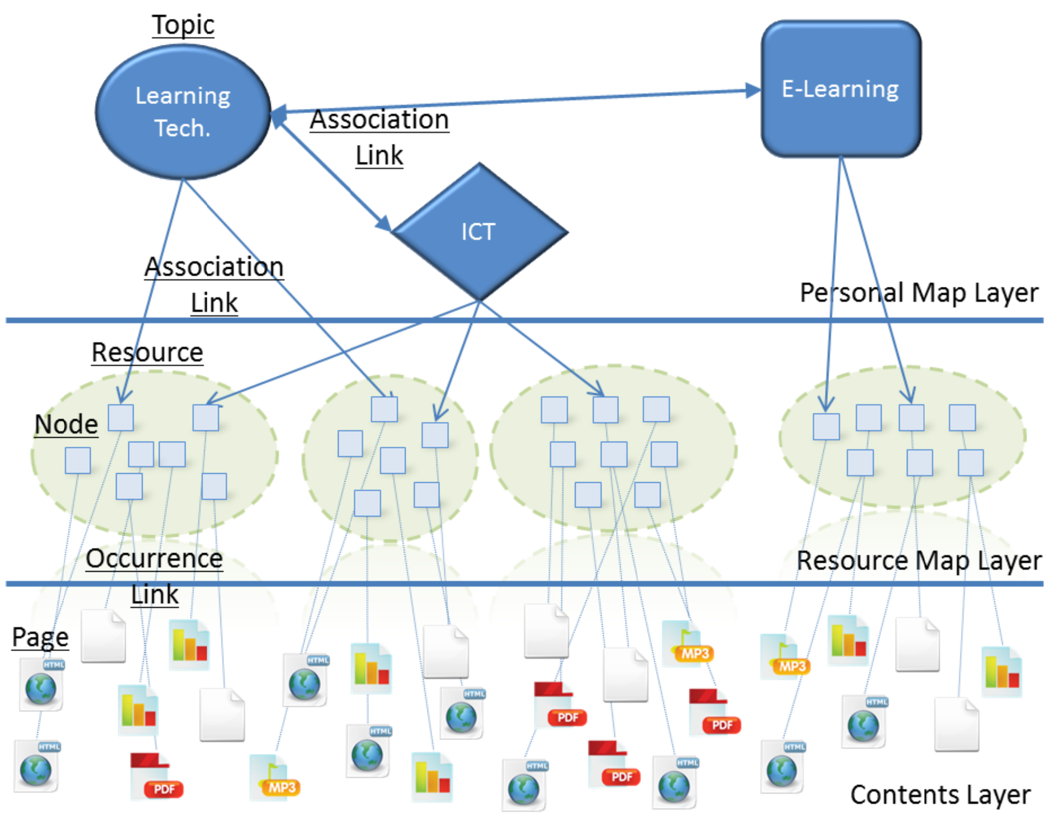

Figure 5 Relationship Diagram among Personal Map, Resource Map and Contents

3.3 Community Map Layer

For the purpose of sharing learning achievements in the community, community map layer merges the personal topic maps with that of other community members by displaying bubble form charts based on their features and relations as shown in Figure 6. The size of each bubble represents the number of occurrence links in each topic. The relative position between bubbles is calculated by the number of association links among topics, and the color density of each bubble represents the number of learners interested. In these ways, all the personal topic maps are classified into groups at this layer to be better viewed and share in community learning. This map also provides glossary, taxonomy, thesaurus of community by enabling the community members to edit different topics having the same meaning.

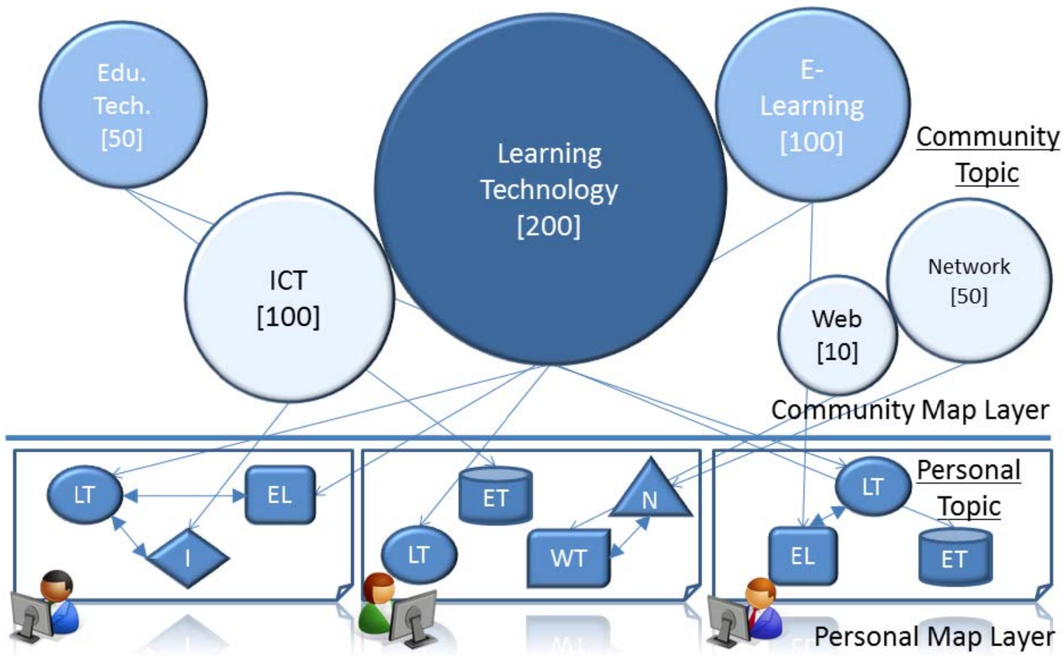

Figure 6 Examples of Community-based Map

4. System Architecture

Figure 7 shows a block diagram of the whole learning environment. This section describes distinctive functions of the system.

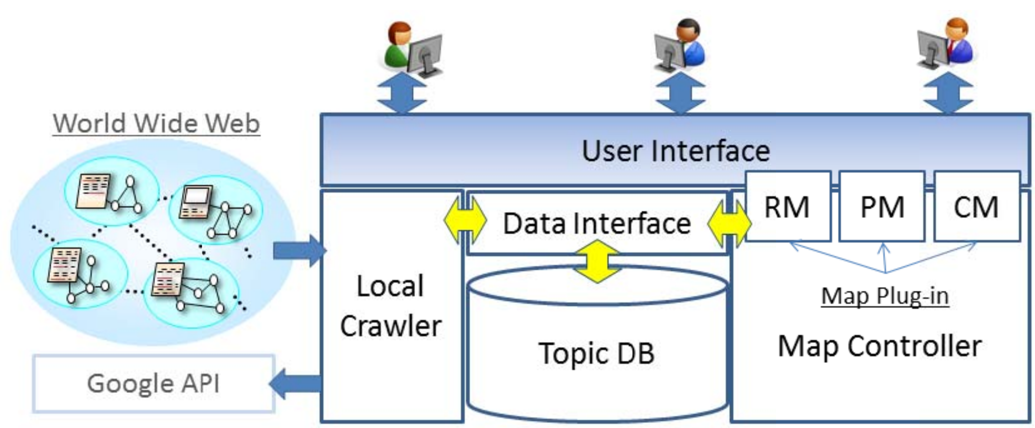

Figure 7 System Architecture

4.1 Local Crawler

As we already know that the traditional search engines like Google is the first thing we can think of using when it comes to searching information. Therefore, in order to find related lists of URLs, it is necessary to embed some common search engines into this learning environment in case the learners decide to make their own topics. As soon as the embedded search engine outputs a bunch of related URLs, the learners can select several links with most relevance. Local crawler gathers information of chosen links to a much deeper level. The depth can be decided by common experience which must ensure the real stuff will come up after average times of crawling. The key point should be remembered when constructing the crawler is that the strategy of adaptive focused crawling [6] is better to be followed in order to find the information with the most relevance with the searching keywords input by learners. In database module, the gathered information is stored by XML forms according to Topic Maps format.

4.2 Map Controller

Map Controller is responsible for map editing and visualizing functions through layers of the resource, personal, and community map. As for maps created at the upper three layers have their own features, each layer has their own plug-in map controllers. Resource map plug-in generates spatial maps automatically based on the results crawled by the local crawler. It shows the structure of the crawled URLs in form of links and nodes representing actual contents. By clicking each node, the learners can access the real contents behind it. Personal map plug-in drafts the personal topic map initially. The learners can edit their own personal topic maps like adding or deleting certain nodes, building association and occurrence links, taking notes and etc. Several association types are defined in the plug-in such as super-sub (is-a), related term, synonym, antonym, etc. Community map plug-in merges the personal maps in the community members and represents them with conclusive bubble charts. It also provides associative search and community filtering functions for the purpose of sharing their learning achievements.

4.3 How to Construct Topic Maps

At beginning, learners input keywords into search engine APIs in order to get related search results so that they can look for the topics of interest under certain field at the content layer. If the learners select interesting Web resources from search results, the local crawler gathers information of the Web pages from the resources selected and stores it to the database.

Then, the learners create their own topic maps by trimming occurrence links defined by the initial maps and improving upon relations among topics while learning the pages in self-directed way; meanwhile they can add notes and restructure relationships among topics and nodes.

As community-based learning, the learners search topic maps created by other learners associatively and modify them into forms of their own. As for beginners of Web-based self-directed learning, it could be helpful getting informed with useful learning resources organized by community members with similar interest. The community map of each field of interest would become more and more complete and sophisticated by progress of community-based leaning.

5. Conclusion

This paper has described the multi-layer map-oriented learning environment for self-directed and community-based learning in hyperspace provided by Web-based learning resources. The key idea is to provide community learners with communication basis via superposed map representations. This paper has also presented the system architecture, which aims at visualizing vast information resources on the Web and at creating informative topic maps by community learners in a piecemeal growth process. Although there are restrictions like the change of the learner's interest, the correctness of the information of web pages, in completeness as the teaching materials, this method of self-directed learning on the web is still worth pursuing.

In the near future, we will develop the environment proposed as practical Web application and design some map plug-in functions with personalization or adaptation such as the form of visualization for topic maps, suitable crawling methodology for local crawler, etc. And other existing functions for supporting self-directed learning can also be integrated, e.g., the tools for learning path planning and knowledge reflection [3].

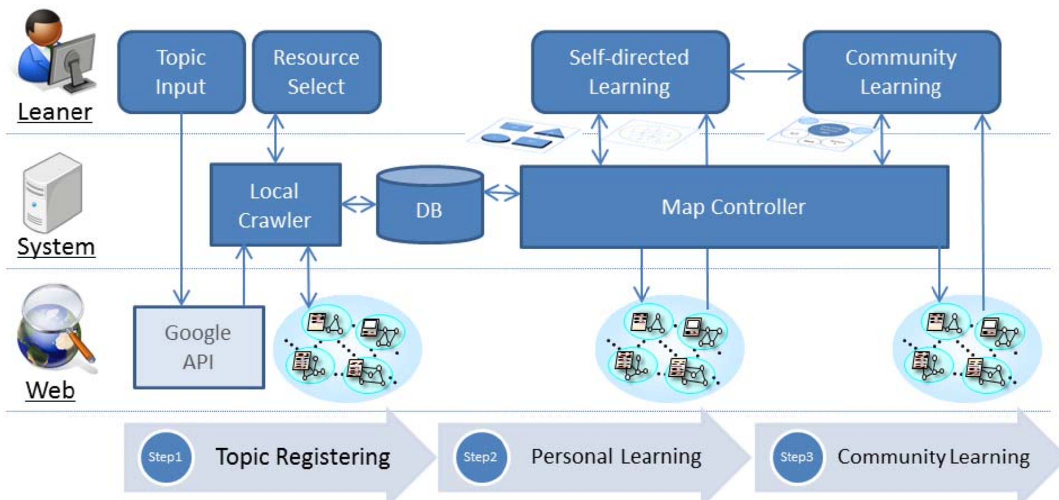

Figure 8 Flowchart for Constructing Topic Map

Acknowledgements

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Fundamental Support and Reflection Support for Report Writing from Web

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Abstract: In educational institutions,it becomes the problem that students just copy-and-paste the information onto their reports because knowledge is not constructed. We are developing the knowledge construction support system for effective report writing from the web. In this paper, we describe the fundamental support functions and the reflection support function.

Keywords: Report writing, reflection, knowledge construction, copy-and-paste, web

Introduction

By the spread of the Internet, nowadays, we can collect much information easily from web and construct knowledge. In other words, web pages can be used as unlimited resources for knowledge construction. Knowledge construction from the web has been known to be highly effective because we can apply our self-directed ways to knowledge construction [1]. However, information written on web pages is not entirely reliable as it is not always written by specialists, but instead, in many cases by the general public, who might not have proper knowledge. To construct knowledge effectively, we need to evaluate the information from multi-perspectives.

In educational institutions, students are often given report writing assignments. Many of the students will make maximum use of web pages as one of the information resources for report writing. Information written on web pages is digital data. Therefore, the students can easily copyandpaste the information onto their reports. Here, such a copy and paste can be seen as a problem in report writing. This is because they may just copyandpaste the information onto their reports and finish report writing. This problem means that students cannot construct knowledge and those reports are not written based on the students' knowledge— not externalized as their constructed knowledge. As a result, those reports may have superficial and low-quality contents. For example, they may write reports from the misinformation written on a web page without multi-perspectives evaluation. We call this problem "unproductive copy and paste". A survey report says that quarter of university students was suspected of plagiarism by the unproductive copyandpaste [2]. To make matters worse, the unproductive copyandpaste can be regarded as copyright violation. This serious situation must be eradicated as an adverse effect of report writing from the web.

In this study, we proposed a model of knowledge construction from the web and developed the system that supports knowledge construction (report writing) [3]. In this system, a student compares and/or applies information written on two web pages, write a note as their short constructed knowledge, and finally write a report from the written notes. The most characteristic point of this system is to forbid the student to copy and paste the information to the note. Therefore, it is expected that students construct knowledge and write high-quality reports without the unproductive copy and paste. This characteristic can be regarded as load application approach, where giving load is considered to be effective for knowledge construction. For example, Kashihara et al. have succeeded in enhancing students' explanation skills by inducing them to make as many cognitive loads as possible [4]. In adaptive hypermedia research, Hübscher and Puntambekar have argued “the use of too much navigation support can be detrimental to the learner because it frees him or her up from thinking” [5].

For more effective report writing, we think that report writing should include the phase of “reflection” where students revisit their visited web pages, reflect on their notes, and/or refine their reports— reconstruct their constructed knowledge. Therefore, the system should support the reflection phase, implementing a new function.

1. Knowledge Construction from Web and Report Writing

An advantage of knowledge construction from the web is that students can construct a lot of knowledge by using the web as unlimited resources. On the other hand, knowledge construction from the web is not always easy. For effective knowledge construction, the students have to not only read the content of their visited web pages but also think about the content from multi-perspectives.

We made a simple model of knowledge construction from the web (Figure 1). The following focuses on the activity of “web exploration” in the knowledge construction phase and the phase of “reflection”.

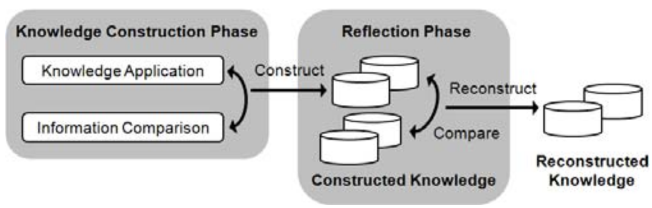

Figure1. Model of Knowledge Construction from Web

1.1 Web Exploration

Students visit web pages by following hyperlinks and read the content of their visited web pages. And, the students construct knowledge by thinking about the content. We have proposed multi-perspective thinking as a model of web exploration (web-based exploratory learning) [6][7]. Figure 2 shows the multi-perspective thinking model. Multi-perspective thinking is defined as follows: “a student constructs knowledge by thinking about his/her target topic from multi-perspectives.”

1.1.1 Information Comparison

Information comparison is that a student compares the content (information) of more than two web pages on one target topic in order to construct the correct knowledge. To be more precise, the correct knowledge comes from the repeat of thinking about common points and different points that exist in the compared content. A perspective in the information comparison shows up as a difference in the content of web pages on the target topic.

1.1.2 Knowledge Application

Knowledge application is that for one target topic, a student applies his/her constructed knowledge about the related topics to his/her constructed knowledge about the target topic in order toconstruct the widely connected knowledge of the target topic. To be more precise, the widely connectedknowledge comes from the repeat of thinking about the relations between the target topic and the related topics. A perspective in the knowledgeapplication shows up as a difference in topics.

These two activities in the multi-perspective thinkingmodel are seamless.

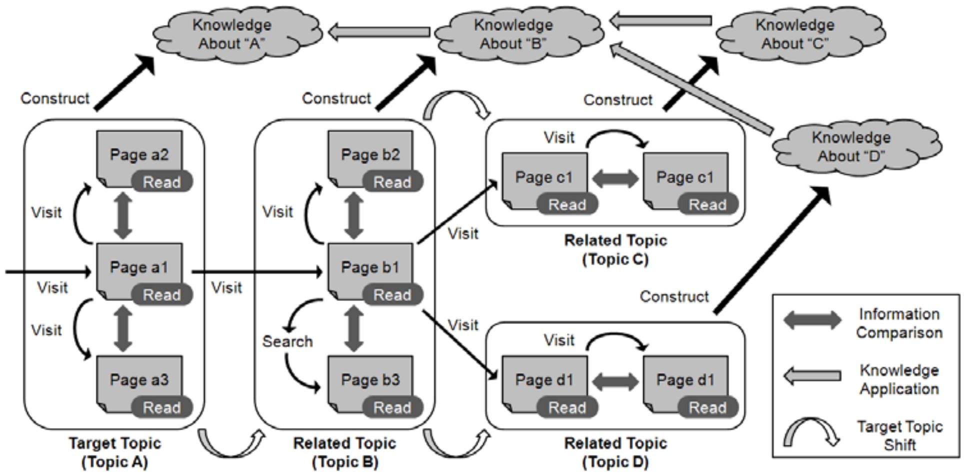

Figure2. Multi-perspective Thinking Model

1.2 Reflection

Reflection can be rephrased as knowledge reconstruction, which is done after knowledge construction. At this phase, a student reconstructs his/her constructed knowledge by some reflection methods. One of the principal reflection methods is that the student compares their constructed knowledge. Reflection leads to making their constructed knowledge more correct and well-structured.

1.3 Report Writing

A report writing assignment is suitable for seeing students' inquiry capability, organizational skill, and constructed knowledge. Teachers often give students a target topic of report writing not having a single correct answer and recommend the students to use the web as the primal resource, expecting that the students will do multi-perspective thinking in knowledge construction from the web. Therefore, report writing will result in— can be regarded as— knowledge construction from the web.

On a routine basis, students complement and stabilize their constructed knowledge by externalization—note taking is a typical example. This activity can be applied to knowledge construction from the web. The student would externalize their constructed knowledge as digital media (e.g., annotation) in the recursive process of the information comparison and the knowledge application. If well compiled, the externalized knowledge can be a report (product).

1.4 Report Writing Model

It is important to consider how the externalized knowledge can be well compiled for a report. The compilation activity can be regarded as a certain kind of reflection. Therefore, students should compare and apply their externalized knowledge in order to complete their reports.

We think that reflection is important for effective report writing and propose a model of report writing from the web, which is based on the multi-perspective thinking model and consists of the four steps (Figure 3). This model represents the process of effective report writing.

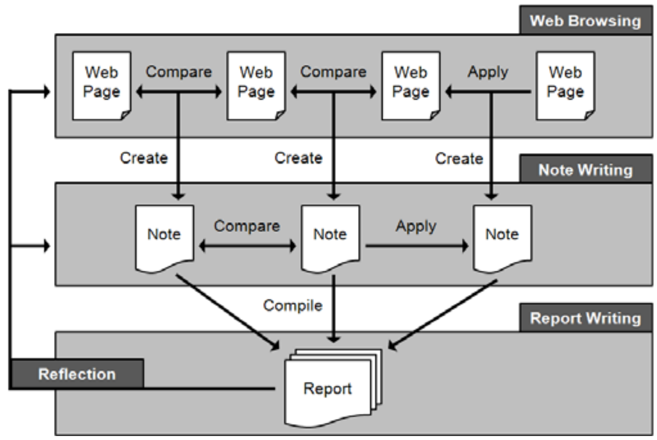

Figure3. Model of Report Writing from Web

(1) Web browsing (web exploration)
The content of web pages about a report topic differs among the page authors. At the first step for effective report writing, a student visits as many web pages as possible and does the information comparison and the knowledge application to construct the correct and widely connected knowledge.

(2) Note writing
A report should be written from their constructed knowledge. Therefore, the student externalizes their constructed knowledge as a note in order to write a report. At this step, his/her note is a temporary resource for report writing.

(3) Report writing
The student writes a report by doing the multi-perspective thinking toward and then compiling the written notes.

(4) Reflection
The report written through the above steps is not the completed version but just a draft version. In this model, the student is required to revisit his/her visited pages, do the multi-perspective thinking, and reflect (revise) the written notes. Then, the student does the multi-perspective thinking toward the reflected notes and refines the draft version. Such a reflection is repeated one or more times, and the final version of his/her report is completed.

2. Report Writing Support System

We developed a report writing support system based on the report writing model. This system, which is integrated with a LMS server, works on a client PC with Microsoft .NET framework.

2.1 Fundamental Support Functions

This system has the following fundamental support functions forencouraging students to do multi-perspective thinking andpreventing them from the unproductive copy-and-paste.

(1) Two embedded web browsers

Two web browsers are embedded alongside in this system so that a student can do multi-perspective thinking smoothly(without split-attention effect [8]) for his/her visited webpages. In the step of “report writing”, these browsers display not web pages but notes that the student wrote. The student can easily compare or apply his/her created notes to write a report.

(2) Ban of copy-and-paste

In this system, it is banned to copy and paste text data on web pages. The function cannot copy-and-paste from other applications such as Internet Explorer directly. Therefore, the student has to type their constructed knowledge into the note as text data. As a matter of course, the student can transcribe text data on his/her visited web pages by typing the text data precisely. If seeing the superficial result of this transcription, teachers may be suspected of the unproductive copy-and-paste. However his/her typed text data may have been constructed as knowledge, because a typing load is much bigger than a copy-and-paste load. This function is the fundamental for effective report writing. Currently, the student is exceptionally allowed to copy and paste image data. This is because duplicating image onto the note requires him/her extra skills and gives high load.

(3) Storing note and report files on the LMS server

In this system, the written notes and the written report are always stored not on the student’s client computer but in the LMS server. This function prevents him/her from copying assignment products created by peers. The text-based note is stored as RTF (Rich Text File).

2.2 Reflection Support Function

The early version of the system did not have a reflection support function. It is difficult for students to totally reflect report writing because they only have web browsing histories, which are provided byte two web browsers and only arranged in order of time axis. Therefore, we implemented a reflection support function in the system.

Figure 4shows the architecture of the reflection support function. This architecture, which stores data of web browsing history and notes linked to two compared web pages (two displayed web pages when a student wrote a note), visualizes the data to simplify the reflection operations by the reflection support module. For example, as soon as the student clicks on the title of a note, the note and its linked web pages are displayed.

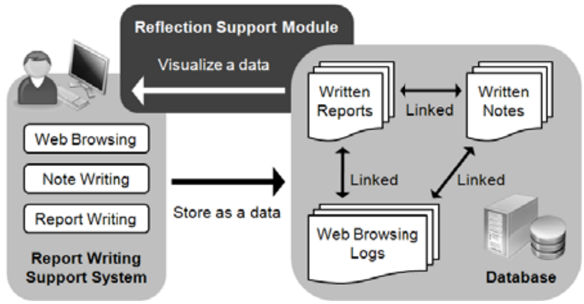

Figure4. Architecture of Reflection Support Function

2.3 Usage Flow and User Interface

(1) Login and report selection

A student who has done registration can activate the system by logging in through password authentication. After the login, the list of the student's report assignment is displayed as shown in Figure 5.In this list, “Lecture Name”, “Report Name”, “Submission Deadline”, “Last Update”, and “Condition” are displayed by each report. When passing the deadline of a report, the condition automatically become the status of “completed”. Before the deadline, the condition remains the status of “editing” and the student can edit a chosen report.

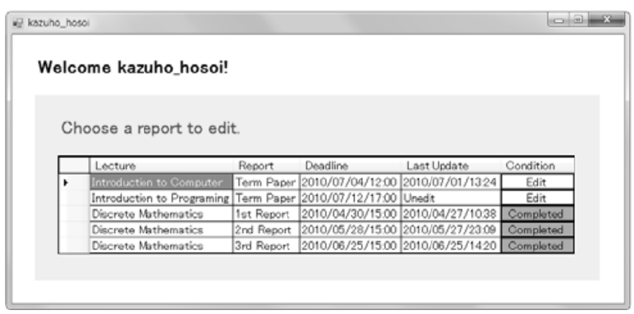

Figure5. Screen of Report Choice

(2) Web exploration

The main user interface of the system roughly consists of two web browser components (“WB components” for short) (top-left and bottom-left) and the note writing component (“NW component” for short) or report writing component (“RW component” for short) (right). Figure 6 shows the main user interface. First, a student may often input a search query (keyword) into a search engine to find web pages. After web search, the student compares the two displayed web pages.

(3) Note Writing

On the NW component, the student can write the note in a manner similar to popular word processor software. As soon as he/she presses the "Save" button, the written note is stored as RTF in the LMS server.

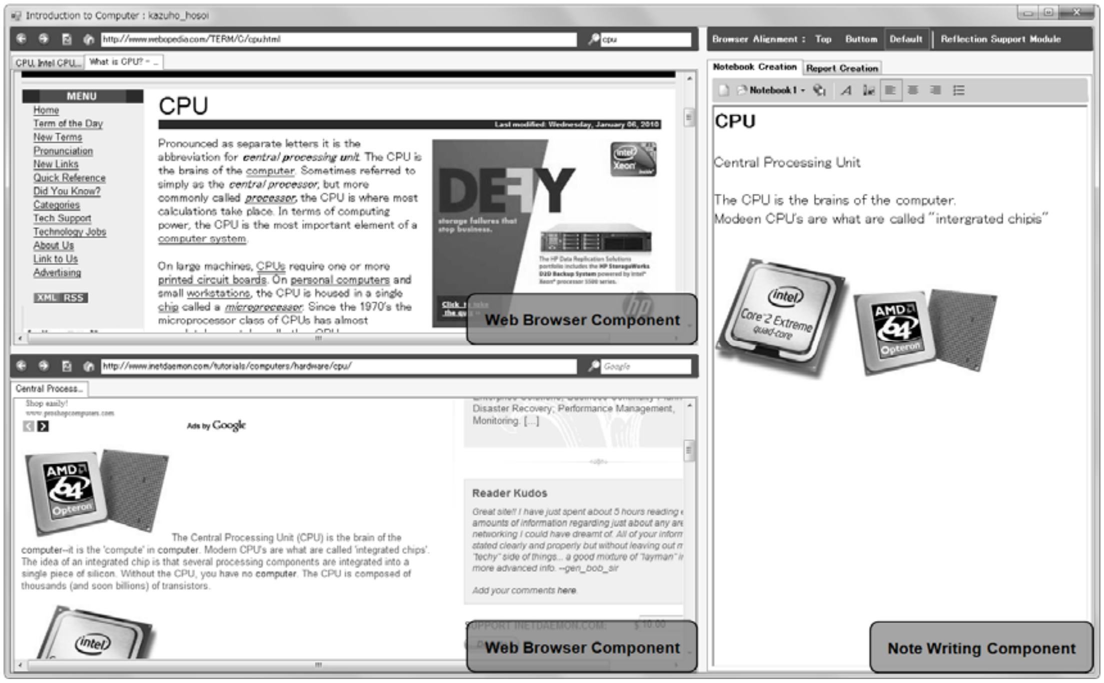

Figure6. Main User Interface

(4) Report Writing

After the successive note writing, the student tries to write a report. At this step, the two WB components change to two NW components and the NW component changes to theRW component, which has the same functions as the NW component. Therefore, the student can write his/her report in the same manner as the note writing. In this step, the student is allowed to copy and paste text date on the two NW components into the RW component, because the text date has already been typed by the student― he/she has already constructed the knowledge written on the NW components.

(5) Reflection

When being stuck at report writing, after writing the draft version of his/her report and so on, the student shifts to the reflection phase. The student presses the "Reflection" button and the reflection support function runs. Figure 7 shows the user interface for reflection. The user interface consists of “Note” objects, “Browser” objects, “Tab” objects, and “Web Browsing Log” objects. Each object is mutually related, and shows report writing logs (histories) concerning the report the student is editing. The title of the web page that had been displayed on two web browsers when the student saved a note is highlighted in a bright color. Therefore, the student can look down at the process of the note writing and the report writing.

After looking down at the process, for reflection, the student selects the title of a note or a web page, and clicks the "Note" object or the "Web Browsing Log" object. When the "Note" object was clicked, the selected note is displayed as a new tab to the web browser component. At that time, the student can choose a web browser that displays a new tab by mouse operation. By left-click, the student can display the selected note to the top web browser, and display it to the bottom web browser by right-click. In addition, the state when the note was written (saved) is recreated to the NW component and the WB component by middle-click. The web page that had been displaying when the note was written is displayed to the WB component and the written note is displayed to the NW component. When the "Web Browsing Log" object was clicked, the selected log is displayed as a new tab to the WB component. In the same manner as the "Note" object, the student can choose a web browser that displays a web page by left-click and right-click. By this reflection support function, the student can easily look down at the report writing process and revisit web pages.

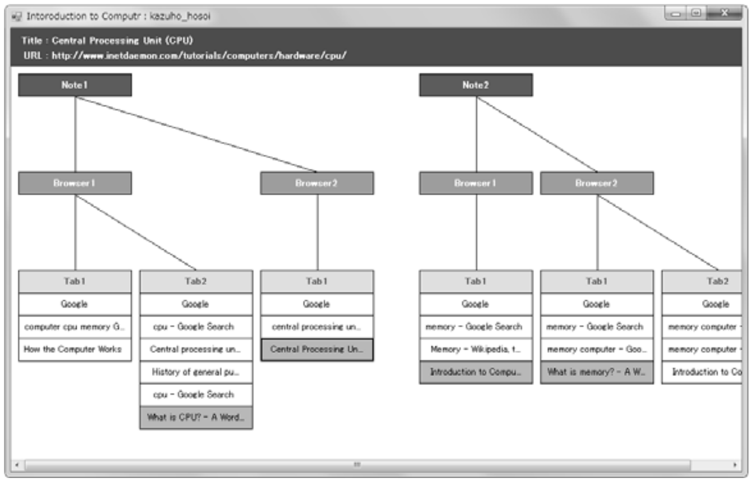

Figure7. User Interface of Reflection Support Function

3. Conclusion

In this paper, we described the fundamental support functions and the reflection support function for effective report writing from the web. This system is based on the model of knowledge construction from the web and the model of report writing from the web that we proposed. By the system, students can base on these models and effectively construct knowledge with report writing.

As future works, we will develop the function is visualized by a new method on the reflection module. As one of the new visualization method, we propose the visualization by time axis. We conduct experiments to evaluate whether the system will be accepted by students and will actually lead to effective report writing.

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Reconstructing Learning Resource with Collective Knowledge

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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 these learning 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 these resources to reconstruct the hyperspace, which consists of useful pages and links to be learned. This paper proposes a collective knowledge mining method that can extract these useful pages and links from learning histories gathered from the group of learners. The results of the analysis with case data indicate the possibility that this method extracts valid pages and links as collective knowledge.

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 learning 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][7]. Such self-directed navigation involves constructing knowledge, in which the learners would integrate the contents learned at the navigated pages [7].

However, there are the following problems with regard to self-directed learning in the hyperspace provided by a Web resource. First, it might become difficult for learners to learn according to their learning goal since the hyperspace could be navigated/learned in multiple goals. 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 learning resource with the same goal to reconstruct the hyperspace [6]. In order to obtain such collective knowledge, this paper demonstrates a learning history mining, which can extract pages and links, which could be useful for learning, from learning histories that could be gathered from the group of learners.

On the other hand, it is difficult to identify these useful pages and links from navigation histories generated by Web browser since they do not make clear which pages have been really learned and do not imply how pages learned have been integrated in knowledge construction. The history mining method accordingly requires learning histories that could represent the knowledge construction processes as properly as possible. We have already developed an Interactive History system (IH for short), which allows learners to annotate their navigation history with knowledge construction process [5]. The proposed history mining method uses learning histories generated from learners who use IH to identify useful pages and links.

This paper also describes an analysis of the learning history mining with case data. The results indicate the possibility that the mining method extracts valid pages and links as collective knowledge.

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1. Navigational Learning with Web resources

Let us first consider self-directed learning with Web resources. In hyperspace provided by Web resources, learners can navigate the Web pages in a self-directed way. The self-directed navigation involves making a sequence of the Web pages, which is called navigation path [5]. It also involves constructing knowledge, in which the learners would make semantic relationships among the contents learned at the navigated pages. The navigation path often includes the pages belonging to different Web sites. The constructed knowledge is also composed of diverse ideas/contents since each Web site is designed by its own author. The learners can accordingly learn more widely in an individualized way [5]. In this paper, such navigation with knowledge construction is called navigational learning.

The hyperspace provided by Web resources, however, is not always well-structured. There are often no links between relative Web pages. It could be also used in multiple learning goals. It is accordingly difficult for learners to learn in such hyperspace.

Our approach to reducing such difficulty is to reconstruct Web resources so that the hyperspace could be appropriate for learners to learn with their learning goals. The types of resource reconstruction operations are classified into the following: (a) revising and refining page contents, (b) extracting part of the hyperspace, and (c) reconstructing the hyperspace including deletion, addition, and change of links. In this work, we focus on extracting part of the hyperspace and reconstructing the hyperspace as resource reconstruction.

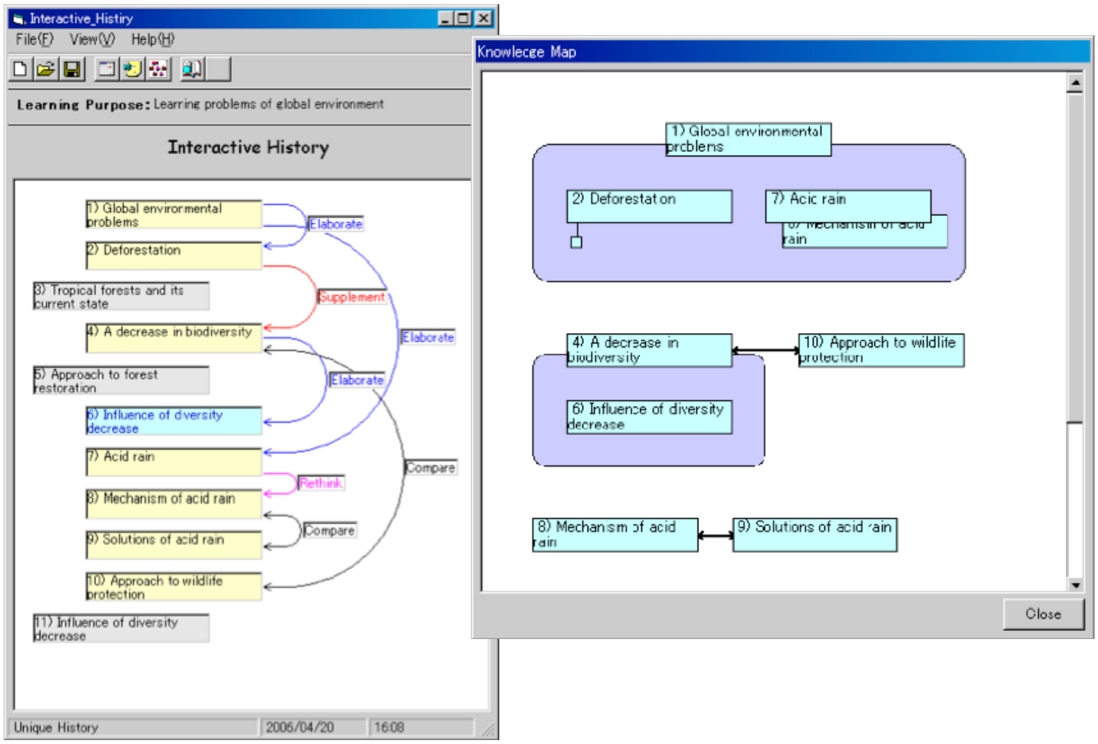
2. Framework for Learning Resource Reconstruction

Let us here propose a framework for reconstructing a Web resource, which uses learning history mining. The learning history mining method can extract the 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 from the group of learners, which could be instructive for other learners to learn the resource with the goal. The framework uses learning histories generated with IH to identify the useful pages and links, which compose a partial hyperspace of the Web resource as reconstructed resource.

The reconstructed resource is represented as highlighted hyperspace map where the useful pages and links are highlighted on the map of the original hyperspace. Such representation is informative for learners to achieve the learning goal.

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

2.1 Interactive History



(a) Annotated Navigation History (b) Knowledge Map

Figure 1.Example of Annotated Navigation History and Knowledge Map.

In IH, the knowledge construction process is modeled as follows. Learners generally start navigating the 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 currently classify navigation goals into six: Supplement, Elaborate, Compare, Justify, Rethink, and Apply. We refer to the process of fulfilling a navigation goal as primary navigation process (PNP for short) [3]. 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 [5]. In each PNP, learners would integrate the contents learned at the starting and terminal pages. For instance, a learner may search for the meaning of an unknown term to supplement what he/she has learned at the current page or look for elaboration of the description given at the current page. Carrying out several PNPs, learners would construct knowledge from the contents they have integrated in each PNP.

IH allows the learners to annotate a navigation history, which includes the pages sequenced in order of time they have visited, with their PNPs. Figure 1(a) shows an example of annotated navigation history.

IH monitors learners' navigation in the Web browser to generate the navigation history in the *Annotated Navigation History* window. Each node corresponds to the page visited. The learners can make annotations of the PNPs, which they have carried out, by means of the *Navigation Goal Input* window. (See [4] in more detail.)

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Step 1. Generate a set of the first degree PNP from the focused set.
Step 2. Calculate the support value of each PNP.
Step 3. Exclude the PNP which value is less than Sth.
Step 4. Generate a set of (K+1) degree PNPs from a set of K degree PNPs.(Initial value:K=1) If a set of (K+1) degree PNPs is not generated, go to *Step 7*.
Step 5. Calculate the support values of the(K+1) degree PNPs to be extracted from the set.
Step 6. Exclude the (K+1) degree PNPs which values are less than Sth. Add one to the value of K, go to *Step 4*.
Step 7. Output the set of K degree PNPs.

Figure 2. Mining Algorithm.

In addition, IH can generate a knowledge map from an annotated navigation history automatically. Figure 1(b) shows a knowledge map generated from Figure 1(a). The knowledge map generally consists of several islands including some PNPs. We call them knowledge islands (KI). We define the number of PNPs included in KI as a degree of KI.

2.2 Learning History Mining

In order to reconstruct a Web resource, our framework prepares a repository that accumulates annotated navigation histories learners generated with IH, and that classifies them according to Web resources they learned and to learning goals they had. It generates a set of annotated navigation histories called *focused set* from the repository, which have been generated from the same Web resource as a 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

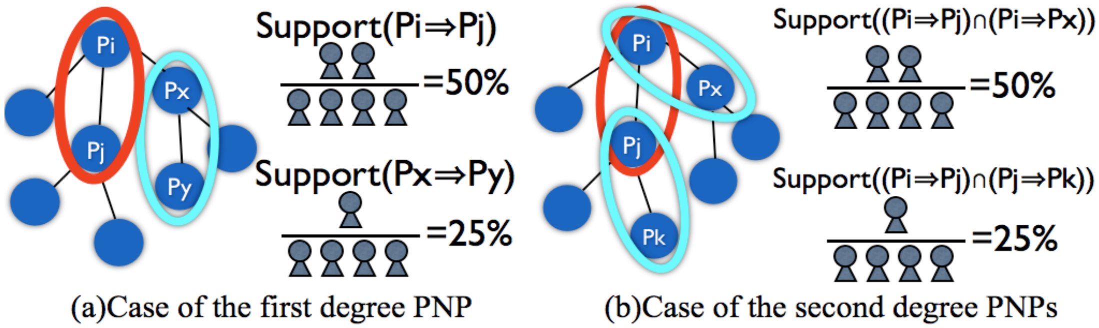

Figure 3.Examples of Support Value Calculation.

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

Figure 2 shows the procedure of learning history mining. First, a set of the first degree PNP is generated from the focused set, which includes all the PNPs in the set. The support value of each PNP is then calculated. If the value is less than *Sth*, the PNP is excluded. A set of the second degree PNPs is then generated. The second degree PNPs mean the two PNPs connecting via the starting or terminal pages. 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*. 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 3(a) shows an example of calculating the support value of the first degree PNP. Figure 3(b) also shows an example of calculating the support value of the second degree PNPs. In these examples, the number of transactions included in the focused set is four. *Sth* is 30 %. In Figure 3(a), the value of Support (*Pi->Pj*) is 50 % because there are two learners who execute the PNP. The value of Support (*Px->Py*), on the other hand, is 25 % because there is only one learner who executes the PNP. In this case, the PNP (*Px->Py*) is excluded since the support value is less than *Sth*.

A set of the second degree PNPs is then generated, and the support value of each of the second degree PNPs is calculated. As shown in Figure 3(b), there are two learners who execute the PNPs (Pi->Pj) and (Pi->Px). The support value of the second degree PNPs is 50 %. There is one learner who executes the second degree PNPs (Pi->Pj) and (Pj->Pk) whose support value is 25 %. In this case, the second degree PNPs (Pi->Pj) and (Pj->Pk) is excluded.

2.3 Hyperspace Reconstruction

Figure 4 shows a hyperspace map 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 about stock investment with the goal of learning the basics about the stock investment. Sth was 25%. The total number of the pages included in the resource was 85, and the average number of links per page was 5.84. It had a quite complex hyperspace. The number of the navigation histories in the focused set was 16. The largest degree of KI was 11 in those histories.

The highlighted part of the hyperspace map in Figure 4 shows the sixth degree PNPs (including pages and links) output by the learning history mining, which is represented in detail as shown in Figure 5. Such reconstructed hyperspace could facilitate navigational learning process with the same learning goal.

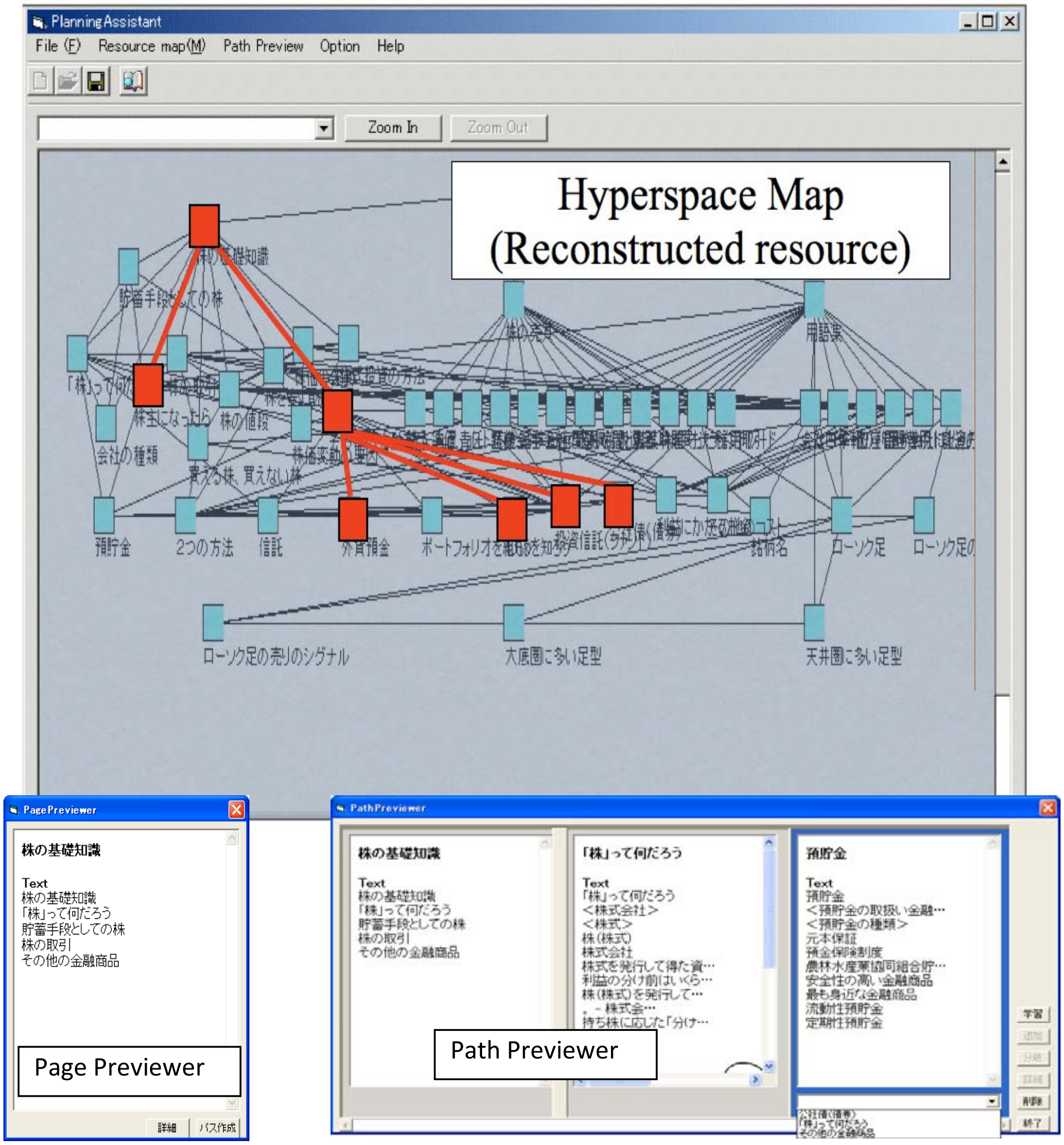

Figure 4. A Hyperspace Map Representing Reconstructed Resource.

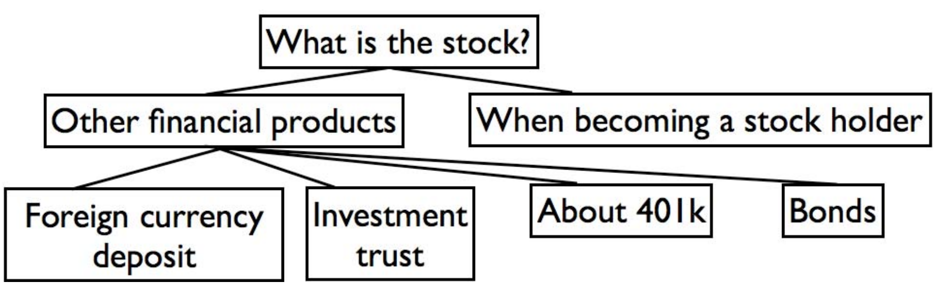

Figure 5. Details of Reconstructed Hyperspace.

In order to help learners follow the reconstructed hyperspace, our system provides them with page previewer, and path previewer in addition to hyperspace map of reconstructed Web resource as shown in Figure 4. Double-clicking any highlighted node in the hyperspace map, the learners can have an overview of the Web page corresponding to the clicked node, which is generated by the page previewer. The page previewer helps the learners to decide from which page they start navigation. When they decide the starting point of the navigation path, they can start the path previewer. The path preview window has a link list, which includes anchors of the links the current page contains. Selecting any one from the list, they can have an overview of the page, to which the selected link points. They can then put the page previewed into the sequence, making a navigation path. The learners are next expected to follow the navigation path to navigate and learn the Web pages with Web browser [2].

2.4 Analysis

We have conducted the analysis of the reconstructed hyperspace shown in Figure 4. The purpose of the analysis is to investigate whether the learning history mining is suitable for constructing the Web resource. In this analaysis, we used the following data: (i) PNPs or pages that were output by the learning history mining (such as Fig.5), and (ii) maximum degree of KI included in learning histories used for the mining. The maximum degree of KI in the navigation history can be viewed as a core of the knowledge structure constructed in hyperspace. We have accordingly checked whether and how much the PNPs or pages output by the mining were included in the maximum KI.

As for 4 subjects among 16 subjects, all the PNPs output were included in their maximum KIs. As for the remaining 12 subjects, Table 1 shows the analysis summary. Since it seems the subjects whose learning histories did not include KIs more than the fifth degree were not good at knowledge construction, we excluded those subjects (6 subjects) to analyze. As for the subjects (B), (E), and (F), more than 50 % of the PNPs or pages output were included in the maximum KIs. Totally, there were the 7 subjects among 16 subjects whose core structure

Table 1. Analysis Summary.

	Maximum degree of KI		The ratio of PNPs and pages(output by the mining) included in the KI	
	Degree	Number of pages included	PNPs included	Pages included
Subject(A)	4	5	2/6(33%)	3/7(43%)
Subject(B)	7	8	5/6(83%)	6/7(86%)
Subject(C)	3	5	0/6	0/7
Subject(D)	1	2	0/6	0/7
Subject(E)	8	9	4/6(67%)	6/7(86%)
Subject(F)	7	8	1/6(17%)	4/7(57%)
Subject(G)	3	5	0/6	0/7
Subject(H)	11	14	0/6	0/7
Subject(I)	6	7	2/6(33%)	3/7(43%)
Subject(J)	11	13	0/6	0/7
Subject(K)	2	3	0/6	0/7
Subject(L)	1	2	0/6	0/7

in their knowledge construction process included more than 50% of the sixth degree PNPs shown in Figure 5.

2.5 Effects Expected

Let us here consider effects obtained from the learning resource reconstruction. We expect two effects from viewpoints of resource author/provider and learners. First, it is time-consuming for the resource author/provider to reconstruct the hyperspace suitable for individual learners. It is also quite difficult for them to decide how the hyperspace should be reconstructed in advance. The learning history mining enables the author/provider to reconstruct it by means of collective knowledge automatically extracted.

Second, the reconstructed hyperspace allows the learners to reduce their cognitive efforts for navigating hyperspace and integrating the contents learned at navigated pages. The learners are then expected to more readily construct their knowledge from the reconstructed hyperspace for achieving the learning goal.

3. 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 gathered from a group of learners who learned the same learning resource with the same learning goal, which can be viewed as collective knowledge.

This paper has also analyzed the validity of this mining method with case data. The results suggest that it could extract pages and links useful for self-directed learning in the hyperspace as collective knowledge. We believe such learning resource reconstruction contributes to not only learners but also resource author/provider.

In future, we would like to evaluate the effectiveness of the resource reconstruction method in more detail.

Acknowledgments

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Workshop

Human-Centered E-Learning

Workshop Organizer

Sherry Y. Chen (Graduate Institute of Network Learning Technology, National Central University, Taiwan)
Yung-Chi Hsu (Graduate Institute of Network Learning Technology, National Central University, Taiwan)

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Preface

The Workshop on Human-Centered E-learning is part of the 18th International Conference on Computers in Education (ICCE2010) that was held from November 29 to December 3, 2010, at Putrajaya, Malaysia.

The Workshop tends to investigate how to use Human Centered Design (HCD) to improve the development of e-learning tools so that these tools can effectively support teaching and learning for different types of users.

The development of e-learning tools should be accessed anytime and anywhere by users. Moreover, as a result of such convenience, a wide range of people have begun using e-learning tools for supporting teaching and learning. Thus, it is important to ensure that such e-learning tools can accommodate diverse users' needs. To address this issue, there is a need to incorporate the HCD into the development of the e-learning tools. More specifically, the HCD is used to not only investigate the behaviors of using e-learning tools between different types of users but also analyze how users' individual differences influence their perceptions for the e-learning tools. After doing so, such investigations can be used as guidelines to develop the e-learning tools to meet users' needs.

The contributions that are presented here cover various types of E-learning applications, such as web-based learning systems, robot-based learning, learning styles, digital learning resources, Learning *Scratch*, mobile-based learning system, and web-based problem-solving activities and seek to provide answers to the following questions:

- How E-learning approaches can be improved by considering users' needs?
- What design guidelines should be established for development, and what criteria are needed for evaluating E-learning approaches that can accommodate users' needs?
- How users' individual differences can be used to indentify learners' needs in an E-learning system?
- What type of information is needed from user profiles to identify the users' needs to develop the Human-Centered E-learning systems?
- What kind of a framework can be developed to build Human-Centered E-learning systems?
- How users' individual differences influence their learning reactions to E-learning systems?

We hope that the Workshop will contribute to the global research in E-learning by comprehensively reviewing state-of-the-art E-learning approaches that accommodate users' needs, will help integrating users' needs into E-learning applications, and will give some insight into analytical and architectural aspects of E-learning.

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Mining Learners' Disorientation in Web-based Learning

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Abstract: Web-based learning systems provide flexible ways for learners to develop their own learning strategies. However, some learners may experience more disorientation problems when they need to decide the learning strategies by themselves. In other words, not all of learners are suitable to use the Web-based learning systems. Therefore, it is necessary to investigate how learners' individual differences influence their disorientation problems. To this end, this study addresses this issue. Unlike other previous studies, we will not only examine how learners' individual differences influence their disorientation but also investigate how the learners' disorientation influences their learning performance. The other novelty of this study is the fact that we use a data mining approach to conduct data analyses. The results indicate that learners' computer experience is a major factor to influence their disorientation. Moreover, their disorientation may also influence their learning performance. The results are useful for developing Web-based learning systems to reduce learners' disorientation.

Keywords: Disorientation, Individual differences, Learning performance, Data mining

Introduction

The major advantage of the Web-based learning systems corresponds to their flexibility [2]. More specifically, learners can obtain information from the Web-based learning systems by different ways [17]. More specifically, the Web-based learning systems provide a nonlinear way to help learners develop their own learning strategies.

On the other hand, learners have diverse background, including subject knowledge, cognitive styles, Internet skills, and computer experiences, and so on [3]. Thus, not all learners feel comfortable to develop learning strategies by themselves. In other words, some learners may feel confused when they use the Web-based learning systems. Therefore, reducing learners' disorientation problems needs to consider their individual differences. In other words, there is a need to investigate how individual differences affect learners' disorientation problems when using the Web-based learning systems. Such investigation is important because understanding learners' disorientation is helpful to develop the Web-based learning systems that meet learners' real needs [8] and it can provide guidelines for designing Web-based learning systems that can accommodate learners' individual differences and their corresponding disorientation problems.

In addition to identifying the relationships between learners' individual differences and their disorientation, another important issue is how learners' disorientation problems influence their learning performance [13]. In summary, learners' disorientation problems may not only be influenced by their own individual differences but also affected their learning performance. In other words, it is helpful to understand learners' disorientation because such understanding can be useful to develop the Web-based learning systems that can enhance learners' performance.

Therefore, we not only need to investigate the relationships between learners' individual differences and their disorientation, but also should pay attention to analyzing how the learners' disorientation problems influence their learning performance. To this end, the study presented in this paper investigates these two issues. Such investigation can contribute not

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only to provide the knowledge of how to reduce learners' disorientation problem from an individual difference perceptive, but also to provide the understanding of how to enhance learners' performance by reducing their disorientation problems. To conduct a deep investigation, a data mining approach is adopted because our previous research shows that it can discover some unexpected relationships [5]. This paper is organized as follows. In section 2, the literature review is described. In section 3, the methodology used to achieve our aims is described. In section 4, the experimental results are presented. The conclusions are summarized in the last section.

Literature Review

Previous studies indicate that non-linear learning strategies may cause learners' disorientation problems. In other words, learners may get lost or become disorientated in the Web-based systems [17]. In an early study, Perlman [9] indicated that the learners' disorientation problems can include uncertainty over what learners had and had not read, the lack of organizational cues to find the information they wanted. Based on these disorientation problems, recently, a number of studies investigate the relationship between learners' individual differences and the degree of disorientation when using the Web-based systems. Ford and Miller [7] indicate that females more easily get lost than males. In addition to gender differences, Mohageg [15] suggested that novices might more easily get lost than experts. Therefore, there is a need to provide novices with suitable content structure to reduce their disorientation problems. Moreover, Last et al. [13] indicate that the level of students' prior knowledge may influence their disorientation problems. As showed in their work, students with high prior knowledge reported positive feelings about using the system and vice versa. Moreover, they also indicated that the students' disorientation problems may also influence their performance. In summary, such findings provided the guidelines for the improvement of the design of the Web-based systems so that learners can avoid getting lost.

Although the aforementioned studies indicate that learners' disorientation problems, which may be influenced by their individual differences, have great impacts on their performance, they mainly conduct data analyses with statistical techniques to which are used to prove known relationships by verifying existing knowledge [16]. However, the problems of the statistical techniques lie within the fact that such techniques cannot detect unexpected relationships [20]. To address this issue, a data mining approach is a better candidate because it can search for valuable information in large volumes of data [11] and uncover some unexpected relationships. The main difference between statistical analyses and data mining lies in the aim that is sought. The former is used to verify existing knowledge to prove a known relationship [16] while the latter is aimed at finding unexpected relationships [20]. Due to the fact that the data mining approach can provide such benefits, recently, several studies used the data mining approaches to evaluate the effects of learners' behaviors. These studies demonstrate that clustering is a useful data mining method (e.g.,[14]). The clustering method is mainly used to partition rough data into several groups base on their similar features [19]. It is suitable for investigating differences and similarities among learners' behavior. For example, an early study by Hay et al. [12] adopted a clustering algorithm to extract sequences with similar behavioral patterns. Their results indicated that learners' navigation patterns are distinctive among different clusters. It implies that clustering can provide the structural properties to identify dissimilarities between each group. Moreover, our recent research [4] adopts a clustering method to investigate the relationship between human factors and students' learning behaviors in the Web-based learning systems. The finding of their work indicates that prior knowledge and subject content are two potential factors, which can distinguish learning behaviors among different clusters of learners.

As mentioned above, the clustering method is a useful tool for investigating the learners' behaviors in Web-based learning systems. Thus, this study adopts the clustering method not only to evaluate the relationship between learners' individual differences and their disorientation problems but also to analyze the relationship between learners' disorientation problems and their performance.

2. Methodology

This section describes the methodology used to reach the two-folds aims of this study and introduce techniques applied to analyze corresponding data.

Web-based learning systems**:** In this study, the subject content of a Web-based learning system is *Interaction design* (Figure 1). The Web-based learning system allow learners to develop nonlinear learning strategies to seek information.

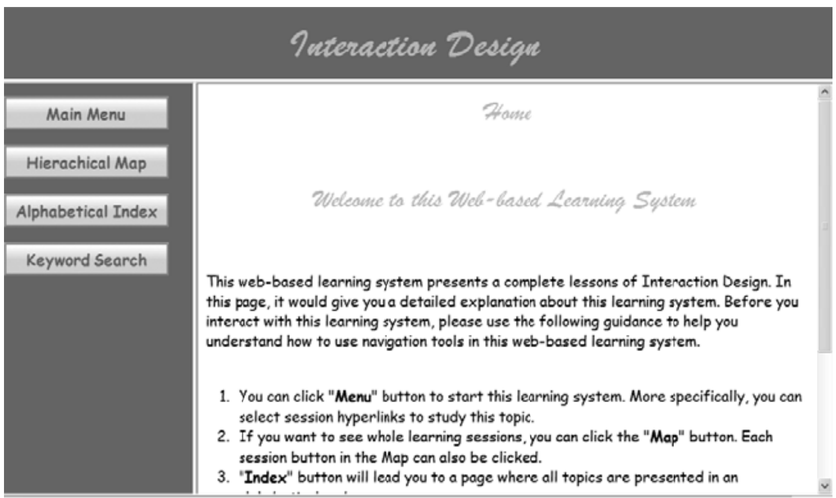

Figure 1. The Web-based learning system.

Participants**:** 50 students from a university in Taiwan participated in our study. These participants were undergraduate or graduate students and they took part in this study voluntarily. All participants had different Internet skills and computer experience of computer aid learning tools to help us identify our aims.

Procedure**:** The procedure was composed of four steps (Figure 2). Each participant had a log file, which recorded his/her personal information, i.e. Internet skills and computer experience of computer aid learning tools. In addition, the participants needed to take the pretest and posttest, which were designed to evaluate participants' learning performance before and after using the Web-based learning system. More specifically, the participants' learning performance was measured based on the differences between the score of posttest and the score of pretest. Both tests included 20 multiple-choice questions, each with three different answers and an "I don't know" option. After learners interacting with the Web-based learning system, they needed to fill out a questionnaire, which was used to measure students' disorientation problems. The questionnaire was developed by an analysis of previous studies on disorientation problems ([9], [18] and [1]). There were 16 questions and each one used a five-point Likert scale ranging *very much, quite a lot, average, not much,* and *not at all*. The smaller of the values represented the low levels of learners' disorientation problems and vice versa. The details of the questions are showed in Table 1.

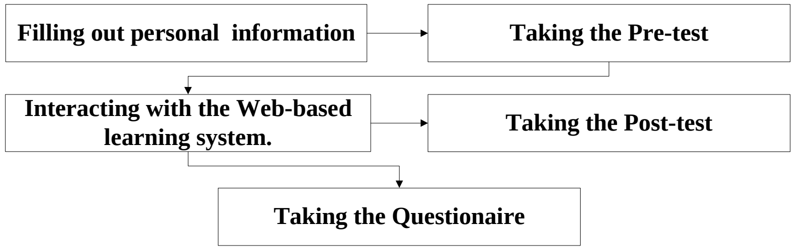

Figure 2. Procedures.

Table 1. The details of questionnaire.

ID	Question
1	I felt the structure of this system not clear.
2	It is very difficult to know which buttons/icons corresponded to the information I wanted.
3	I sometimes got lost because the buttons and icons made me confused.
4	I would have found it more helpful to be given a suggested route through this system.
5	It is hard to find a route for a specific task in this system.
6	I got confused because same page was available through different links or buttons.
7	When proceeding through this system, I was confused which options I wanted, because it provided too many choices.
8	The links provided in this system cannot help me discover the relationships between different concepts.
9	It is not easy to choose any learning topics according to my needs and progress.
10	It is not easy to choose learning sessions according to my needs.
11	It is not easy to review something that I have learnt in this system.
12	I felt confused with the links that show different colors.
13	I was lost with using back/forward buttons.
14	I have difficulties in browsing pages containing texts and links in the same pages.
15	When I navigated in this system, I often forgot where I was.
16	Sometimes I found it hard to keep track which bits I had learnt.

Data Analysis**:** In this study, a clustering method was used to analyze the participants' individual differences, the participants' learning performance and the participants' responses to the questionnaire. Among a variety of clustering techniques used for clustering method, a K-means [10] algorithm is widely used to partition the data into several clusters according to their similar features. The major principle of the K-means algorithm uses k initial centers, each of which is assigned to each cluster, to partition data into k clusters. Each pattern in the cluster is decided based on the nearest distance between the pattern and each cluster center. However, a major limitation of using the K-means algorithm is that the number of clusters needs to be predefined. In other words, there is a need to identify the most suitable number of clusters to perform the K-means algorithm. Such an issue can be treated as parameter exploration [6], which decides the suitable value of parameters. The parameter exploration is useful when dataset is not large. Thus, the issue of the K-means algorithm is suitable for this study because the dataset was not large. Therefore, the parameter exploration was applied to decide the parameters of the K-means algorithm in this study. Subsequently, the number of clusters is set for the large range of value to investigate the robustness in the clustering results. The suitable number of clusters is determined based on not only the smallest distance between the features in same cluster, but also the largest distance between the features in different clusters. After doing so, the suitable number of the K-means algorithm is three.

3 Results and Discussions

The purpose of clustering is to group learners based on their responses to the questionnaire. The higher score from the questionnaire means the situation that they will more easily get lost and vice versa. After performing the K-Means algorithm, three clusters are produced. The percentage of learners within each cluster is satisfactory for the total number of 50 instances. Clusters can be characterized as well balanced: Cluster 0 (N = 21): 42%, Cluster 1 (N= 17): 34%, Cluster 2 (N = 12): 24% (show as Figure 3). As showed in Table 1, the learners are grouped according to the following trends.

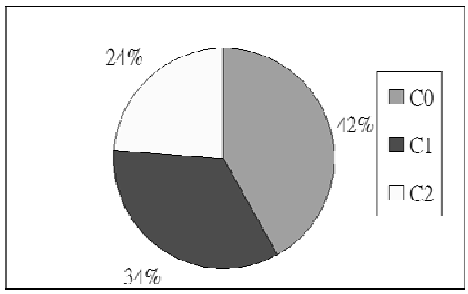

Figure 3 the result from K-Means algorithm.

—Cluster 0 (C0). Learners feel comfortable when using the system. In other words, they are clear with the structure, buttons and icons. On the other hand, they think it would be helpful if a suggested route can be given through this system.

—Cluster 1 (C1). Learners may feel a little confused when using the system. Because the back/forward buttons are unclear to them and it is difficult to keep track which bits they had learnt.

—Cluster 2 (C2). Learners may more easily feel confused when using the system. They are unclear with the structure, buttons and icons and it is difficult to keep track what topics they had learnt. Moreover, they also think that too many options are provided so they do not know how to choose them.

The relationships between students' disorientation problems and their learning performance are examined based on the mean value of the gain scores of each cluster and the mean value of the scores obtained from the questionnaire (Table 2). As shown in this table, the cluster with low degree of disorientation problems may demonstrate high learning performance and vice versa. More specifically, learners in Cluster 0 (C0) get the lowest score from the questionnaire but they have the highest gain score. In contrast, other clusters may get higher scores from the questionnaire but their gain scores are decreased.

Table 2 Score from questionnaire for Each Cluster

Cluster (C)	The score of questionnaire		Performance		Instances
	Mean	STD	Mean	STD	
C0	2.33	0.46	5.29	3.24	21(42%)
C1	3.35	0.36	4.82	2.83	17(34%)
C2	5.23	0.47	3.25	3.57	12(24%)

The aforementioned results indicate that learners' disorientation problems greatly influence their learning performance. Thus, there is a need to further investigate the relationship between learners' disorientation problems and their learning performance.

Beside, the aims of this study also tend to investigate how learners' individual differences influence their disorientation problems. Therefore, the learners' performance and their individual differences are needed to taken into account. The details of the discussion will be showed below.

4.1 Learning performance

In addition to Table 2, the relationships between learners' disorientation problems and their learning performance are further illustrated in Figure 4. As shown in Figure 4, the relationship between learners' disorientation problems and their learning performance are in inverse. More specifically, the learners that never feel confused may obtain high performance while the learners that easily feel confused may have low learning performance. A possible reason is that learners that may not feel confused can easily obtain information they want from the Web-based learning system. As showed in C0, learners which never feel confused are clear with the structure, buttons and icons. In other words, they cannot only easily recognize where to find the topic but also easily understand other relevant topics. It implies that such learners can identify logical relationships between each topic from the Web-based learning system. Thus, this is the reason why they can demonstrate high performance. In contrast, the learners who easily feel confused may feel difficult to locate the relevant information they need. As showed in C1 and C2, both of them easily feel confused because they cannot recognize what topic they have learned or how to locate relevant topics. In other words, they feel confused with the logical relationships between each topic. Thus, their performance is not as good as learners in C0.

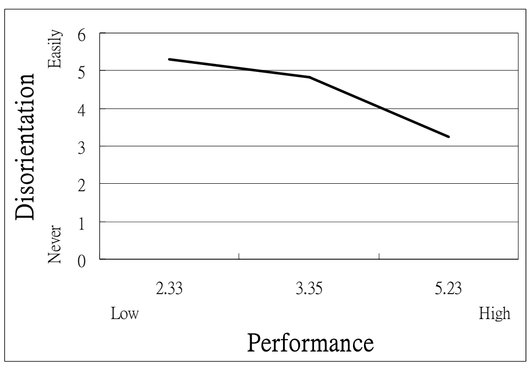

Figure 4 Relationship between learners' disorientation problems and their learning performance.

4.2 Individual Differences

In addition to learners' learning performance, we also investigate how learners' individual differences influence their disorientation. Among various individual difference elements, learners' computer experience is taken into account. The differences of learners' computer experience in each cluster are illustrated in Figure 5. Like Figure 4, the relationship between learners' computer experience and their disorientation problems are also in inverse. More specifically, learners that never feel confused may have more computer experience and vice versa. In other words, learners with much computer experience may feel comfortable with the Web-based leaning system. A possible reason is that learners who have sufficient computer experience can easily understand each function provided by the Web-based learning system so they have less confusion. As showed in C0, learners, who have a high level of computer experience and are clear with the functions, never feel confused. More specifically, they not only understand the meanings of each function but also understand how to use the functions to locate information they need. In other words, learners can easily identify the differences between each function. Thus, they can easily locate information they want by using each function. It also echoes the findings in Section 4.1, which shows that such learners can demonstrate high performance. On the other hand, learners with less computer experience may easily feel confused with each function in the Web-based Learning system. As showed in C1 and C2, both of them easily feel confused because they do not understand the meanings of the functions or how to locate relevant topics by using proper functions. In other words, they may feel confused to identify the differences between each function in the Web-based learning system. Thus, they cannot easily locate the topic they want by using each function. This may be reason why their performance is not as good as learners in C0. (See Section 4.1).

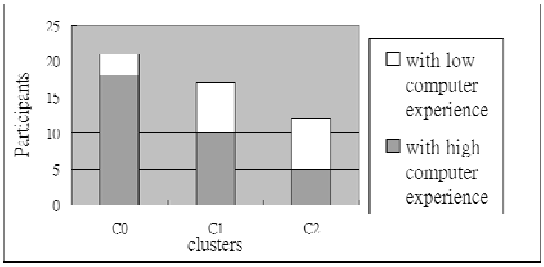

Figure 5 Relationship between learners' computer experience and their disorientation problem.

In summary, the learners' individual differences critically influence their disorientation problems, which may also influence their learning performance. More specifically, learners who have more computer experience may never feel confused to use the Web-based learning system. Thus, they may easily demonstrate high performance. Conversely, learners with less computer experience may easily feel confused when using the system. Thus, it is hard to improve their performance. Figure 6 presents a framework, which summarizes the findings of this study.

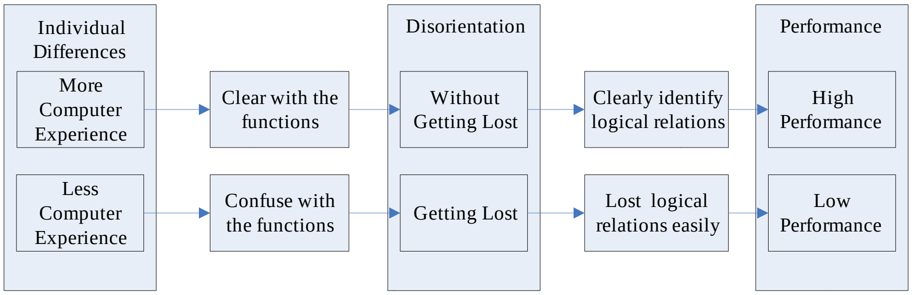

Figure 6 A proposed framework.

5. Concluding remarks

This study investigates learner's disorientation problems with a clustering method. In summary, we found that the learners' computer experiences greatly affect their disorientation problems. Moreover, their disorientation problems also have considerable impacts on their learning performance. In brief, it is necessary to consider learners' computer experience to reduce their disorientation problems, The findings from this study can not only be used to reduce disorientation problems but also to improve their learning performance. In other words, the findings from this study have showed the importance of understanding learners' disorientation problems when using Web-based learning systems. However, this is a small-scaled study so future works should consider a larger sample to provide additional evidence as to learners' disorientation problem but also adopt other data mining methods, such as association rules, classification. Such results can be incorporated into the findings of this study so that reliable user models can be developed to support the development of web-based learning systems.

Acknowledgements

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A Robot-based Learning Companion for Storytelling

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Abstract: Storytelling is a joyful and educational activity for most of children. Storytelling has powerful effects on improving children's skills in language expression (e.g., listening, reading, and comprehension). In this paper, we present a robot-based learning companion to accompany children for storytelling. We hope this system can promote children's interest at storytelling and improve their engagement.
Keyword: robot, learning companion, storytelling, motion capture.

Keywords: Storytelling, Learning companion, Image matching.

Introduction

Over the last two decades, human motion capture systems have been gaining more and more interest from many different research disciplines because they have many potential applications. The automatic analysis of human motion is a very challenging research topic due to its inherent complexity (e.g., body self-occluding problem, diverse body poses). Basically, there are two approaches to implement a human motion capture system: 1) the maker-based approach and 2) the computer vision-based approach. While the marker-based approach requires that a certain amount of rigid markers are attached to the user's body, the computer vision-based approach provides a non-invasive and friendly solution which makes the approach more appealing than the marker-based approach. The potential applications of computer vision-based capture systems can be roughly grouped into three main application areas: surveillance, control, and analysis. Surveillance applications try to provide solutions to the monitoring and tracking of one or multiple subjects at a special location (e.g., people counting, people tracking). Control applications are used to provide human computer interfaces to control something (e.g., games, animation in virtual world). As for analysis applications, they involve in the detailed analysis of the motion data and diagnostics of subjects' performance (e.g., athletes' performance). Some recent review literatures on these related tropics can be found in [1]-[7].

In this paper, we present a playful human-computer interaction system which is based on a computer motion capture system. We try to implement a robot-based learning companion to accompany children for storytelling. Storytelling is a joyful and educational activity for most of children. Storytelling has powerful effects on improving children's skills in language expression (e.g., listening, reading, and comprehension). In addition, storytelling can foster children's creativity and encourage social interactions [8]. Via this robot-based learning companion, children can tell a story in front of a robot-based learning companion and then they act as listeners to watch the robot acts out the story just told by them. We hope this robot-based learning companion can promote children's interest at storytelling and improve their engagement.

The remaining of this paper is organized as follows. Section II will briefly review some related work. The proposed robot-based learning companion is introduced in Section III. The conclusion of this paper is given in Section IV.

1. Related Work

Storytelling is essential for children to develop their language expression, logic thinking, imagination, and creativity [9]. There are several existing storytelling systems which adopt emerging technologies for supporting children to enjoy the activities of storytelling [10]-[22]. MIT's SAGE (Storytelling Agent Generation Environment) which uses a stuffed rabbit provided a storytelling tool for supporting children develop interactive stories [10]. StoryMat developed by Ryokai and Cassell stores children's storytelling play by recording their play stories and movements of stuffed animals they play with [11]. These stories are then played as animations on the mat when another child tell the same story at the same place. PETS (Personal Electronic Teller of Stories) is a robotic pet built with LEGO bricks that could support children in the storytelling process [12]. After children have snapped together special animal parts (e.g., excited, sad) to build a robot, they can give their robot emotions (e.g., excited, sad) to act out throughout their story. Plaisant et al. developed a prototype storytelling robot for use with children in rehabilitation [13]. Children can remotely control a large furry robot by using a variety of body sensors attached to children's bodies. The story told by children can be "played" by the remote robot. TellTale is a toy made of body pieces of a plastic caterpillar [14]. Each body piece can record a piece of a story. The children can put the pieces together and hear the story organized in the order the child has chosen. Sam (an embodied conversational storyteller) was an attempt to have technology play a social role in supporting young children's literacy learning [15]. Dolltalk composed of a platform with a variety of hardware (e.g., tag sensor, accelerometers) allows children to record their stories and hears their voices with the same content but with a different voice [16]. KidPad is a collaborative storytelling tool that supports children to author physical storytelling experiences to share with other children [17]. StoryRoom is a room-sized immersive storytelling environment where it supports children as storytellers from the very start of their experiences [18]. FearNot! is an application of virtual drama to anti-bullying education [19]. Mutlu et al. conducted an experiment to assess the efficacy of the gaze effect as a storytelling robot (Honda's ASIMO) recited a Japanese fairy tale [20]. The aim of the storytelling Alice which is a programming environment is to make the process of learning to program more motivating for middle school girls [21]. A 3D story authoring system for children was introduced to allow children to create roles, design roles' actions, makes and share their owner stories [22]. Each of the aforementioned systems has its own considerations and application scenarios.

While some of those systems are purely programming environments, some of them truly adopt embodied companions (e.g., a stuffed rabbit in SAGE, two dolls in Dolltalk, a plastic caterpillar in TellTable, a large furry robot in [13]). Embodied companions to some extend can enrich children's storytelling engagement and experiences.

In our system, a tiny furry robot bear is adopted to mimic the actions of a child when he or she is telling a story. To teach the robot bear to tell stories, the child is not required to attach a certain amount of sensors on his or her body. All the child needs to do is to tell a story in front of a low-cost Web camera. Then the robot bear will mimic how the child tells the story. Compared to the storytelling robot in [13], our system is more user-friendly. The comparisons between those systems and our system are presented in Table I.

Table I. The use of embodied companions.

	Sensors	PhysicalObjects	Interactive Modes
SAGE[10]	Circuitry Resistor Sensors	Stuffed Rabbit	Converse, Listen & Tell
StoryMat [11]	RF Sensors	Stuffed Bunny	Listen, Tell & Projected Movies
PETS [12] [13]	Light & Touch Sensors	Robotic Pet	Listen, Tell, Sapping, Emotions & Behaviors
TellTale [14]	No	Caterpillar	Listen, Tell & Recombination
Sam [15]	Tags, Motion Detector & Audio Threshold Sensor	Toy Castle & Virtual Avatar	Listen & Tell
Dolltalk [16]	Tags & Accelerometers	Dolls	Listen, Tell in altered voices & Gestures
KidPad [17]	No	Computer	Drawing Tool & Collaboration
StoryRoom [18]	Tags, Touch, Heat, & Light sensors	Augmented Objects	Authoring, Theatrical Experience & Visualization
FearNot! [19]	No	Computer	Graphics
Storytelling robot[20]	No	ASIMO Robot	Gaze behaviors
Storytelling Alice[21]	No	Computer	Programming & Animations
3D story authoring system[22]	No	Computer	Pen, Speech & 3D Graphics
Our System	Web camera	Robotic Bear	Listen, Tell

			in altered voices & Imitating Teller's behaviors

2. The robot-based learning companion system

Our robot-based learning companion called the RobotTell system is composed of a furry robotic bear, a low-cost Web camera, and a notebook as shown in Fig. 1.

Fig.1. The RobotTell System which is composed of a Web camera, robotic bear, and a notebook.

In order to make the robotic bear be able to mimic the storyteller, the RobotTell system must have a simple but effective human pose analysis algorithm to extract meaningful pose information from the storyteller. Based on the extracted pose information, the robotic bear can mimic the storyteller to tell the story which was just told by the storyteller. Based on the computational efficiency consideration, we decided to adopt a template-matching scheme as the core unit of the automatic human pose analysis algorithm. The basic idea of the template-matching scheme is as follows. We assume that the poses of the storyteller can be composed of a set of basic poses. Each basic human pose corresponds to a robot structure poses (i.e., a set of specific joint angles). Each captured image is matched with the set of basic poses to find the most matched basic pose. Then the whole sequence of images can be transformed to be a numerical sequence. Based on the numerical sequence, the robotic bear can sequentially stretch its joint angles to corresponding robot structure poses.

The stages of the human pose analysis algorithm on individual image frames over the image sequence recorded from the storyteller are described below. The flowchart of the human pose analysis algorithm (shown in Fig. 2) involves 6 steps as follows:

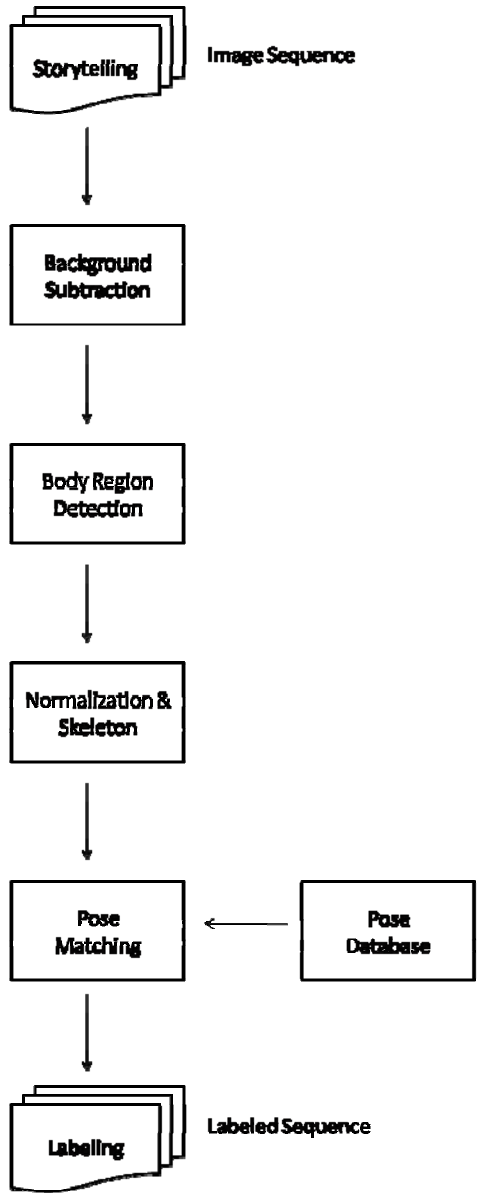

Fig. 2. The flowchart of the pose analysis algorithm in the RobotTell system.

Step 1: Storytelling
Before a child starts to tell a story, a background image without the storyteller has to be acquired for the following background subtraction step. When the child is telling the story, the whole image sequence is recorded and then is analyzed based on the template-matching scheme.
Step 2: Background subtraction
The background of the storytelling environment is assumed to be static. Then, the background subtraction method is utilized as the preprocessing step to segment the foreground from the background so that the storyteller's body can be clipped from the image.
Step 3: Body Region Detection
The silhouette of the storyteller can then be identified from the foreground since the body region will be the largest connected region in the foreground.

Step 4: Normalization and skeleton
The detected body region is firstly normalized as an image with the size of Mb × Nb (e.g., 60 × 80 in our system). Then, a thinning algorithm is adopted to find the skeleton of the silhouette of the storyteller.
Step 5: Pose Matching

The skeleton of the silhouette is then matched to the basic poses in the pose database. Note that the basic poses are all normalized and skeletonized in advance. Since the skeleton images are binary, we can then use the correlation coefficient computation method to select the most matched basic pose from the database.

We adopted 17 basic poses (shown in Fig. 3) in our prototype of the RobotTell system. For each basic pose, we tune the joint angles of the robotic bear to stretch its body structure to display a pose which is similar to the corresponding basic pose. An example of the matching result from an image is shown in Fig. 4.

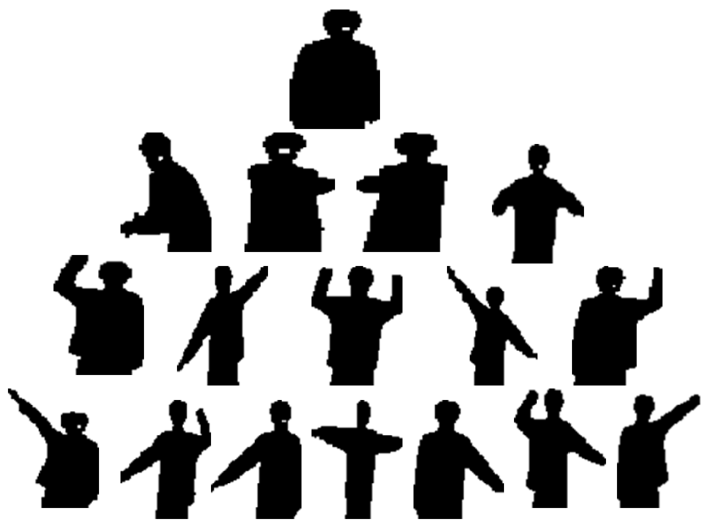

Fig. 3. The 17 pre-defined basic poses stored in the RobotTell system.

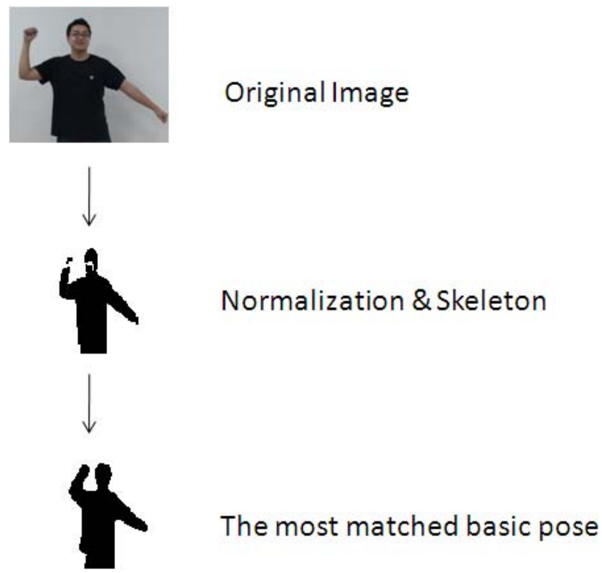

Fig. 4. A sample result of the detected basic pose stored in the RobotTell system.

Step 6: Labeling
After we have found the most matched basic pose for the present frame, we then use a token to label the image frame. The image sequence recorded from the storytelling event is then transformed to a labeled numerical sequence. Based on the labeled numerical sequence, the robotic bear can tell the story as what the child did before. Explain colloquial language and puns. Phrases like “red herring” require a cultural knowledge of English. Humor and irony are difficult to translate.

3. Conclusion

While most of the existing storytelling systems did not incorporate the education method “learning by teaching” into their functionalities, our RobotTell tried to explore the possibility of learning how to tell stories by teaching a robotic companion to tell stories. In our system, a tiny furry robotic bear is adopted to mimic the actions of the children when they are telling stories. To teach the robotic bear to tell stories, the children are not required to attach a certain amount of sensors on their bodies. What the children need to do is to tell stories in front of a low-cost Web camera. Then the robotic bear will mimic how the children tell the stories. One of the aims of the RobotTell is to make storytelling process a joyful and interactive activity. The other aim is to make the system setup as simple and low-cost as possible.

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Effects of Type of Learning Approach and Prior Knowledge on Novices' Motivation, Self-efficacy, Task anxiety and Performance in Learning *Scratch*

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Abstract: The major purpose of this study was to examine whether providing game-play activity before learning generates positive impacts on the learners. The effects of prior knowledge (high vs. low) and learning approach (play-and-learn vs. learn-and-play) on 7-graders' *Scratch* performance was examined in this study. There were ninety-two junior high school students participated in the study. The results showed that (a) those learners received learn-and-play activity possessed higher learning motivation and self-efficacy than the learners received play-and-learn activity, but levels of task anxiety for both groups were moderate; (b) levels of learning motivation and self-efficacy for learners with high prior knowledge and learners with low prior knowledge were about the same, but learners with high prior knowledge held high task anxiety than learners with low prior knowledge; (c) performance on test and project for learners from both learning activities was about the same; finally, (d) high prior knowledge learners outperformed those learners with low prior knowledge on the post-test, but both groups achieved the same level of project performance.

Keywords: game-based learning, prior knowledge, programming concept

1. Introduction

In today's highly interactive digital world, it has been commonly recognized that all students should possess technological literacy [1]. For instance, in England, a policy that required students aged from 7 to 16 to apply computer and technology to their learning in different subjects has been implemented [2]. Moreover, a 5-year plan which required teachers to integrate information and communication technology in curricular has been implemented in Hong Kong [1]. Although computer and technology can enhance teaching and learning by applying it as a supporting tool to cultivate learners' technological literacy and facilitate learners to think independently, effective learning requires learners to engage in the learning process. A considerate design of learning approach is a key to enhance learners' engagement in the learning process. Therefore, the instructional designs of e-learning activities must contain appropriate learning approaches in order to make learning become more engaging and effective.

2. Related Literature

Learning Approach and Game-based Learning

Pedagogy, content and technology (PCT) were three aspects that could be taken into consideration when examining the barriers of technology-based learning activity in a study. According to the pedagogy perspective, learners' learning interests and learning motivation were usually neglected in programming learning [3]. Based on the content viewpoint, even syntax and programming concepts were difficult for novices to understand [4]. In connecting with the technology aspect, programming skill was one of the crucial skills for technological literacy. As Kafai, Ching and Marshall suggested, learners could benefit from the creating process when their role changed from a learner to a designer [5]. By doing so, learners would be able to overcome barriers in learning to program.

Generally speaking, game-based learning, which becomes a promising tool for providing highly motivating learning situations to learners, can be an effective means to assist learners to learn since learners construct knowledge by playing, maintain high learning motivation and apply acquired knowledge to real-life problem solving. Game-based learning enables learners to construct knowledge from trial and error with an integration of engaged playing, problem solving, situated learning and challenges [6, 7]. A successful game-based learning was strongly correlated with higher degrees of flow experience, as suggested by Kiili [8]. However, whether the sequencing of game-based learning activity affects learners' motivation and achievement remains unsolved in previous literature. Since the majority of researches related to game-based learning focused more on the theoretical aspects of gaming and lacked empirical evidence to validate its educational meaningfulness, the present study, therefore, employed an experiential gaming model as the pedagogical framework with two types of learning approaches, including play-and-learn and learn-and-play, to examine whether learners perform equally in learning programming concepts. Accordingly, the effects of learning approach and prior knowledge on learners' performance in comprehension test and project were also examined in the study.

Learning through Game-play

Through ambiguous and challenging trial and error, games-based learning can provide a rich learning context to help learners construct higher level knowledge [6]. Through the game-play processes, learners will be able to develop reflection skills and meta-cognitive strategies and transform the learning experience into problem solving. The developed cognitive strategies help learner bridge prior knowledge with new knowledge and enhance meaningful learning [9]. Therefore, the higher level programming knowledge and skills can be acquired by the learners through game-play. Moreover, different types of game strategies can be utilized to fulfill specific learning objectives. Previous studies [10, 11] suggested that action or sports games were appropriate for declarative knowledge content, adventure games were more suitable for practicing procedural knowledge, and role-play games were suitable for conditional knowledge. Hence, the present study employed matching game and challenge game to provide various types of interactivity to engage learners and facilitate learning of computer concepts and skills through the joyful gaming processes.

The ability to reconstruct knowledge, to express ideas creatively and to create information productions can be referred to as the capability of information technology, whereas technological literacy emerged in today's highly interactive digital world can be referred to as the programming skills [8]. However, novice programmers faced barriers when learning programming [12], which could be categorized into three aspects, including pedagogy, content and technology. The learning activity for programming and learners' learning interests and learning motivation were usually unmatched based on the perspective of pedagogy [3]. From the viewpoint of content, learners, especially novices, lacked practicing opportunity and had a difficult time in comprehending the syntax and concepts of programming [12]. On the other hand, skills on programming were technological literacy for problem solving based on the aspect of technology. For overcoming the barriers in learning programming, Kafai, Ching and Marshall even suggested that the role of learners should be changed from a game user to a game designer since learners could benefit from the creating process and possessed more opportunities to reconstruct acquired knowledge, express ideas and enrich learning experiences [5]. In the present study, for eliminating the barriers in learning programming, two learning approaches, learn-and-play and play-and-learn were employed and their effects on learners' attitudes and achievement were examined.

Individual Differences

Learners' individual predispositions somehow conditioned their readiness to benefit from the learning environment. Giving a certain environment to learners, some benefited more, some less and some not at all. In the field of computer skills learning, computer prior knowledge was suggested to dominate learners' performance. Individual differences in background and prior experience were found to affect the performance and attitude of users of computers [13, 14]. Prior knowledge is either a necessary or at least a facilitating factor in the acquisition of new knowledge in the same content domain. Individuals who have greater knowledge will learn more quickly and effectively. It was also suggested that domain-specific expertise is the most important difference between novices and experts in various knowledge domains, such as physics, algebra, geometry, and computers. Previous studies have shown that the most reliable predictions of computing attitude and achievement are based on the amount of prior computing knowledge [15, 16]. Therefore, it is important to examine learners' prior knowledge along with learners' performance while learning computer skills.

3. Research Methods

Research Design

This study employed a quasi-experimental design to examine the effects of learning approach and prior-knowledge on learners' performance and attitudes. The experiment was conducted in a 4-week session of learning basic programming concepts using *Scratch*. As shown in Figure 1, the play-and-learn approach employed game-play of *Scratch* games first, after that, learning activities on programming concepts using *Scratch* were provided for learners to practice their acquired knowledge and concepts. In contrast, the learn-and-play approach employed learning activities on programming concepts using *Scratch* first, then game-play of *Scratch* games were employed and served as an application context for learners to practice their acquired knowledge and concepts. After game-ply, learners needed to complete the given programming project individually. Participants' levels of prior-knowledge were obtained from their previous computer course grades and were identified as the low prior-knowledge group and the high prior-knowledge group by the mean grade. Multivariate Analysis of Variance (MANOVA) was conducted on learners' performance with a significance level of .05 in the present study.

Figure 1. *Scratch*, the left screen, was employed to serve as a learning context and tool for learning programming concepts; *Scratch* games, the right screen, served as an application context for learners to practice their acquired knowledge and concepts.

Participants

Ninety-two 7-graders participated in the experiment. All participants were novices to programming languages. Participants were randomly assigned to either the play-and learn group or the learn-and-play group. Participants' levels of prior-knowledge (high vs. low) were identified according to their grades on previous computer course. A programming project was employed to facilitate participants to apply acquired knowledge to solve real-life problems after learning from the game-play activities. Project performance was assessed for further analysis.

4. Findings

4.1 Analysis of Learning Approach on Motivation, Self-efficacy and Task-anxiety

The group means of participants' motivation, self-efficacy and task-anxiety measured on a 5-point Likert-type scale are shown in Table 1. For learning approach groups, the play-and-learn group obtained higher motivation and self-efficacy and slightly higher task-anxiety than the learn-and-play group. Similarly, for prior knowledge groups, the high prior-knowledge group obtained higher motivation, self-efficacy and task-anxiety than the low prior-knowledge group. The differences between groups were further analyzed as follows.

Table 1. Group means of participants' motivation, self-efficacy and task-anxiety

Dependent Variable	Group	Mean	SD	N
Motivation	Learn-and-Play	3.003	.816	47
	Play-and-Learn	3.492	.774	45
Self-efficacy	Learn-and-Play	2.823	.697	47
	Play-and-Learn	3.435	.817	45
Task-anxiety	Learn-and-Play	2.984	.859	47
	Play-and-Learn	3.034	.759	45
Motivation	Low PK	3.160	.723	43
	High PK	3.335	.912	49
Self-efficacy	Low PK	3.078	.735	43
	High PK	3.180	.882	49
Task-anxiety	Low PK	2.801	.709	43
	High PK	3.217	.844	49

Two-way MANOVA was conducted to examine the effects of learning approach and prior knowledge on participants' motivation, self-efficacy and task-anxiety. First, as shown in Table 2, Levene's tests of equality were not significant for all dependent measures. The null hypothesis that the error variance of the dependent variable is equal across groups was sustained. The MANOVA summary is shown in Table 3, the main effects of learning approach were significant on motivation and self-efficacy (motivation: $F_{(1,91)}$=8.506, p=.004; self-efficacy: $F_{(1,91)}$=14.545, p<.001) and the main effect of prior knowledge was significant on task-anxiety ($F_{(1,91)}$=6.367, p=.013). That is to say, the play-and-learn group revealed higher motivation and self-efficacy than the learn-and-play group, and the high prior-knowledge group possessed higher task-anxiety than the low prior-knowledge group

Table 2. Summary of Levene's tests for motivation, self-efficacy and task-anxiety

Dependent Measure	F	df1	df2	Sig.
Motivation	.154	3	91	.927
Self-efficacy	.761	3	91	.519
Task-anxiety	1.057	3	91	.371

Design: Intercept+Group+PK+Group* PK

Table 3. MANOVA Summary for group and prior-knowledge on motivation, self-efficacy and task-anxiety

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Group	Motivation [a]	5.432	1	5.432	8.506	**.004**	.088
	Self-efficacy [b]	8.510	1	8.510	14.545	**.000**	.142
	Task-anxiety [c]	.055	1	.055	.089	.766	.001
Prior-knowledge	Motivation	.695	1	.695	1.088	.300	.012
	Self-efficacy	.236	1	.236	.403	.527	.005
	Task-anxiety	3.939	1	3.939	6.367	**.013**	.067
Group * PK	Motivation	.109	1	.109	.171	.680	.002
	Self-efficacy	.001	1	.001	.002	.968	.000
	Task-anxiety	.843	1	.843	1.363	.246	.015
Error	Motivation	56.191	91	.639			
	Self-efficacy	51.483	91	.585			
	Task-anxiety	54.452	91	.619			

a R Squared = .097 (Adjusted R Squared = .067)
b R Squared = .143 (Adjusted R Squared = .114)
c R Squared = .081 (Adjusted R Squared = .050)

4.2 Analysis of Learning Approach on Post-test and Project Performance

The group means of participants' post-test and project performance measured on a 10-point scale are shown in Table 4. For learning approach groups, the play-and-learn group obtained slightly higher post-test and project performance than the learn-and-play group. Similarly, for prior knowledge groups, the high prior-knowledge group obtained higher post-test and project performance than the low prior-knowledge group. The differences between groups were further analyzed as follows.

Table 4. Group means of participants' performance on post-test and project

Dependent Variable	Group	Mean	SD	N
Post-test	Learn-and-Play	7.491	2.674	47
	Play-and-Learn	7.585	2.445	45
Project	Learn-and-Play	7.317	2.244	47
	Play-and-Learn	7.727	2.448	45
Post-test	Low PK	6.380	2.226	43

	High PK	8.695	2.340	49
Project	Low PK	7.377	2.402	43
	High PK	7.667	2.306	49

Two-way MANOVA was conducted to examine the effects of learning approach and prior knowledge on participants' post-test and project performance. First, as shown in Table 5, Levene's tests of equality were not significant for all dependent measures. The null hypothesis that the error variance of the dependent variable is equal across groups was sustained. The MANOVA summary is shown in Table 6, the main effect of learning approach was not significant on dependent measures and the main effect of prior knowledge was significant on the post-test ($F_{(1,88)}$=22.904, p<.001). In other words, the play-and-learn approach and the learn-and-play approach revealed similar effects on participants' post-test and project performance. However, the high prior-knowledge group achieved higher post-test performance than the low prior-knowledge group, but both groups achieved the same level of project performance

Table 5. Summary of Levene's tests for motivation, self-efficacy and task-anxiety

Dependent Measure	F	df1	df2	Sig.
Post-test	1.623	3	88	.190
Project	.677	3	88	.569

Design: Intercept+Group+PK+Group* PK

Table 6. MANOVA Summary for group and prior-knowledge on post-test and project

Source	Dependent Variable	ype III um of quares	df	Mean Square	F	Sig.	Partial Et Squared
Group	Post-test [a]	!02	1	.202	.038	.846	.000
	Project [b]	80.388	1	380.388	.681	.411	.008
Prior-knowledge	Post-test	21.806	1	121.806	22.904	.000	.207
	Project	89.994	1	189.994	.340	.561	.004
Group*PK	Post-test	.526	1	2.526	.475	.492	.005
	Project	96.870	1	196.870	.353	.554	.004
Error	Post-test	67.994	88	5.318			
	Project	9144.098	88	558.456			

a Adjusted R Squared = .183
b Adjusted R Squared = .015

5. Conclusions

Although game-based learning has become a promising activity for providing highly motivating learning to learners, whether the sequencing of game-based learning activity affects learners' motivation and achievement remain unsolved in previous literature. The present study examined the effects of different sequencing on learners' attitudes toward game-based learning and performance in learning from game-based learning by the play-and-learn and learn-and-play learning approaches. The results of this study suggested that the play-and-learn approach can trigger higher motivation and self-efficacy than the learn-and-play approach, and at the same time both approaches help learners maintain at a moderate level of task-anxiety that engaged learners in the game-play learning task. As for prior knowledge, both low prior-knowledge learners and high prior-knowledge learners revealed same levels of motivation and self-efficacy. The possible cause may result from the promising feature of game-based learning in promoting learning motivation and self-efficacy through motivated learning-by-doing activities. For task-anxiety, probably due to the high prior-knowledge learners' better-structured elaborated knowledge, they showed higher concern in completing the game-play task than the low prior-knowledge learners. Therefore, learners with high prior-knowledge may be better to benefit from the game-based learning activities.

As for learning achievement, the play-and-learn approach and the learn-and-play approach revealed similar effects on post-test and project performance. In other words, both the play-and-learn approach and the learn-and-play approach are effective in achieving the same levels of performance. However, the high prior-knowledge group achieved higher post-test performance than the low prior-knowledge group, but both groups achieved the same level of project performance. That is to say, although the low prior-knowledge learners acquire lower comprehension in programming concept, they achieve the same performance level as the high prior-knowledge learner in the hand-on programming project. Therefore, it can be inferred that the learning-by-doing game-play activities can better facilitate learners to apply acquired knowledge in the learning contexts.

In conclusion, game-based learning can be an effective means to assist learners to construct knowledge by playing, maintain high learning motivation and apply acquired knowledge to real-life problem solving. The present study further suggested that applying play-and-learn approach can facilitate learning and, at the same time, maintain high motivation and self-efficacy

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Understanding User Requirements and Expectations of Digital Learning Resources

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Abstract: This paper discusses the need to understand e-learning users, their goals, tasks, and requirements. A research project carried out addressing some of these concerns in the context of basic education in England is presented here. A series of engagement activities were carried out exploring how digital learning resources are actually used in classroom teaching and learning aiming to elucidate user needs and expectations. Results are discussed in detail and some recommendations for future development put forward.

Keywords: Digital learning resources, basic education, user requirements

Introduction

"Know thy user" is the fundamental mantra for Human-Centered Design (HCD) specialists. Understanding e-learning users, their goals, needs and expectations should therefore be the basis on which interactive learning materials, tools and environments are designed. Research addressing learning technologies and e-learning is extensive; current interests range from game-base learning, mobile learning, AI in education and adaptive learning, to collaborative learning and social and virtual environments, to mention but a few topics. It is also noticeable that a high volume of such research is concerned with e-learning in higher education whilst there is relatively little on such needs in Primary or Secondary schools.

The research reported in this paper aimed at understanding learning technology users in basic education schools in England. Comparatively little information is available describing actual usage of Digital Learning Resources (DLR) by teachers and learners in schools. In order to further inform design, and development, research was required exploring users characteristics and context of use to understand, for example, what teachers feel about the suitability of DLR and associated technology available to them, what their understanding of quality is, what aspects enable or block their use of technology; to sum up: what their requirements and expectations are.

1. Research approach

The aim of this research was to understand user needs, expectations and experiences with DLR in Primary and Secondary schools in England. A research team from the Communication and Computing Research Centre (CCRC) at Sheffield Hallam University was thus commissioned to work with teachers and other stakeholders to investigate:

- How DLR are actually used in classroom teaching and learning
- How well teachers feel their requirements for DLR are being met
- What measures and activities could improve the supply, quality and use of DLR in schools

Our approach to tackling this project was firmly grounded on user-centered principles in that user characteristics and their context of use should be understood and used to inform design and development of interactive materials, tools and learning environments.

1.1 *The context of digital technologies in education in England*

It is not just the specific technological context within each school that determines the type of learning interactions that take place and influences the e-learning users' requirements and expectations. Social and organizational aspects are as relevant in HCD and as such understanding the broader landscape in which schools operate was particularly important in shaping the research approach of this study. These aspects might also be relevant for interested readers unfamiliar with the school system in England. According to the national statistics on schools, pupils and their characteristics [5], in the school year 2009-2010 there were 16,971 primary schools and 3,127 secondary schools in England; the total number of maintained schools in basic education was 24,616.

At the administrative level, schools are coordinated by Local Authorities (LA). There are 150 LA in England, and they are responsible for the strategic management of education services [6]. An important role for LA is to support and encourage schools to improve learning with Information and Communication Technologies (ICT), for which different LA have different approaches. In some regions, schools are responsible for the acquisition of DLR out of the school's budget; other LA have adopted regional strategies and have been responsible for the acquisition of specific learning platforms and/or educational software for /some or all schools under their management.

At the strategic level, the main initiative for the future development of ICT in education is "Harnessing Technology" [4], which identifies the main objectives and priorities for the inclusion of digital technologies for teaching and learning.

BECTA is the government agency responsible for helping schools and LA implement the Harnessing Technology strategies.1 BECTA strive to embed effective use of technology in education and to ensure that market developed products and services meet the needs of schools. Its main activities include research, evaluation and independent advice.

Some national strategies that have strongly influenced the current shape of digital technologies in schools include the adoption of Interactive Whiteboards (IWB) around the year 2000, and more recently of Learning Platforms (LP) -i.e. virtual learning environments. According to a recent report [3], 99% of primary school teachers and 84% of secondary school teachers have access to IWB. Similarly, 93% of secondary schools reported they had a learning platform in operations, compared to 67% of primary schools and 56% of special schools.

Additional authorities in the context of digital technologies in basic education are City Learning Centers (CLCs) and regional Grids for Learning (GfL). CLCs were established as part of an excellence program designed to support the educational challenges of the major cities in England [2]. 105 CLCs were set up in urban areas where there was a mixture of social disadvantage and underperformance in schools. CLCs aim at providing enhanced ICT based learning for pupils and teachers, particularly in secondary schools, and to provide access to education to the wider community. In most cases CLCs are based at a building attached to a host school and they serve a network of schools in the area.

1.2 Methodology

Engagement with stakeholders was primarily through workshops, predominantly involving members of the teaching community and some representatives of LA, CLCs and regional Grids for Learning (GfL). The project's fieldwork included 8 workshops, through which 59 participants from 36 schools were engaged in the research. In line with the aims of the project, the main themes identified were:

- Common practice in the use of DLRs
- Current approaches to finding DLRs
- Assessment of fitness for purpose and quality of DLRs

Activities during the workshops were organized around six worksheets addressing each of the themes. Activities aimed at gathering experiences and opinions, and facilitating constructive discussion. Discussions were conducted using semi-structured protocols encouraging participants to share their experiences and to cover the primary objectives, whilst also ensuring that emergent observations were fully recognized.

Data collected through these activities included written information from the participants, collaboratively composed summaries of the discussion tasks and the facilitators' notes. For each theme data was analysed using collaborative discourse analysis techniques, by the research team against the research objectives.

Since participation in the workshops was voluntary, it was important to prevent findings from being potentially skewed due to the self selecting nature of the participants, thus additional strategies were employed, including 13 individual interviews and an online survey gaining 58 responses. These provided additional sources of information used to cross-validate workshop findings.

2. Results

2.1 The school context

Results from the engagement activities emphasized that most teachers are convinced of the value of ICT but they are not interested in becoming ICT experts. They are keen to use what they know and what they think is reliable, but few of them are prepared to spend time experimenting.

Participants suggested that teachers tend to be very inward looking and place much trust in the judgment of their colleagues. It also became apparent that time and inclination are two motivating factors for teachers using DLRs.

Moreover, participants extensively recognized that their learners have spent their lives surrounded by technology and as a result are confident users of ICT. These "digital natives" [7], also known as the "Net generation" [1], represent new challenges for teachers as often they are highly ICT literate - in some cases more so than the teachers.

An additional aspect that emerged was that younger teachers seemed to be more confident using ICT and therefore more enthusiastic embedding DLRs in their practice. This may be related to the fact that some of them are actually digital natives and some others have been taught using ICT. Furthermore, the training these new graduates receive greatly influences their teaching strategies; for example, they make extensive use of software and/or online resources recommended during training.

The Harnessing Technology strategy does appear to be influencing use of DLRs and ICTs on the ground, for example in cases such as: government policies, strategies and initiatives. Examples of these include:

- The introduction of IWB in schools. As expressed by our participants, when this initiative was put forward, schools were not convinced about its potential advantages. Currently, IWB are extensively used and perceptions of their usefulness are quite positive among teachers.
- Changes to the National Curriculum in relation to the ways ICT is delivered in schools.
- Major changes in the school provision, such as the introduction of compulsory modern foreign languages and how these are taught using ICTs.

With the increasing use of DLRs, the technological infrastructure of the school plays a major role. Infrastructure determines to a great extent the kind of resources teachers can or cannot use in class and technology's reliability is a big concern: if the infrastructure does not work, the DLRs will not. The issue of preparing for a class when technology might fail was widely discussed during our workshops, and having a strong back-up plan (a "plan-B"), was considered essential.

2.2 Advantages and disadvantages of DLRs

Most teachers accept the benefits of ICT but are frustrated by its limitations, where the common argument is that DLRs are not designed with teachers and learners in mind. Participants identified four key advantages of DLRs. They offer:

- Enhanced teaching and learning by providing interaction, explaining or demonstrating concepts in a different, innovative way
- Visually appealing to children - colourful, neat graphic content, which can help create interest and engagement
- Some DLRs such as animations and simulations can help explain difficult concepts or experience processes that otherwise would not be possible
- Sharing DLRs represents a mechanism to share good practice

In the same way, some disadvantages of DLRs were discussed, particularly that:

- Content prepared outside school can be blocked, unavailable or may not work in the classroom; e.g. video clips from YouTube
- Finding or creating the right DLR can be time consuming
- Lack of time may make it difficult for teachers to get to know a DLR well
- Resources do not change quickly enough to keep up with curriculum changes
- DLRs may be expensive
- Lack of available titles to suit specific needs, including infant schools, Special Educational Needs (SEN) children, migrant and ethnic minority children, and students in Pupil Referral Units.

2.3 Drivers for using DLRs

According to our participants, the main driver for using DLRs is to enhance learning. DLRs are treated as any other resource: teachers plan their lessons and look for the best resources to meet the needs of their learners. A strong message frequently expressed throughout the engagement workshops was therefore that DLRs are not the answer to everything.

To incorporate DLRs within the teachers’ practice, resources have to fit within their individual approach and particular strategies. Thus, an important requirement of DLRs is flexibility; fitting resources to specific contexts also leads to many teachers being keen to create, adapt and repurpose DLRs (see section 2.5).

DLRs are therefore used where they add value to the teaching and learning process. DLRs are expected to enhance teaching, making learning more interesting and helping to achieve desired learning goals.

Selection of DLRs depends on the specific subject being taught and the extent to which objectives from the National Curriculum are effectively being supported. Moreover, the group age, key stage and ability level determines suitability of existing DLRs.

Personalized learning is quite high on the agenda for teachers. Accordingly, DLRs are chosen or rejected based on how well they can support pupils with different ability levels, learning styles or special needs. Additional considerations include ease of use, attractiveness and whether the resource will help engage children in their own personalized learning.

2.4 Blockers for using DLRs

While most classrooms have IWB, not all of them have individual computers for the learners to use. Using laptops may help, but it requires careful consideration of some practical issues such as moving the laptop trolley around the school, making sure that batteries are fully charged and getting access to the Internet if required.

Compatibility issues also extend to the types of computers co-existing in schools and the need for versions to suit Macs as well as PCs. In addition, older DLRs may not work properly with newer versions of operating systems. In addition, technology is ageing and there is not always provision in the budget to keep the school ICT infrastructure up-to-date.

Not just availability of equipment, but availability of DLRs in school is an issue; which is linked to the school budget and the school priorities.

Laptops and PCs are commonly configured to minimum specs to keep costs down, but most recent DLRs require extensive memory, disk space, etc. In the same way, the availability of different types of IWB around classrooms means that different types of interaction are possible and also that different file formats are required for DLRs. This in turn means that depending on the equipment available in specific rooms, use of DLRs such as video clips may be hindered - e.g. file formats, codecs.

Training and technical support available are also important issues influencing use of DLRs in schools. The general perception among participants was that the acquisition of the necessary skills to successfully use DLRs for teaching and learning is not commonly linked to a strategic school approach. Hence, the view was that it is necessary to invest personal time.

2.5 Creation and Re-purposing DLRs

Creation and re-purposing of DLRs were topics extensively discussed. Some teachers create their own digital resources by capturing assets (e.g. through the use of digital cameras, camcorders, voice recorders,) or developing software content (e.g. interactive games). Many others re-purpose existing DLRs by assembling learning activities, personalizing interactive content, creating slide shows using digital assets of various types or editing digital content such as video clips.

Creation and adaptation of DLRs are linked to issues of ownership and control. Ownership develops where the teacher is able to create and adapt content fit for purpose and of suitable quality. Sense of control develops as the teacher can ensure that a particular DLR will work as it is expected; for example, being able to play a particular video clip regardless of the room in which they will teach.

For the more experienced users, control over DLRs can be exercised by, for example, buying some of the support software for personal use or by posting content using their own independent website. However, as mentioned in section 2.2 currently, developing or adapting DLRs is time-consuming and requires knowledge and skills that not all teachers posses. Control therefore, goes hand-in-hand with competence.

Secondary schools tend to require more DLR autonomy and control. Primary teachers appeared to prefer sharing DLRs. This could be due to subject specialism and staff specialism within secondary education.

2.6 Needs and desires of DLRs

Participants were explicitly asked what they needed and wanted from DLRs. While their answers to this question were diverse, a series of common needs and expectations were identified and are discussed below.

The main requirement for DLRs is that they must be flexible. DLRs are expected to fit within different teaching styles and strategies and to be easily adaptable. Nonetheless, teachers are quite clear that a DLR cannot be everything for everyone.

However, teachers need to be able to easily adapt DLRs to their specific teaching needs, such as using resources with a whole class or individual learners; changing the language to suit the age range of the children; extending or reducing lesson content and learning tasks to be carried out; or personalizing the look and feel of the resource - including fonts sizes, colors and local images or content, which is seen as a further advantage when working with SEN children.

Flexibility extends to the possibility of using a particular DLR regardless of the equipment available for interacting with it, e.g. diversity of IWBs, classroom computers or portable devices.

DLRs are also required to enhance, that is, add value to the teaching and learning process; therefore meaningful learning activities and different options for assessment and feedback are features highly regarded by teachers. It is also expected that feedback can be used to personalize learning tasks for each child. This in turn implies that DLRs are valued where they provide teachers with facilities for keeping track and monitoring individual progress.

In addition, with the higher uptake of Learning Platforms, DLRs are expected to easily fit within the school platform, providing anywhere and anytime access for teachers and children. E-safety was an issue widely discussed. In one extreme, some teachers are afraid of exposing pupils to inappropriate content and therefore avoid online interactions. In the other extreme are teachers who consider e-safety as a basic requirement, but not to the point of blocking content (e.g. websites, video clips, and images) teachers had researched at home. In such cases, filters and firewalls are seen as blockers.

Staff training and development opportunities were highlighted as important needs. Strategies such as networking with other teachers either internally or externally through teacher training days specifically designed to address DLR issues were seen as quite effective.

Effective use of DLRs in teaching is reliant upon a diverse range of factors. These to a certain extent increase the perceived risk of using DLRs, suggesting in turn that DLR flexibility and teacher competence are core to managing that use.

2.7 Quality Criteria for DLRs

Teachers were asked to draw upon their experience to identify the quality criteria they employ in the selection and rejection of DLRs. Criteria that were commonly used to judge fitness for purpose and quality of DLRs were:

- Contextualization, in terms of teaching needs (subject, type of resource, curriculum, key stage, type of lesson activity, type of technology being used, type of learner etc)
- Suitability and relevance
- Accurate and trustworthy content
- Reusability and interoperability: could resources be identified at component level and easily integrated with other resources? Would they work on all LPs?

Additional relevant factors included: the ease of finding DLRs, their cost and whether they were presented in a jargon free manner. Conversely, reasons why a DLR might not be selected consistently focused on issues regarding how DLRs are presented to teachers. There were references to "*too much language*" and " *too high a level of language used*".
When asked how a DLR was chosen, the key message was one's experiential assessment using a trial or demo version of a DLR. Once working at this level, "*appropriateness"* and *"personal judgment*" were employed.

Teachers' priorities lie within pedagogic principles. In particular the data clearly shows matches to the Curriculum and assessment to support learning to be very highly rated by teachers.

3. Implications for further development

Teachers may be characterized as time-poor, task-oriented and heavily dependent on online searching facilities to locate digital resources. They are convinced of the value of ICT but they are not interested in becoming technical experts. Teachers are keen to use what they know and what they think is reliable, only some of them are prepared to spend time experimenting. Participants in this research added that teachers place trust in the judgment of other teachers, and that preparation time and inclination are two vital ingredients to using DLRs, whilst trust is also a major concern.

For teachers, issues center on perceptions of the risks which DLRs pose to effective teaching and personal teaching capabilities. These perceptions of risk are balanced by the recognition of the potential for DLRs to improve teaching practice.
Some suggestions derived through the research focused on organizational change to provide guidance and support, instill confidence and technical knowledge, and to enhance both knowledge and practice of DLR enhanced teaching and learning:

- Demonstrator activities can be designed and tailored to show how DLRs are successfully employed in class teaching situations and to illustrate the benefits to both teachers and learners.
- Support and education activities can help teachers recognize how best to manage and counter risks. For example, DLR supported teaching in CPD programs, with the emphasis on teaching and learning outputs, not technical skills.
- Leadership initiatives can be created to facilitate the development of teaching practices and pedagogies appropriate to the digital environment. The use of DLRs and tools is relatively immature and teachers and learners are developing their understanding of what works and what might be possible.

- Use champions, experts and other exemplar personnel can be used to encourage sharing of success and effective practice.
- In supporting decision making, LA and other ICT advisors can be expected to be authoritative about the appropriateness and quality of e-learning tools and content.

3.1 DLR expectations and requirements

Regarding teachers' expectations and requirements of digital learning resources, our research highlighted the need for better tools and resources to be more widely available and flexible enough to adapt to teachers' and learners' needs.

E-learning tools and resources need to add interest to lessons and help engage learners. They key words mined from the data collected in this research include: *flexible, interactive, stimulating, motivating, attractive, adaptable, easy to use,* and *suitable.* Contextualized content is vital for teachers. Clear learning objectives, linked to the National Curriculum, indicating age groups, key stages and ability levels supported are a must for digital content.

Flexibility requires content of different granularity. Teachers may, for example, look for specific assets or pieces of information, but they can also look for ideas, schemes of work, lesson plans or interactive content. Flexibility also refers to the suitability of resources to fit to different teaching styles and strategies, as well as different approaches to learning.

Considering that teachers have no time to experiment, providing easy to use, easy to learn e-learning is important DLRs are expected to provide familiar interaction styles, layouts and functionality, following industry conventions, patterns and standards thus is crucial.

To mitigate the perceived risks that e-learning poses to effective teaching, providing support for developing "plan-B" can be advisable; for example, providing low-tech alternatives for digital content such as printable resources.

Technical configuration of equipment available in schools is diverse, e-learning tools and content cannot assume availability of extensive resources (memory, disk space, etc.). Furthermore, different standards (e.g. IWB) make interoperability a key requirement.

As the project has shown, not enough is known about how, where and why e-learning works, with some sectors less well understood than others. Future improvements in DLRs and, more generally, developments to enhance the effective use of e-learning technologies depends on better understanding of the needs of teachers and learners. This study has outlined some areas of that understanding, but more is needed.

Notes

1. At the time of writing this report, the UK Government had announced a package of public sector savings which includes the planned closure of BECTA.

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Students' Intentions and Achievements in Using Open and Closed Network Resources for Web-based Problem Solving

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Abstract: Owing to the popularity of computers and computer networks, fostering the web-based problem-solving ability of students has become an important educational objective in recent years. This study attempts to compare the effects of using closed and open network resources on students' intentions and learning effectiveness with regards to web-based problem-solving activities. An experiment was conducted by situating students from a senior high school computer course in web-based learning environments with different network resources to find the answers to several questions about "structured programming design". The experimental results show that the low-achievement students who learned in both the open-resource network and closed-resource network made remarkable progress. However, the high-achievement students who learned in the closed-resource network had significantly better performance than those who learned in the open-resource network. In addition, the learning task completion ratio and the difficulties the students encountered were recorded and analyzed, and the perceptions of the students regarding their engagement in the learning activity are compared and discussed.

Keywords: Information searching, problem-based-learning, open network inquiry, closed network inquiry

1. Background and Motivation

Problem-based learning has been recognized as being an important and challenging educational issue in the past decades [1, 6, 14]. Nowadays, most of the information needed for solving problems can be obtained by searching the Internet via search engines, or digital libraries via the online information-searching interface. While searching for information to solve problems, the students need to express their intentions as keywords, evaluate the correctness and relevancy of the searched data or information, extract the proper content portions or statements, and organize the extracted content for solving the problems [4, 5]. Previous studies have shown the positive effects of using online technologies to support problem-based learning [12, 13, 20]. Researchers have further suggested that the provision of web-based problem-solving instructions has the potential to enhance and sustain the problem-solving skills of the learners [8, 20].

There are two kinds of web-based problem-solving environments: the first is the Internet, which provides an open but ill-organized environment for obtaining resources [2, 3, 18]; the other is digital libraries, which provide a closed and well-organized resource for problem solving [2]. From the Internet, students can search for universal data and complete their learning tasks via the search engines. On the other hand, the content of a digital library is usually relevant to some specific topic; moreover, its data are categorized and presented in a unified format. The content on the Internet changes at almost every moment, while that in a digital library is updated periodically. The amount of data on the Internet is too large to count, whereas that in a digital library is limited.

Recently, many web-based problem-solving activities have been conducted using such open or closed network resources. For example, the students at the Department of Primary School Mathematics Teaching in Anadolu University Education Faculty took part in an experimental online problem based learning course [15]. In addition, a newly established polytechnic in Singapore employed problem-based learning to support its curricular implementation in view of the utility of the Internet as an informational repository [9]. In Taiwan, a web-based problem-solving activity for Taiwanese history was conducted by providing the learners with a digital library [2]; moreover, some activities concerning social science courses were carried out in a learning environment with search engines [7]. Among the web-based problem-solving environments, Meta-Analyzer, a freeware which combines the functions of search engines and e-portfolio management, has been successfully applied to many studies in various application domains [17].

Although the two web-based problem-solving strategies have been applied to many learning activities in the past decade, few studies have attempted to compare the effects of applying these two different approaches to the learning performance of students. During the web-based problem-solving activity, the students' attitudes, search strategies, computer use experience, and prior knowledge related to the problems could significantly affect their learning performance [11]. Consequently, this study aims to investigate and compare the effects of using the two approaches on students' learning attitudes, behaviors and performance from various aspects. An experiment has been conducted on the "structured programming" unit of a computer course in a senior high school in Taiwan.

Three research issues are investigated in the study. First, will the students' attitudes towards the Internet, their Internet self-efficacy, and their information commitments affect their web-based problem-solving outcomes in different information-searching environments? Second, will different information-searching environments affect the learning achievements of the students after participating in the web-based problem-solving activity? Third, what are the students' degrees of acceptance (usefulness, ease of use, satisfaction, and perceptions) of the information-searching environments after participating in the web-based problem-solving activity? The research questions abovementioned will be explored in the study.

2. Method

The theme was not taught using traditional teacher-centered explanations, but rather, the students learned from the process of problem-solving. They could learn and gain new knowledge from the process of data collection and problem-solving during the student-centered activities. The backgrounds of the students were deeply explored at the beginning of the study. Therefore, the pre-test of structured programming knowledge was conducted to evaluate the beginning proficiency of the participants. Their Internet self-efficacy, information commitment, and attitudes toward the Internet were also investigated. In addition, the experiences of using information and computer technologies, such as the operating system, data processing, the Internet, and the search engines, were surveyed by questionnaire so that the backgrounds of the students were considered as much as possible.

Procedure

One group used the open-resource network, called Meta-Analyzer, to search for related knowledge and solve the given problems while the other group utilized the closed information inquiry mode, called the Web-Quest Library, to find the related data constructed in the digital library by the teacher. The study aimed to avoid making meaningless comparisons between the open-resource network and a closed-resource network with insufficient information for solving the tasks. Therefore, the prerequisite of the activities in the closed information inquiry mode was that there were sufficient resources, which was confirmed by the teacher in advance. In other words, the teachers not only increased and constructed the knowledge or instructional materials in the digital library, but were also sure that the knowledge and information was plentiful enough for solving the problems they designed. If the students had ability to find the information, they could structure their answers and solve the problems. The flowchart of the study is shown in Figure 1.

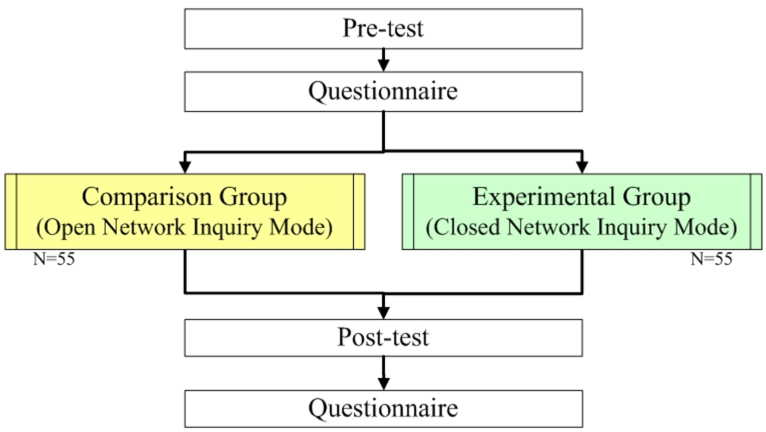

Figure 1. The experimental procedure

System functions

No matter whether using the open or closed information inquiry modes, all of the information inquiry processes, such as which web-site the students browsed or bookmarked, which keywords the students used for searching, what answer the students filled in on the form, and so on, were recorded under their teacher's account in the database. The difference between the two information inquiry modes is the scope of the information resources. In the closed information inquiry mode, called the Web-Quest Library, the data of one theme is constructed by the teachers and the data can be accumulated, but the range is not as vast as that found by the more popular search engines. In the open-resource network, called Meta-Analyzer, the data resource used in the system is the Google search engine, so the students can look for any universal data on the net. For convenience of naming the two groups, the study defines the Meta-Analyzer users as the comparison group, and the Web-Quest Library users as the experimental group. A comparison of the two different inquiry modes is explored in the study.

Participants

One hundred and ten 10th grade students were randomly divided into an experimental group and a comparison group. Fifty-five students in the comparison group carried out the activities using Meta-Analyzer, while the other fifty-five students in the experimental group performed the activities using the Web-Quest Library. All the students' actions in the two systems were recorded in the database. The teachers could be well aware of all the problem-solving processes of each student, what keywords each student used, and all the websites or data each student reached or read by observing the e-portfolios. In each group, the students whose grades were in the top twenty-seven percent based on the pretest were classified as the high-achievement group. They were deemed to remember some prior structured programming knowledge. The students whose grades were in the bottom twenty-seven percent of the pretest were classified as the low-achievement group. The others in the medium rank were classified into the medium achievement group. Moreover, all the participants have computers and network access at home, and have a chance to surf on the Internet every week, so the background of the participants' individual computer and Internet experience was also assessed to be approximate.

Questionnaire concerning Internet environments

This study used the Internet Attitude Scale (i.e. IAS) for measuring Internet attitudes, which was developed and validated by previous research [21]. Therefore, it can be ensured that the Internet attitude background of the users was identical. Moreover, the students' Internet Self-Efficacy (i.e. ISE) was also taken into consideration to prevent interference when the two different information inquiry modes were compared, because previous studies have provided evidence that the factor of ISE influences how participants use the system; for example, high ISE students have better information searching strategies [16]. In addition, the background of using computer experience had to be found to be alike in this study because individual computer experience is also one of the key factors affecting individual feelings about using the system as an information retrieval tool [10]. Last but not least, information commitment has an impact on the results of information seeking [19]. Therefore, the information commitment of the students may affect the answers they find and the knowledge they can gain from the network.

3. Results

To ensure that the two groups had similar backgrounds, an independent t test of the pretest for the two groups confirmed that there was no significant difference ($t=-1.023$, $p=.309$). In addition, the Information Commitments Survey, Internet Self-Efficacy and attitudes toward the Internet are controlled items, and the survey of the questionnaires and scales showed no significant difference between the students in the different modes at the beginning. The following three sections respond to the three research questions designed in the study.

3.1. Analysis of the e-portfolios in the different network inquiry modes

All the behaviors online were recorded in the database. When the students integrated their existing knowledge and information search strategies to solve the problems, the inquiry times and their problem-solving records were stored in the database so that the completion ratio of the problem solving task could be further analyzed. The results show that a higher ratio of the experimental group than the comparison group successfully completed all problems after examining the problem solving process online. The statistical results display that a higher percentage of participants finished the task but failed in one problem in the comparison group. Most of the students in each group were frustrated by the second problem because the resources for solving the problem are not easily found using just the topic as the keywords, that is structured programming. The students had to comprehend the first problem and solve it, and then use the answer to the first problem as the keywords to search for the resources to answer the second problem; otherwise, they would not easily find the complete answer. The task completion ratio of each group is shown in Table 1. There were two students who did not finish the task on the net because the open-resource network provides users with such extensive information that it may result in misconceptions, or the students may spend too much time searching.

Table 1. The task completion ratio of the two groups on the net

	Comparison group	Experimental group
The percentage of the people who successfully completed all PBL tasks on the net	43.64%	61.82%
The percentage of the people who finished the task but failed in one problem	43.64%	29.09%
The percentage of the people who finished the task but failed in two problems	3.64%	9.09%
The percentage of the people who finished the task but failed in three problems	5.45%	0.00%
The percentage of the people who did not finish the PBL task on the net	3.64%	0.00%

The findings of the study remind instructors that unlimited resources in an open inquiry mode bring more trials to learners when they search for data to solve their tasks. It is imperative for teachers to confirm that there are enough resources and provide appropriate search domains when problem-based learning is carried out on a network.

3.2. Analysis of the Pretest and Posttest

Before the activities of problem-based learning in the different inquiry information systems were carried out, the students in each group were divided into three achievement levels. Moreover, the pretest results showed that there was no significant difference between the two groups (*t=-1.023, p=.309*). After the treatment of the problem-based learning activities in the two inquiry information systems, the post-test showed that students in both groups had made progress. The paired-samples t tests of the pretest and posttest in each group are shown in Table 2. The results indicate that the learning outcomes of the students in both the comparison and the experimental groups improved remarkably. It can be found that the low-achievement students in both the comparison and the experimental groups made great progress after the problem-based learning activities on the web. It can thus be concluded that open and closed information inquiry modes both benefit low-achievement students, as they gained the most improvement in terms of the concept of structured programming.

Table 2. Paired-samples t test of the pretest and posttest of each group

All achievement grouping		N	Comparison group				Experimental group			
			Mean	SD	MD	t	Mean	SD	MD	t
High achievement	Pretest	15	65.67	9.04			72.33	12.66		
(Posttest-Pretest)	Posttest	15	77.67	8.84	12	4.58**	86.67	7.94	14.33	4.90**
Medium achievement	Pretest	25	43.4	5.35			42.8	8.55		
(Posttest-Pretest)	Posttest	25	66.8	11.63	23.4	9.25**	66.8	15.06	24	8.86**
Low achievement	Pretest	15	20.5	7.81			17	7.75		
(Posttest-Pretest)	Posttest	15	57.5	18.6	37	11.52**	59	15.72	42	10.16**

**p < .01

From Table 2, it is found that the low-achievement students in the experimental group increased forty-two marks on average after the experimental treatment; however, the low-achievement students in the comparison group only increased thirty-seven marks on average. To examine whether the posttest results show a statistically significant difference, ANCOVA was executed to compare the posttest of each group by excluding the influence of the pretest. The results show that the high-achievement students in the experimental group had significantly better performance than the high-achievement students in the comparison group. However, there was no significant difference between the learning outcomes of the medium-achievement students in the experimental and comparison groups. There was also no significant difference between the learning outcomes of the low-achievement students in the experimental and comparison groups. This means the students in the high achievement group who learned by problem-solving in the closed-resource network had better learning effectiveness than those in the open-resource network. The information searching activities in the open-resource network bring finite benefits to the high-achievement level students. The students who applied problem-based learning by information searching in the closed-resource network made more progress than the students in the open-resource network on average, although there is no significant difference between the posttest of the low-achievement students in the two groups. Therefore, the open inquiry mode is also useful in many circumstances.

3.3. Analysis of the Technology Acceptance Model

The relationships of enjoyment, usefulness, ease of use, and satisfaction with the system quality are analyzed in the study, and user intentions are further inferred. A seven-point Likert scale questionnaire was used to evaluate the technology acceptance model of the two different network inquiry modes. The descriptive statistics results are shown in Table 3. From the comparison of the two groups in the table, the users perceived higher enjoyment, ease-of-use, and satisfaction with the closed-resource network than with the open-resource network. The three factors achieve significant difference in the independent sample t test. Although the differences of perceived usefulness and user intention between the two groups do not reach significance, the two factors in the experimental group appear to have a higher mean than those in the comparison group.

Table 3. The independent sample t test of the technology acceptance model variables between the two groups

Descriptive Statistics	Comparison group			Experimental group			t
	N	Mean	SD	N	Mean	SD	
Perceived Satisfaction with the quality of network inquiry mode	55	5.19	1.18	55	5.58	0.83	-2.00*
Perceived Enjoyment	55	4.84	1.35	55	5.36	1.04	-2.30*
Perceived Ease-of-use	55	4.87	0.79	55	5.26	0.86	-2.42*
Perceived Usefulness	55	5.25	1.09	55	5.43	0.87	-0.956
Intention to use	55	5.18	1.05	55	5.40	1.09	-1.092

*$p < .05$

After analyzing the agreement and disagreement percentages of the five TAM variables, it was found that around 87 percent of the students gave positive feedback about their perceived satisfaction with the closed-resource network, while only 4 percent stated the opposite. In addition, more than 80 percent of the students in the experimental group gave positive feedback about its perceived usefulness, and more than 70 percent gave positive feedback about their perceived ease of use and enjoyment of the closed-resource network. As a result, more than 75 percent of the students were interested in using the closed-resource network. However, the comparison group had relatively less interest in using the open-resource network.

4. Discussion and Conclusion

Information-searching competence has been recognized to play an important role in problem solving [9]. In this study, we attempt to compare the effects of using closed and open network resources on students' intentions and learning effectiveness in web-based problem-solving activities. Experimental results show that both the closed and open network systems had contributions to assist the students in problem-solving and learning performance. However, the learning effectiveness of the high-achievement students in the experimental group was significantly better than those in the comparison group. Accordingly, this study suggests the instructors to conducted problem-solving activities in a closed network for those high-achievement students.

On the other hand, the results of TAM investigation show no significant difference between the two groups in the dimensions of user intention and perceived usefulness. Nevertheless, for the dimensions of satisfaction, enjoyment, and ease-of-use, the students in the experimental group gave significantly higher ratings than those in the comparison group, implying that the learning system with closed network resources was more acceptable to the students than the open network resources.

The results of the study suggest that digital libraries can be put into use more widely and are worth developing. Collecting the instructional resources into a digital library prevents the students from searching for information which they are not sure is correct. However, one drawback is that the two modes only use text to search for and answer the problems. Pictures cannot be inserted into the answer sheet of the two modes during problem-solving. Therefore, in the future, it is suggested that researchers increase the functions of the two modes so that pictures can be used when answering problems. Moreover, the instructors are encouraged to continue providing diverse information resources and constructing more instructional materials in the closed-resource network. Future studies can try to combine other appropriate pedagogies such as BIGSIX pedagogy into the network information inquiry modes in addition to problem-based learning.

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Workshop

Technology-Transformed Learning: Going Beyond the One-to-One Model?

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Preface

The advancement of personal computing devices, from personal computers to mobile devices, has been gradually changing the landscape of the technology-transformed learning. This facilitates the incorporation of one-to-one computing (one-device-or-more-per-student) into education and opens up endless possibilities of the design and enactment of innovative teaching and learning models (or the enhancement of pre-existing models), ranging from conventional personal computer labs to perpetual and ubiquitous learning, personalized learning, authentic and contextualized learning, seamless learning, rapid knowledge co-construction, among others. This leads to the further empowerment of the learners in deciding what, where, when, and how they would learn, and whom they would learn with/from.

After the initial hype, however, there have been voices within the researcher community to reassess the notion of one-to-one computing in classroom and informal learning, such as whether one-to-one settings may impact peer collaboration and teachers' roles, the issues of student and social readiness, as well as the explorations of alternative or hybrid settings of many-to-one, one-to-many, many-to-many, and one-to-one configurations.

This workshop aims to provide a forum where international participants can share knowledge, experiences and concerns on the one-to-one technology-enhanced learning (TEL) and explore directions for future research collaborations. Three full papers are accepted to serve as a starting point for in-depth discussion. The themes of the three papers encompass language learning and science learning, mobile-assisted social networking as a means of mentor-learner matchmaking, personalized seamless learning, and context-aware ubiquitous technology for personalized guided learning trail - demonstrating a good variety and potentials in what one-to-one TEL may impact the teaching and learning approaches in both formal and informal learning contexts. It is hoped that our discourse in the workshop will rise above the presentations and map out directions for future research and collaborations.

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Social Networking based on Language Exchange site in Mobile Learning Environment

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Abstract: This paper proposes a social networking site based mobile environment for learning foreign languages called SONLEM, which encourages learners to find a partner who can solve their language learning problems through an online community, and an appropriate request chain of friends that can provide recommendations upon request. The learner can practice their second language with a native speaker who is learning their 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. The rapid advance in broadband and wireless Internet technologies has promoted the utilization of wireless applications in our daily lives. In the meantime, a variety of embedded and invisible devices, as well as the corresponding software components, have been developed and connected to the Internet wirelessly [3]. 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 (Social Networking 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 [4, 5].

The SONLEM environment supplies learners to study the second language. It allows the members to find foreign language partners, practice their foreign language with native speakers. The partners can help problem-solving each other. So it enhances cooperation between learners. It also encourages sharing their knowledge, interacting, collaborating, and helping each other. The SONLEM environment is a website for language exchange and international communication.

For example, Takahashi is Japanese and he is studying Chinese. Takahashi wrote a blog in Chinese and wanted somebody to correct it for him, so he input the keyword “Language Learning, Chinese” and search for it on the system, and then the system discover the people who are related to the keyword and recommended the appropriate CF (Chain of Friends) for Takahashi.

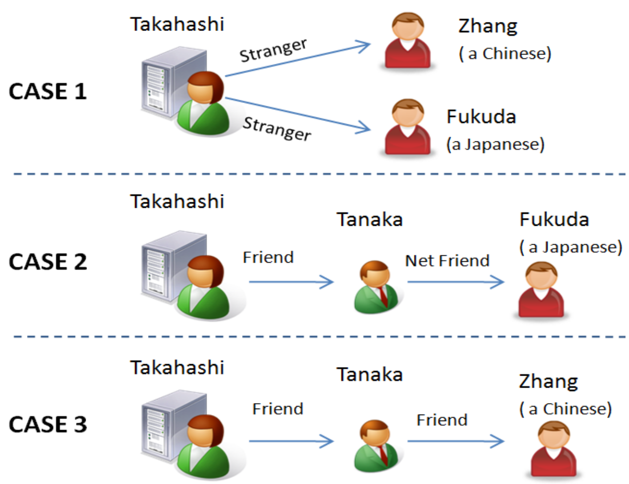

Figure 1. Request CFs.

As shown in the Figure 1, Zhang and Fukuda can speak Chinese, Fukuda is a net friend of Tanaka, Zhang is a friend of Tanaka, and Tanaka is a friend of Takahashi. There are 3 Request CFs:

For the case 1, Takahashi asks for the help to Zhang or Fukuda. But as there are no acquaintances between them, it is difficult that he gets help from Zhang or Fukuda.

For the case 2, Fukuda is a net friend of Tanaka and he is a Chinese learner.

For the case 3, Zhang is a friend of Tanaka and Chinese is his mother tongue.

Comparing the case 2 with the case 3, the system recommended the case 3 for Takahashi. Then Takashi asked Tanaka introduce his friend Zhang to him.

In the SONLEM environment, 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. Relevant Research

There are many “language exchange” SNS sites for learning such as “Lang-8” (http://lang-8.com/) and “Italk” (http://www.italki.com/). “Lang-8” and “Italk” are SNS sites for language exchange. Using these two sites, you can write in the language you are studying, and the others (whose mother tongue is the language you are studying) will correct your diary. And you can correct the diaries for them who write diaries in your mother tongue. You are able to not only learn a language, but teach others your own language as well.

But the “Lang-8” and “Italk” only offer a social networking platform to help each other. The author of this paper is a Lang-8 member. He wanted to make friends with the people whose native language is English and sent messages to them, but nobody replied his messages. He wrote two diaries on the Lang-8 in English, wanted somebody to correct his English, at the end nobody corrected them for him. So, it is difficult to get help from strangers.

PeCo-Mediator is a system to seek for capable cooperators through a chain of personal connections (PeCo) in a networked organization [6], the experimental results of the system show that the PeCo-Mediator system facilitates users' encounters with cooperators and develops new helpful connections with the cooperators.

The SONLEM environment not only offers a social networking platform to help each other, but also helps learners to find out a language learning helper. Beyond simply looking at who is connected to whom, the SONLEM environment can indicate the strength and direction of a relationship.

The relationship is friends or acquaintances on the SNS. A novel approach using this relationship helps learners to find an appropriate person who is able to solve the problem even if he is a stranger, an appropriate request CF will be recommended upon their request, and then they help each other through the SONLEM environment. In this way it can enhance personal relationship, expand network of friendship, and support knowledge sharing and knowledge creation.

The SONLEM environment is a mobile learning environment. For example, a foreigner in a restaurant of Japan, cannot understand the menu of Japanese, so he uses the mobile phone takes a picture of the menu and updates to the SONLEM environment. Then a friend in the bus gets the message by mobile phone, helps him to translate it and the problem is solved.

2. 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 [7]. This paper describes the design and the implementation of the SONLEM environment.

3. 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 the answers that are believable and trustworthy.

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.

3.1 Find the appropriate person

In order to find an appropriate person who can help the learner to solve his problem, learner has to be aware of other person's profile, interest and past actions [8]. In this language learning system, the profile includes members' mother tongue, second language and language they are learning.

The language abilities are classified into four levels: "Beginner", "Intermediate", "Advanced" and "Native". Beginner is a person whom is just learning the language. Intermediate is a person whom knows simple words and sentences and are learning more intricate grammars and creating longer sentences. Advanced is a person whom can speak semi-fluently and have a large base of vocabulary. Native is a person whom is a native speaker of that language.

At first, the learner should write some keywords about the problem and search for it on the SNS. Then the SONLEM will discover the person who can effectively solve the problem through their profile. Their profile includes their action history and personal information. Finally a recommendation is made about the appropriate person to who can best aid the learner.

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:

$$\left(LMK = \frac{n - n_m}{n} \right) \text{ , where } \quad 0 \le LMK \le 1$$

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?

3.2 Recommend an appropriate request CF

When a learner needs to ask for help from the stranger, the SONLEM environment is able to advance the learner an appropriate 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.

3.2.1. 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, they have a direct contact, such as contact in person, by telephone, by emails or by letters. Other personal relationships are unfamiliar: They are strangers, and they have no personal contacts.

In PeCo system, the strength of personal relationship is estimated by the degree of frequency of e-mail exchange. 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.

Level 1: Strangers are persons whom the learner has never met before.
Level 2: Slight acquaintances are persons whom the learner has never met before, but has talked for many times, such as net friends.
Level 3: Close acquaintances are persons whom the leaner has met and talked with him for many times.
Level 4: They are friends or close friends.
Level 5: They are family members or relative.

Moreover, for the net friend, the level will change automatically according to the frequency of the helping each other and the visited times.

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.

3.2.2. 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" [8].

Six degrees of separation refers to the idea that, if a person is one step away from each person they know and two steps away from each person who is known by one of the people they know, then everyone is an average of six "steps" away from each person on the earth (http://en.wikipedia.org/wiki/Six_degrees_of_separation).

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.

3.2.3. 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:

$$\left(CFA = \sum_{k=1}^{n} \left(\frac{k}{6} * \frac{5 - m_k}{5} \right) \right), \text{ where } 1 \le m \le 5,\ n = \{1,2,3\ldots\}, \text{ and } \mathrm{k} = \{1,2,3\ldots\mathrm{n}\}$$

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.*

3.3 Facilitates collaborate learning

This environment also relates to the collaborative learning pedagogical theory. “Collaborative learning” is an umbrella term for a variety of educational approaches involving joint intellectual effort by learners, or learners and teachers together [10]. Collaborative learning encourages knowledge sharing while making use of the learner’s physical context and mobility.

The SONLEM environment facilitates the members’ collaborative learning. It supports members to help each other, and the helping history will be recorded. If Learner A helped Learner B, then Learner B asks help from Learner A will become easily, because they are no longer strangers. So the network of the friendship is expanded according to the frequency of the helping each other.

4. 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.

As mentioned above, while a learner uses the system, he should preset the level of the personal relationship. As shown in the Figure 2, it is the interface for setting personal relationships. The learner inputs the information of his friends, family or someone else, and then searches on the system. A list of the search results will be displayed on the page. The learner selects the person in the list and set the level of the personal relationship.

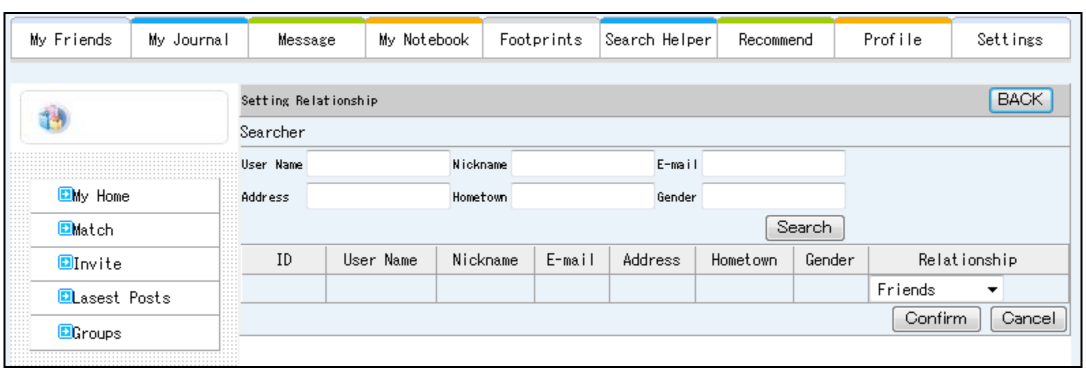

Figure 2. setting of the personal relationship.

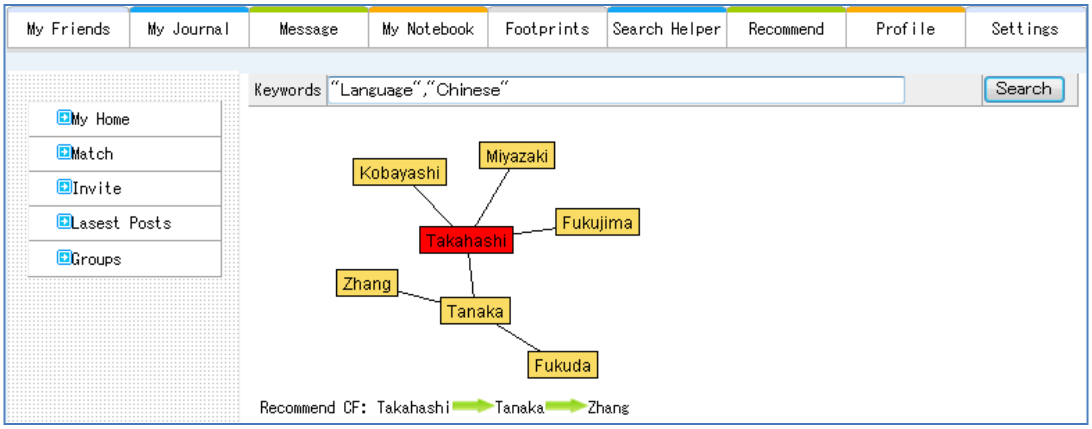

Figure 3. Appropriate request CF.

The learner uses the Figure 3 to find an appropriate person. He inputs the keywords about his problem and searches it on the system, and then a personal graph will be displayed. At the same time a "Recommend CF" will be recommended for the learner on the bottom of the page.

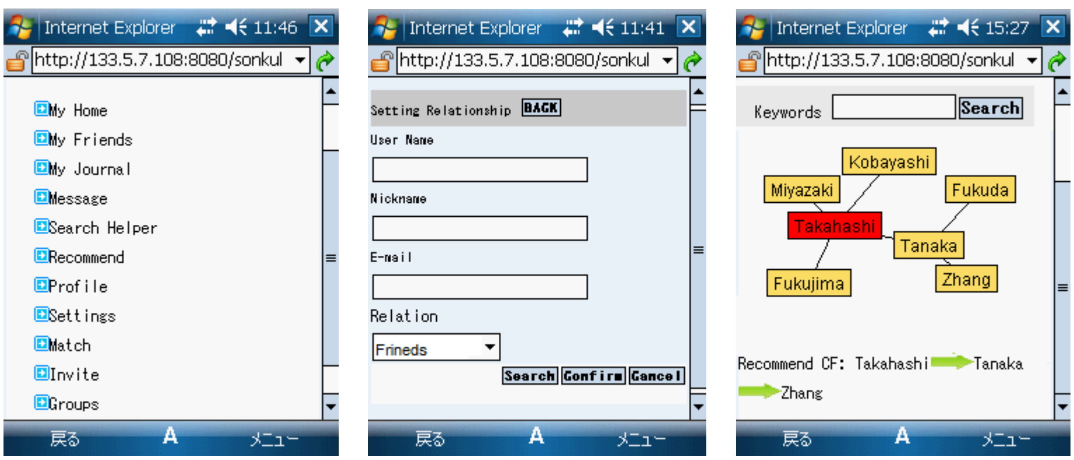

Figure 4. PDA.

The Figure 4 shows the interfaces on the PDA.

5. 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. They have the same interest, purpose and consideration, it is easy to make friends and a longstanding friendship is expected.

This system is to enhance learning chance. 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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Supporting an English Course Using Handhelds in a Seamless Learning Environment

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Abstract: In this paper, we propose mobile-assisted seamless vocabulary learning and present learning scenarios seeking smooth and seamless transitions between learning in-class and out-class, incorporating students' self-directed learning into classroom activities so that learning both in-class and out-class interacts with each other, which is ultimately expected to result in effective and fruitful vocabulary learning. Two experiments using mobile devices are proposed to find out some answers to the following questions: (1) Does the use of mobile devices support seamless English vocabulary learning? (2) Can the additional contents recommended by the system help linking in-class and out-class vocabulary learning?

Keywords: MALL (Mobile Assisted Language Learning), Seamleass Learning, Vocabulary Learning, ESL

Introduction

English has become the lingua franca of the world due to globalization and internationalization in recent decades [1]. Therefore ESL (English as a Second Language) education is inevitable for non-English speaking countries including Japan. It has been long pointed out that Japanese ESL learners are lacking in vocabulary though it is an essential component in language skills. It is evident that with more unknown words, learners face more difficulty in understanding English [2]. Therefore it is very important to build up vocabulary to improve one's English skill. But it is also true that vocabulary teaching/learning methods are often considered boring [3]. Then the following question occurs: 1) What if technology can support effective and enjoyable vocabulary learning for ESL learners? If such a system were successfully implemented, its contribution to vocabulary learning or furthermore, language education in general, would be immeasurable.

1. Theoretical Background

Seamless Learning

Recent progress of mobile and wireless technologies offers us the potential for a new learning environment, namely "seamless learning". It has been gaining quite a few researchers' attention as a new learning environment [4] [5] [6] [7] [8] [9] [10]. "Seamless learning" is used to describe the situations where students can learn whenever they want to in a variety of scenarios and that they can switch from one scenario to another easily and quickly using one device or more per student ("one-to-one") as a mediator [4]. It allows learners to learn any time, anywhere, and provides them with multiple ways of learning throughout the day. The term, seamless learning is also used to describe lifelong learning in various environments across time and location seamlessly through the use of the technology as a mediating tool [5]. In this paper, however, we use this term in the narrower sense, that is, by seamless learning, we mean learning which occurs with smooth and seamless transitions between in-class and out-class learning, between handheld use out-class and desktop use inside-class. Seamless learning can be depicted in a two-dimensional way 1) in-class and out-class learning and 2) planned and unplanned learning. Thus there are four types of learning accordingly: in-class planned learning, in-class unplanned learning, out-class planned learning and out-class unplanned learning [8]. And if the technology could help these four types of learning interact with one another and help them to be incorporated into one continuous learning beyond time and space, learning could be very successful (Figure 1).

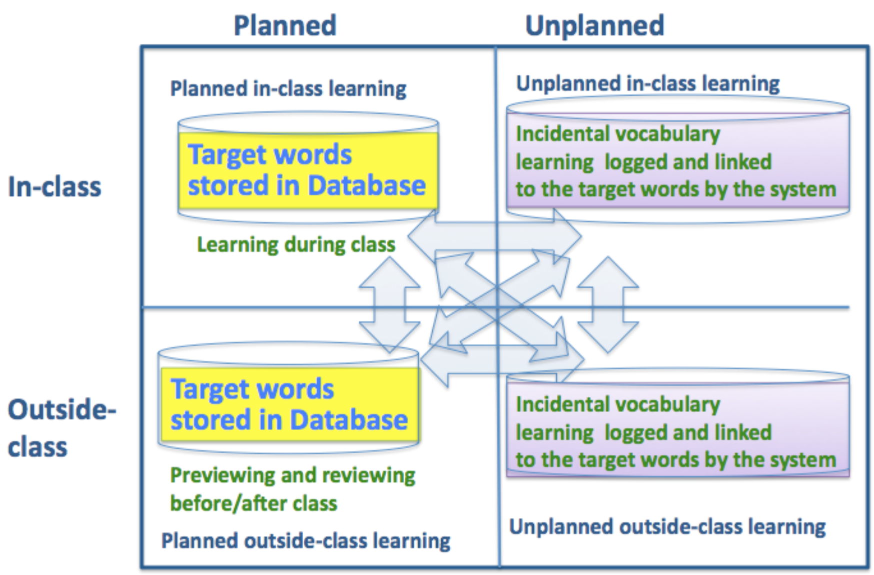

Figure 1. Incorporation of Four Types of Vocabulary Learning with the help of technology (adapted from So et al, 2008 [8])

In addition, we need to consider that we usually have only one instructor per class, small or large. What the teacher can do through these four types of learning is limited. So peer-to-peer (P2P) collaboration is necessary for successful seamless learning. How we can adopt P2P collaboration effectively in a seamless learning is the key issue. We aim to create a knowledge-aware virtual learning community to promote P2P interaction in our seamless learning environment.

Cyclic Model of Learning

One premise of our seamless learning idea is that there are four processes of learning: preview, in-class lesson, review, and expanded study and that these four processes should be connected with each other to make smooth continuous learning. This concept is depicted by the term, 'cyclic model of learning'. Takeuchi (2007) proposed 'cyclic model of learning' [11] (Figure 2), by which he means 'class', in a broad sense, means not only learning in-class but also learning out-class and it allows teachers to incorporate students' self-directed learning into classroom activities [12]. Though it is called 'cyclic', the image is more like 'spiral', since the learners are improving their skills, expanding their knowledge, where learning occurs seamlessly from one in-class learning to another with out-class learning in between (Figure 3).

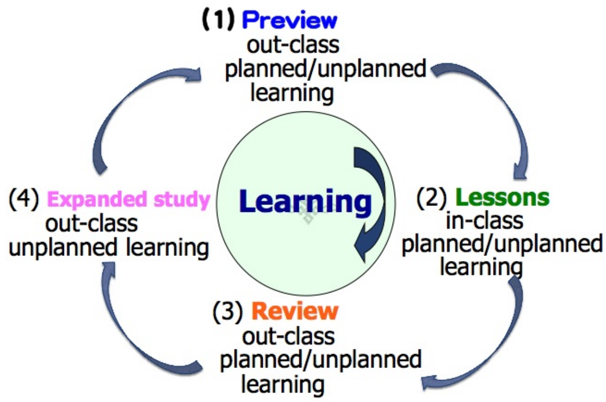

Figure 2. Cyclic Model of Learning (adapted from Takeuchi, 2007)

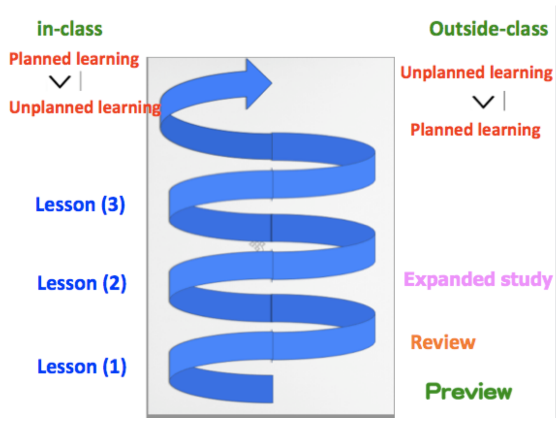

Figure 3. Seamless Learning based on Cyclic Model of Learning

Seamless learning and cyclic model of learning, these two concepts share the same idea that learning can occur wherever they are, and that every learning experience both in-class and out-class interacts with each other, which should result in effective and fruitful learning experiences. This concept is critical for English education in Japan since it has been pointed out that learning time of English at school is not sufficient: 630 – 650 hrs during 6 years of junior and senior high school education [11], plus 112.5 hrs, for instance, during college years at our university (based on the University of Tokushima enrollment guideline 2009). Shortage is apparent when we consider the fact that 1200 hrs is necessary to achieve basic level of French language in Canada [13]. In fact, Ministry of Education, Culture, Sports, Science and Technology have decided to introduce once-a-week English class (45 minutes for one class and 35 classes a year) for elementary school 5th and 6th graders from 2011. But it will only add 52.5 hours to total learning hours. It is far from satisfactory to solve the lack of learning time. Then how should we cope with this shortage problem? If in-class learning time is limited, there is no other way but to learn out-class. Thus we strongly suggest mobile-assisted seamless vocabulary learning which motivates students to learn out-class and encourages their self-directed learning. According to the survey we have conducted in October 2010 over 164 university freshmen and sophomores (age: 18 - 20) majoring in literature, law, economics, and commerce, 162 (98.8%) reported owning mobile phones. 182 students were invited to respond and 164 responded to the survey. So it endorses the widespread use of mobile phones among college students in Japan.

2. System Design

Based upon the above ideas, we design the following Seamless Mobile-Assisted Language Learning Support System (hereafter we call it SMALL System) (Figure 4). In our system, (1), (3), in Figure 2 are mobile-based out-class planned learning, (2) is a PC-based in-class planned/unplanned learning and (4) is a mobile-based out-class unplanned learning.

Word Data in Figure 4 consists of target words to be learned through one semester. Data is imported to the system from an electric or OCR scanned textbook.
Quiz Logs consist of all the quizzes done by the students. All the students' activities and quiz results are analyzed and evaluated. This newly gained data reflect review quizzes and difficulty level adjustment and facilitate their learning processes.
Learner Info contains the students' English levels and their fields of interests for the distribution of the customized contents.
Related Contents are obtained through RSS feed and delivered to the students' mobile devices according to their English levels and their interests for the expanded study.
Learning Log System or SCROLL is a system developed by our team. It supports learners' capturing and recalling their learning logs (http://ll.is.tokushima-u.ac.jp/learninglog/signin) [14]. The students register their newly acquired words through their expanded study and the system gives them quizzes from new words.

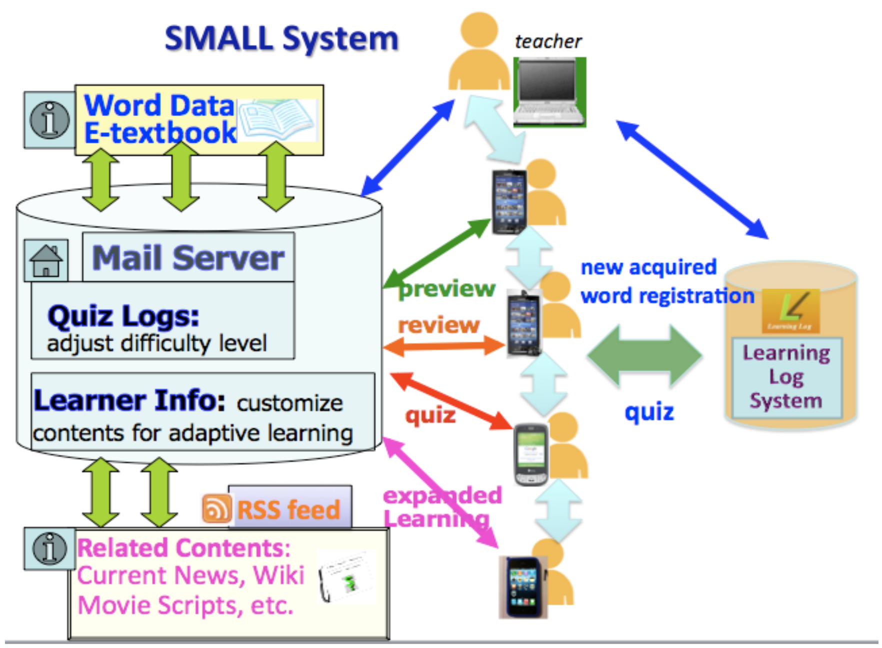

Figure 4. SMALL System (Seamless Mobile-Assisted Language Learning Support System)

The scenarios based on Figure 2 are as follows. Students will be beforehand given English vocabulary-level tests to establish their level of English and also questionnaires will be given to identify their fields of interests. They are assigned to write about their current interests on the designated website (blog, twitter, foursquare etc.) on a regular basis so that the system can identify them which reflect the contents to be delivered for extended study.

They are informed that these assigned writings will be evaluated and reflected on their school reports.

(1) **Preview (mobile-based out-class planned/unplanned learning):** Students receive messages which show the URLs to read the text for preview and take target word quizzes (Figure 5 & 6). Students can choose either web-based texts and quizzes or mail-based texts and quizzes. They answer multiple-choice quizzes until they make correct answers. They can read texts and answer quizzes at any time and at any location using mobile devices, whether it is a smart phone or a conventional type.

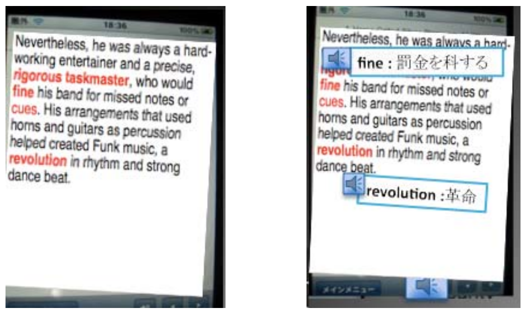

Figure 5. Preview text interface

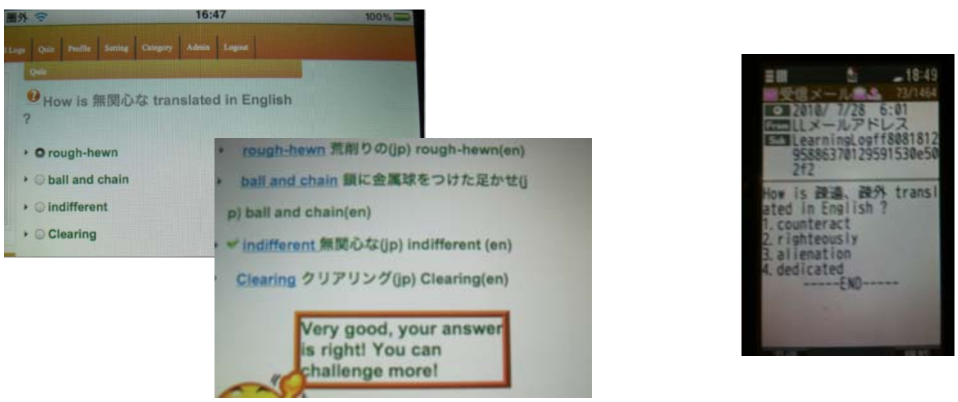

Figure 6. Quiz interface 〔 web-based (left & middle) & mail-based (right) 〕

(2) **Lessons (PC-based in-class planned/unplanned learning)** :In the electronic/scanned textbook, target words are hyperlinked and when the teacher clicks them, new windows will be opened and they show names of the students who made wrong answers so he can pay attention to them during class (Figure 7). They are given web-based quizzes to make sure if they learn the target words during lesson.

(3) **Review (mobile-based out-class planned/unplanned learning)**: Students receive messages which show the URLs to read the text for review and take target word quizzes. The system reports the review test results with most frequently mistaken word ranking lists and the teacher will review these words in the next class. So the learning occurs continuously.

(4) **Expanded Study (mobile-based out-class unplanned learning)**: Students receive messages which show the URLs for expanded study. The SMALL System recommends the contents of each student's interests which include target words learned in class. The target

words for the week are highlighted in the expanded study texts for recalling so that in-class learning is reinforced through out-class learning.

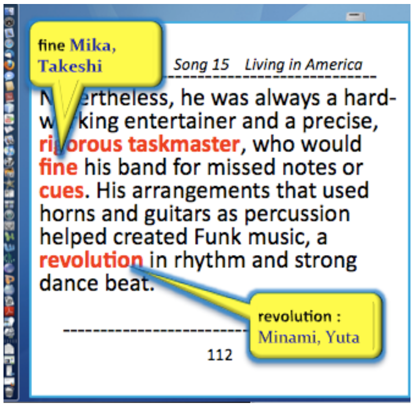

Figure 7. Textbook with Hyperlinks

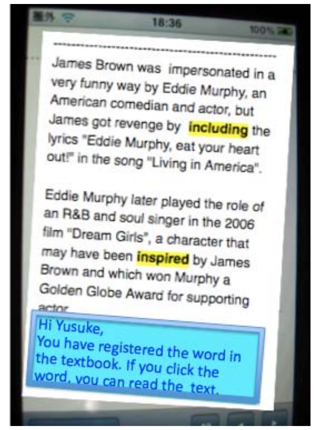

Figure 8. Mobile user interface while reading contents provided by the system

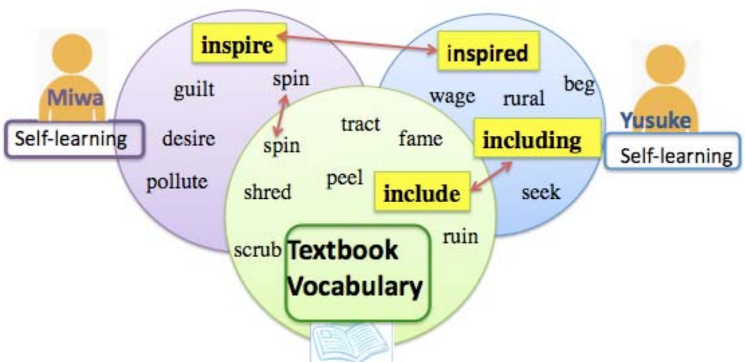

Figure 9. Link between in-class learning and outside learning

Figure 8 and 9 show how in-class vocabulary learning and out-class vocabulary learning are linked. When a student, Yusuke, resisters new word, "including", which he already learned in the textbook, then it is hyperlinked. If he clicks it, it jumps to the textbook page where it appears. If Yusuke and Miwa registered the same new word, "inspire", then it is hyperlinked and by clicking, it jumps to the other part's text. We learn words from the context [15]. The system provides the contexts to let them learn how the word is used, which is expected to lead to the effective vocabulary learning. If some students have read the same contents, the system will send a message to encourage them to start a chat or discussion. It will be expected to add some fun factor to likely-to-be boring vocabulary learning. With the help from the system, students can be aware of what they have learned before, and what other students are learning. In addition, each student is supposed to present in-class in turn what he/she has learned through his/her expanded study so that the teacher can incorporate students' unplanned self-learning into classroom activities. Students are encouraged to collaborate with other students who have the same interests.

In order to help the students retain their vocabulary, the system gives them quizzes containing the newly acquired words through out-class unplanned learning. They are provided with quizzes of the words they already have answered correctly after a certain interval to make sure if they are retaining their newly acquired vocabulary. That way it is expected that their short-term memory will be transferred into long-term memory. In order to motivate them to learn more, the System shows each student his degree of advancement by counting his correct answers out of total number of target words.

3. Methods

The System is scheduled for completion next year. Upon its completion, the following experiment will be conducted. The numbers of the subjects are subject to change according to the size of the target classes.

3.1 Experiment

Eighty university students will be divided into two groups with the equal English proficiency according to the pre-test result. The test consists of target words to be learned in the textbook. Each group will engage in learning vocabulary, where Group A will use SMALL System, while Group B will learn vocabulary in a conventional way, e.g., using a paper dictionary without technology. Evaluation will be carried out over a period of six weeks. At the end of the phase, the subjects will undergo two kinds of post-tests: the same vocabulary test as the pre-test (Post-test 1) and a vocabulary test containing self-learned words gained through unplanned learning (Post-test 2). As for Group A, Post-test 2 will be created by the System which identifies what they have learned through self-learning. As for Group B, the students are asked to write down their newly gained words through unplanned self-learning on the template sheets. They will submit their sheets when the phase is over. Then personalized Post-test 2 will be created in the following procedure. Submitted sheets will be folded in the way that only English word section will appear to use them as test sheets. Another possibility is that submitted sheets will be scanned and modified so that only English word section may appear. Both post-tests will be designed to tap partial knowledge of word meanings. The students will be given individual interview and questionnaires which will help us examine advantages and disadvantages of SMALL System. Further data will be collected from the subjects of Group A by means of the log data contained in the server.

4. Early Insight and Future Works

As our preliminary survey showed 98.8% of the students owned mobile phones. Widespread use of mobile phones endorses practicability of SMALL System. Since the System is still under development, we have not acquired any data to be analyzed, but possible advantages of SMALL System might be: 1) In-class and out-class vocabulary learning are closely linked so that what they learn in-class will be reinforces in out-class learning and vice versa. 2) Since we learn words from contexts, its linking context function can lead effective vocabulary learning. 3) It encourages out-class self-learning, which is expected to compensate the lack of learning time in class. 3) Linking between the students who registered the same word or who read the same contents can trigger peer-to-peer interactive learning, which is expected to add some fun factor to vocabulary learning which is likely to be monotonous. 4) Customized contents can help students enhance their motivation to learn more. The disadvantage of this system is that it may be unfair for the students who do not own mobile phones.

As our further future work, improvement of the system's capability of identifying related words or derived lexical items will be needed so that when the students resister related words, it will be able to successfully make links. That way one's unplanned self-learning will be entwined with that of other students more deeply.

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A Context-Aware Ubiquitous Learning Environment for Enhancing Science Inquiry Ability of Students via On-Site Device Operating

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Abstract: Enhancing science inquiry ability of students has been recognized to be one of the most important education issues nowadays. Although various simulation programs have been developed for training science knowledge and ability, several problems have been revealed in practical learning activities. One major problem is owing to the lack of experiences in practical applications for what have learned from the textbooks. To deal with this problem, this study presents a context-aware ubiquitous learning system that employs Radio Frequency Identification (RFID) technology to detect and examine real-world learning behaviors of students and provide personalized learning guidance accordingly. Experimental results from a science course of an elementary school show that this innovative approach is able to improve the learning achievements of students as well as enhance their learning motivation.

Keywords: ubiquitous learning, sensing technology, context awareness, RFID

1. Introduction

In the past decade, various computer-assisted or web-based learning systems have been developed to provide a more adaptive learning environment with plenty of learning resources. Much attention has been focused on new learning strategies with appropriate software tools and environments [1], such as Computer scaffolding [2][3], the activity-theoretical approach [4], and Computer-Supported Intentional Learning Environments (CSILE database, e.g., [5]). These learning strategies have been applied, together with Internet access, in classroom teaching.

Several studies have demonstrated the benefits of computer- and network-based learning (e.g., [6][7][8][9]), but experienced educators have emphasized more the importance and necessity of “authentic activities” in which students are able to work with problems from the real world [10][11][12]. In order to situate students in authentic learning environments, it is necessary to place them in a series of designed lessons that combine both real-world and virtual learning environments [13].

Recently, the advance of wireless communication, sensing and ubiquitous technologies has provided unprecedented opportunities to carry out new learning strategies by integrating real-world learning environments and the resources of the digital world.

Thanks to these new technologies, individual students, by using a mobile device to access the digital content via wireless communications, are able to learn in real-world situations with support or instructions from the computer system. Moreover, the learning system is able to detect and record the students' learning behaviors in both the real world and the digital world with the help of the sensing technology. Such a sensing technology-enhanced mobile learning model has been called context-aware ubiquitous learning [13]. It not only provides learners with an alternative to deal with problems in the real world, but also enables the learning system to interact with the learners more actively [14][15].

Without proper support, the new learning scenario might become too complex for the students. Educators have indicated that "technologies should not support learning by attempting to instruct the learners, but rather should be used as knowledge construction tools that students learn with, not from" [16]. Computers, among the existing technologies, have been recognized as being a potential tool to support learning and instruction, such that the learners act as designers, and the computers function as tools for interpreting and organizing their personal knowledge [16] [17] [18]. Hence, it has become an important and challenging issue to develop personalized learning guidance systems to assist learners to interpret and organize their personal knowledge for mobile and ubiquitous learning.

In this paper, a ubiquitous learning system that employs RFID technology to detect the learning behaviors of students and provide learning guidance in the real world is presented. Moreover, a learning activity on a science course has been conducted to evaluate the effectiveness of the innovative approach in comparison with traditional approach. Those experiences could be helpful to those who intend to develop context-aware ubiquitous learning environments and activities.

2. Relevant research

Although technology-enhanced learning has been widely discussed and employed in past decades, researchers have indicated the necessity and importance of "authentic activities" in which students can learn to cope with problems in real-world environments [10] [13] [19]. Four criteria concerning the instructional design of situated learning have been pointed out as follows [13]:

(1) To select the situation or sets of situations that will afford the particular knowledge that the teacher wishes each student to acquire [20].
(2) To provide the necessary "scaffolding" for novices to operate in the complex realistic context and for experts to work in the same situation [3] [21] [22].
(3) To provide supports that allow teachers to track progress, assess information, interact knowledgeably and collaboratively with individual students or cooperating groups of students, and prepare situated learning activities to assist the students in improving their ability in utilizing skills or knowledge [23] [14] [24] [25].
(4) To define the role and nature of assessment and what it means to "assess" situated learning [26] [27].

In recent years, researchers have noticed the efficiency and popularity of mobile and sensor technologies. Several studies have been conducted to demonstrate the practice of those new technologies in supporting authentic learning. Chen, Kao, and Sheu [22] reported a mobile learning system that uses handheld devices for scaffolding students' learning about bird watching. Chen, Chang, and Wang [28] presented a learning environment to scaffold learners with mobile devices and sensor techniques. Chu, Hwang, Huang and Wu [29] demonstrated a technology-enhanced authentic environment where the learning system guided the students to learn in the real world with sensing technology, and detected the learning behaviors of individual students. It is obvious that guiding the students to learn in the real world with supports from the digital world has become an important and challenging issue. To effectively and efficiently assist students in interpreting and organizing their personal knowledge, the provision of knowledge construction tools is needed. The necessity of developing computer-assisted tools or environments to engage learners in constructive, higher-order, critical thinking about the subjects they are studying has been acknowledged [17]. Several recent studies have also demonstrated the effectiveness of applying computer facilities to provide personalized learning guidance [30]. Therefore, it has become an important and challenging issue to develop personalized learning guidance systems for ubiquitous learning with sensing technology.

In the following sections, we shall present a ubiquitous learning system that is able to provide personalized learning guidance in the authentic learning environment. In addition, the experimental results of conducting a learning activity on a science course are presented to demonstrate the effectiveness of this novel approach.

3. Ubiquitous learning Environment with RFID Technology

In this study, the authentic learning environment is a science park located at southern Taiwan. It contains various science devices, and nine devices concerning planetology, optics and electromagnetic induction have been selected as the target learning objects of this study. Each target object is labeled with an RFID tag, while each student holds a mobile device equipped with an RFID reader. In addition, wireless communication is provided to enable communication between the mobile device and the computer server that executes the learning system.

Figure 1. The context-aware ubiquitous learning environment

The students who participate in the learning activity are guided to learn to operate those devices in the science park. As they move around in the authentic learning environment, the learning system can detect the location of individual students by reading and analyzing the data from the nearest RFID tag. Accordingly, the learning system is able to actively provide personalized guidance or hints to individual students by interacting with them via the mobile device, as shown in Figure 2.

Figure 2. Authentic environment and learning scenario

Personalized Ubiquitous learning Guidance Mechanism

A personalized learning guidance mechanism was employed in developing the ubiquitous learning system for assisting the students to learn to operate those target devices by employing a cognitive apprenticeship approach [22] [23] [31]. We aim to provide systematic teaching and guidance for the learners, and opportunities of practicing learning tasks as well as reviewing learning processes. The flowchart of the learning guidance mechanism is given in Figure 3.

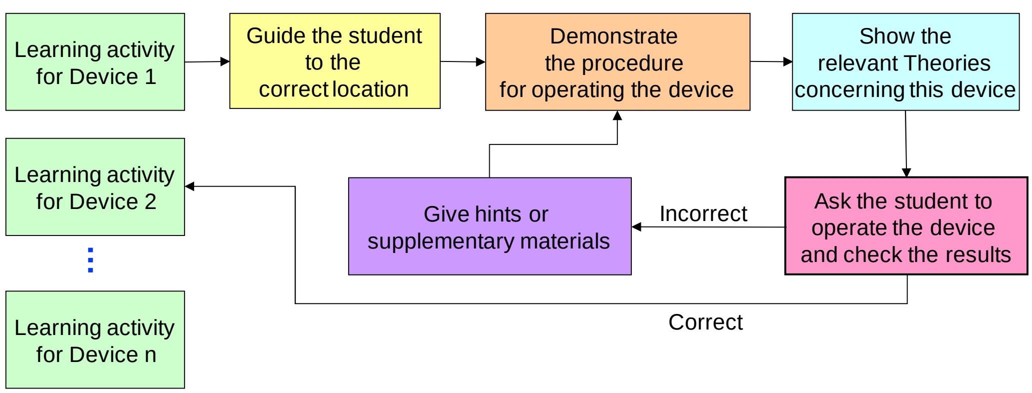


Figure 3. Personalized ubiquitous learning guidance mechanism

With the help of the sensing technology, the ubiquitous learning system can detect the location of individual students, and guide them to find the location of the target devices. Once a student arrives at a target device, a series of questions is presented to guide them to operate that device. Moreover, the learning system guides individual students in further learning based on their responses to the questions; that is, personalized guidance is provided. The details of the personalized ubiquitous learning guidance procedure are given as follows:

Step 1: Guide the student to find the location of the target device.
Step 2: Introduce the device.
Step 2.1: Demonstrate the functions of the device and show how the device can be operated.
Step 2.2: Present the theories and examples that are relevant to the device.
Step 3: Ask the student to operate the device and check if the results are correct.
Step 3.1: If the student fails to correctly operate the device (the results are incorrect), some hints or supplementary materials are given, and the student is asked to go to Step 2.

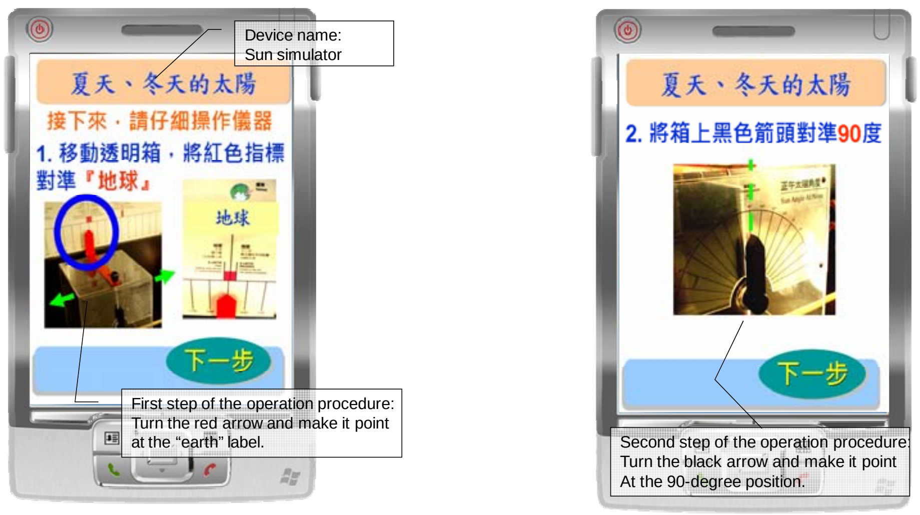
Step 3.2: If the student correctly operate the device (the results are correct), the learning system will show some encouraging information.
Step 4: Guide the student to visit the next target device and repeat Steps 2 to 3 until the student pass the evaluation for all of the target devices.

Ubiquitous learning System for Science Device Operations

Based on this innovative approach, the Mobile Science Device Trainer (MSDT) has been developed to assist the students in operating the science devices. MSDT is able to detect the location of individual students and provide them with adaptive supports via the use of PDA's (Personal Digital Assistants) equipped with RFID and wireless communication equipment.
Figure 4 shows an illustrative example of MSDT in guiding the student to find the target object "Sun simulator" on the science park.

Figure 4. Example of guiding the student to find the target device

While arriving at the location of the target device, the student is asked to operate the device by following the instructions given by the learning system. In the example given in Figure 5, the student is asked to turn the red arrow on the device and make it point to the "earth" label (see Figure 5(a)), and then turn the black arrow to the 90-degree position (see Figure 5(b)).



(a) (b)

Figure 5. Example of guiding the student to operate the target device

4. Experiment and Analysis

To evaluate the effectiveness of the innovative approach, an experiment was conducted on a science course of a science park (planetarium) located in southern Taiwan. The experiment aimed to investigate the learning outcomes when the students in the control group employed PDAs to learn (u-learning approach). That is, it aimed to determine whether the students who learned with MSDT had better achievements than those who learned in the u-learning environment. In the following subsections, the design and analysis of the results of the experiment are given in detail.

4.1 Participants

The participants of this study were 43 fifth-grade students taught by the same teacher in an elementary school. After receiving the fundamental science device knowledge in a science course, the participants were divided into a control group (n = 21) and an experimental group (n = 22).

4.2 Learning Design

In the first stage of the experiment, the students receiving the fundamental knowledge of the target devices in the science park (about 80 minutes), all of the students were then asked to answer a pre-questionnaire and take a pre-test (50 minutes). The question items in the pre-questionnaire were concerned with the students' attitudes to the science course. The pre-test aimed to evaluate the students' basic knowledge about the course.

In the second stage, the students in the experimental group were arranged to learn to operate the nine target devices using MSDT, while those in the control group were guided to learn via traditional approach (by the teacher). This stage took almost 120 minutes. After conducting the learning activity, the students were asked to take a post-test and answer a post-questionnaire (50 minutes).

4.3 Learning achievements of students

Table 1 shows the t-test results of the pre-test. Notably, the mean and standard deviation of the pre-test were 71.14 and 14.56 for V1 (experimental group), and 73.09 and 11.21 for V2 (control group). As the p-value (Significant level) =.56 > .05 and t =-0.60, it can be inferred that V1 and V2 did not significantly differ at a confidence interval of 95% in the pre-test. According to the t-test result (t=-0.97, p > .05), it was evident that the two groups of students had equivalent abilities before learning the subject unit.

Table 1. *t*-test of the pre-test results

	N	Mean	S.D.	*t*
Experimental group	22	88.22	13.86	-0.97
Control group	21	91.90	10.87	

Table 2 shows the t-test results of the post-test; in addition, the original means and standard deviations are also presented. The mean and standard deviation of the post-test were 60.19 and 16.76 for the control group, and 70.55 and 15.42 for the experimental group. From the post-test scores, it was found that the students in the experimental group had significantly better achievements than those in the control group (t = 2.11, p < .05). This result implies that learning with MSDT in an authentic learning environment significantly benefits the students more than learning in the traditional environment. That is, this innovative approach is helpful to the students in improving their learning performance.

Table 2. *t*-test of the post-test results

	N	Mean	S.D.	t
Experimental group	22	70.55	15.42	2.11*
Control group	21	60.19	16.76	

*p< .05

5. Conclusions

Recently, mobile and wireless communication technologies have become popular among research groups. In ubiquitous learning, the students are situated in a real-world environment with supports from the digital world. Thanks to the novelty and pleasure of using mobile devices outside the classroom, such learning activities frequently receive promising feedback from the students [20] [22]. Therefore, most researchers and school teachers regard such equipment as a convenient channel that enables students to access digital resources from the Internet. Nevertheless, the issue of developing new strategies or tools to improve the learning achievements of students in such learning environments has attracted relatively little attention.

In this paper, we present a sensing technology-enhanced ubiquitous learning system, which employs a cognitive apprenticeship approach to guide students to learn to operate a set of target devices in a science park of southern Taiwan. The developed system has been applied to a learning activity of a science course in an elementary school. The results of the experiment demonstrate that this innovative approach promotes learning motivation, and improves the learning achievements of individual students as well. This finding is quite different from those of previous studies [29] [32] [33], which mainly investigated the correlation among the learning motivation, the learning behaviors and the technology acceptance in mobile and ubiquitous learning. In addition, the usage of this innovative approach (i.e., learning via operating the devices) is different from those of most previous studies which mainly focused on guiding the student to operate the learning objects [34] [35]. Therefore, this study has the rather positive implication that ubiquitous learning can be effective if proper strategies can be provided to guide the students to interact with the learning context.

Acknowledgements

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Workshop

The Design, Implementation and Evaluation of Game and Toy Enhanced Learning

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Preface

Game and Toy Enhanced Learning (GTEL) has been widely accepted as a powerful alternative to traditional ways of teaching and learning, with the merits of motivated learning and practicing higher-order thinking through trial-and-error within a challenging context. The emerging research area of GTEL has attracted interdisciplinary researchers to study the related important issues from various perspectives. Using games and toys for learning has demonstrated the potential in enhancing students' motivation, meta-cognition, problem-solving skill, attitudes, and creativity. However, the opposite opinions drawn from the addiction perspective also expressed the hesitation in applying digital games for learning. The gap between the positive and the negative opinions needs to be further discussed and resolved.

The goal of this workshop is to discuss the design, implementation, and evaluation of employing digital games and toys to enhance learning within social contexts. This workshop provides a forum, with short paper presentations and an interactive session, for ICCE 2010 participants to share ideas and experiences in studying the ways to enhance learning through the use of digital games, intelligent toys as well as other advanced computing technologies. Five papers were finally selected for this workshop. Each selected paper went through a blinded peer review process. These workshop papers examine various game-based learning issues, including affective learning, attitudes, cognitive load, learning support agent for collaborative learning and 3-D computer game for solving orientation problems. It is hoped that these issues will bring about in-depth discussions during the workshop and promote further exploration on the derived research issues.

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Seventh grade Students' Learning Attitudes toward Game-based Programming

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Abstract: Scratch is a visual programming language, whose feature is that learners can develop programs through dragging and dropping graphical source code. This research sampled three different groups of seventh grade students: regular class, math-talented class and music-talented class, and used game-based and visual programming tool to teach students the concept of programming. Then we analyzed the differences in learning attitudes and effectiveness between genders and among different classes.

Keywords: programming learning, game-based learning, visual learning

Introduction

Scratch is a programming teaching software developed by Massachusetts Institute of Technology in the USA, adopting the graphical interface and programming through simple dragging and dropping. This study aimed to instruct students by using visual programming language toolkit, exploring the changes in effectiveness of and attitude toward learning programming among different groups of seventh grade students.

we conducted Scratch courses on the learning platform, and used games to guide students to learn the concept of programming. Through assignments, students learned the basic concepts of programming and the basic skills of Scratch. The subjects of this study are 92 students in the seventh grade, including students from regular class, math-talented class and music-talented class. These students learned in a computer course once a week for one semester. This study adopted mixed methodology. For qualitative research method, students were observed during their programming learning process, and their works were analyzed and compared. For quantitative research method, after the course ended, questionnaires were used.

1. Literature Review

Middle School Programming Language Instruction

In Nine-Year Integrated Curriculum, Information Education is not included in the seven learning areas, but listed among six issues. For computer courses in middle schools, most are focused on software teaching. Papert claimed that the learning of programming makes one think more logically and improves their ability of judgment [9]. With the popularization of computers and Internet in recent years, middle school students have more access to various kinds of software. Students are more equipped in prior knowledge of different software than before, and thus programming language instruction can be put into middle school curriculum to develop students' logic skills and design ability.

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Visual Programming Learning

When people write source code, the abstract language and symbols often lead to difficulties in learning. Beginners start with drawing flow chart when they first learn programming. The flow chart may help people understand the operating logic of programming, but it does not effectively help beginners to write programs [14]. The choice of programming tools will influence beginners' programming learning. Visual development environment provides learners with more friendly interface and helps beginners to capture the basics of program design [2].

Scratch Programming

Scratch is a programming language developed by MIT Media Lab. Scratch is a visual programming language that allows various programs to be assembled together like building blocks [15]. The code fragments in blocks palette are divided into 8 categories with a color of its own: movement, looks, sound, pen, control, sensing, operators, and variables.

Game-based Learning

The use of digital games in the education context improves learning through strengthening students' motivation. Digital games generate learners' learning motivation through pleasure [10][11]. The digital games with learning as its goal "serve as a method for supporting the teaching aims and learner objectives by defining the "learning activity as play" and highlighting the potential of briefing/debriefing which take place before and after "serious play" to reinforce the learning outcomes." [3]

Individual Differences

1.1 Gender

Gender is what we normally call as males and females [1]. Males show greater interest in learning technology-related courses, while females appear to have better performances than men in technology learning [12][13].

1.2 Learning styles

The learning style is a stable index that shows learners' cognition, interaction and response to the learning context, and that incorporates learners' individual cognition, personal feelings and mental behaviors [8]. Learning styles are the choices made when learners process received messages, and these styles are connected with learners' personal preferences. Different class attributes also generate different learning styles in different classes.

2. Method

We used quasi-experimental design and gave 3 classes of seventh grade students one semester of Scratch Programming instruction on Moodle learning platform, once a week for a total of 18 weeks. The regular class consisted of 34 students (18 males, 16 females), the math-talented class 29 students (12 males, 17 females), and the music-talented class 29 students (7 males, 22 females). The research process is shown in figure 1.

Table 1: Participants

	Regular Class	Math-talented Class	Music-talented Class
Males	18	12	7
Females	16	17	22
Total	34	29	29

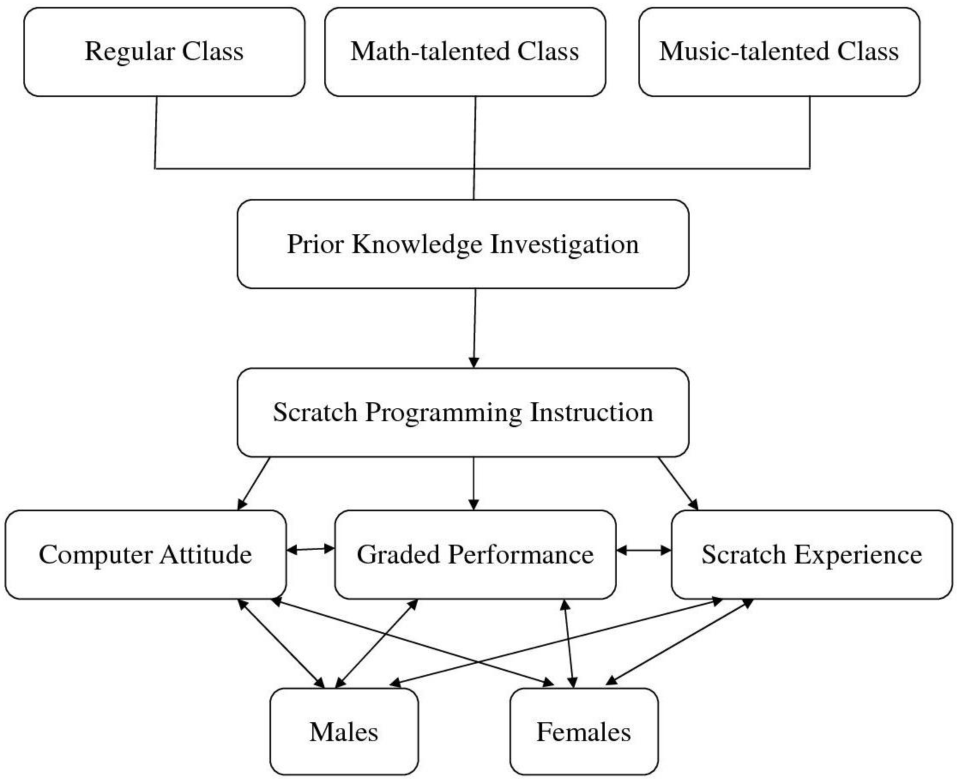

Figure 1. Research process

2.1 Use Visual Programming Software Scratch for Instructional Design

In this study, the instruction of the Scratch software was given in a game-based method to the seventh grade students. After each instruction, students were asked to make a weekly theme programming project and to upload it to the learning platform for teachers' grading. The final grade was based on all the projects the students had handed in. The instructional activity design is shown in the following table.

Table 2. Learning project activity

Theme of the game	Programming Instruction	Source of the game
Cross the river	Think about different solutions	From Internet
Guess the number	Think about random numbers	From Internet

Hit the bricks	Think about objects	Scratch Example
HelloInManyLanguages	Learn about sequential structure	Scratch Example
Cat and mouse	Learn about usage of loops	Self-made project
Grade Conversation	If-then-else	Self-made project
Lotto game	Random numbers	Self-made project
FishChomp	Control of keyboard and mouse	Revised from Scratch Example

2.2 Research Tools

2.2.1Scratch

This study used Scratch, a visual programming language software developed by MIT, version 1.4.

2.2.2Scratch Learning Questionnaire

We revised the Scratch Design Questionnaire developed by He, Y. Y., Chang C. K., & Liu, B. J. (2010) [5] and added the construct of usefulness. The questionnaire uses five-point Likert scale, with 8 negative statements, using reverse scoring. Respondents filled out the questionnaire after the instruction of Scratch. The questions are divided into the following categories:

Table 3. Scratch design attitude questionnaire

Constructs	Item No.	Number of items
Learning Anxiety	1~9	9
Playfulness	1~7	7
Enjoyment	1~3	3
Usefulness	1~4	4

3. Analysis

After a semester of Scratch instruction, we distributed questionnaires for the regular class (35 sets), math-talented class (30 sets), and music-talented class (29 sets). After removing invalid questionnaires, we received 15 sets of valid questionnaires from the regular class, 18 from the math-talented class and 21 from the music-talented class.

3.1 Students' Basic Skills

Table 4. Investigation on students' prior knowledge

Item	Percentage of the regular class			Percentage of the math-talented class			Percentage of the music-talented class		
	M	F	S	M	F	S	M	F	S
Do you have a computer at home?	100	100	100	100	100	100	100	100	100
Do you have internet access at home?	100	100	100	100	87	93	100	100	100
Do you have computer books or magazines at home?	20	70	53	58	50	55	66	72	71
Does anyone else at home use computer?	100	100	100	100	93	96	100	100	100
Do parents encourage you to use computer?	40	50	46	25	56	41	0	44	38
Prior to the computer class, had you learned programming?	0	40	26	41	56	48	66	38	42
Do you know how to use emails?	80	90	86	100	100	100	66	100	95
Do you know how to use instant messaging?	100	90	93	91	93	93	66	94	90
Do you know how to use blogs?	60	100	86	75	87	86	0	83	71
Do you know how to use Plurk?	0	20	13	8	0	3	0	16	14
Do you know how to use Facebook?	40	60	53	66	43	51	33	50	47
M: Male, F: Female, S: Summation, Unit：%									

Table 4 shows that for the seventh grade students, almost everyone has computer and internet access at home. About 90 percent of students know how to use emails and instant messaging. About 40-percent students in the math- and music-talented class had learned about programming, while there are fewer in the regular class.

3.2 Scratch Program Design Attitude

Table 5. Scratch program design attitude result

Constructs	Regular class			Math-talented class			Music-talented class		
	M	F	S	M	F	S	M	F	S
Learning Anxiety	3.49	3.63	3.59	3.37	3.63	3.52	4.52	3.67	3.79
Playfulness	3.60	3.44	3.50	3.44	3.68	3.58	4.05	3.50	3.58
Enjoyment	3.80	3.50	3.60	3.67	3.75	3.71	5.00	3.67	3.86
Usefulness	3.65	3.15	3.32	3.40	3.50	3.46	4.17	2.99	3.15
M: Males, F: Females, S: Summation									

From Table 5, which shows Scratch program design learning attitude. This illustrates that in different constructs, each class and gender differs.

3.3 Learning Effectiveness

Grades were marked by teachers and determined by the completion of assignments handed in each week. The results were posted on the learning platform. A passing grade of 60 was given when the assignment matched the programming concept and met teacher's requirements, and a range of additional 1-40 was given according to students' creativity.

Table 6. Semester grades

Average grade	Males	Females	Summation
Regular class	54.31	80.11	66.45
Math-talented class	63.79	87.07	77.44
Music-talented class	57.22	80.54	74.32

In all classes, females had better grades than males. During the Scratch programming instruction, male students showed more interest than female students. However, boys were prone to distractions such as Internet and games, less concentrated in learning, and hence they received lower grades than girls.

Table 7. Summary of the research

Aspects	Sub-aspects	After Learning
Concerning computer learning attitude		1.math-talented class 2.regular class 3.music-talented class
		males > females
learning attitude toward Scratch	Learning anxiety	1.music-talented class 2.regular class 3.math-talented class
	Playfulness	1.music-talented class

		2.math-talented class 3.regular class
	Enjoyment	1.music-talented class 2.math-talented class 3.regular class
	Usefulness	1.math-talented class 2.regular class 3.music-talented class
Scratch learning effectiveness		1.math-talented class 2.music-talented class 3.regular class
		females > males

4. Conclusions

In effectiveness, based on classroom observation and final grades, male students were easily affected by distractions such as Internet and games during the learning process. They aimed to have their projects meet the lowest requirement standard set by the teacher. On the other hand, girls were more concentrated than boys. In project design, in addition to meeting the teacher's requirements, they added their own creativities and thus they received higher grades than boys. Concluding from the above, we have learned that using game-based program design in the middle school can indeed generate students' greater interest in learning and that the use of the programming software Scratch can effectively alleviate beginners' fear for programming through the visual interface. Also, differences exist in different class attributes and genders during the learning process.

After a semester of Scratch programming instruction, we have concluded the following based on our research results: (a) In computer learning attitudes, math-talented students better than regular students and music-talented students, (b) Female students learned Scratch better than male students, (c) Math-talented students learned Scratch better than music-talented and regular students.

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Smart Ambience for Affective Learning (SAMAL): Instructional Design and Evaluation

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Abstract: While much has been written about how emotions affect cognition and memory [1], as well as how emotions attached to the success/failure of academic performance impact learning; little has been researched about the association between immersion in VR and emotions and learning. In this study we focus on the instructional design and evaluation of an innovative learning environment for affective learning which allows students to step into the virtual reality scenarios and through a series of interactive and immersive learning activities provides the learner with a unique learning experience, not found in conventional classroom learning. The design of instructional plans aims to work in conjunction with the virtual scenarios for learning and takes reference from Kolb's theory on experiential learning. The SAMAL (Smart Ambience for Affective Learning) instructional design offers a unique potential of stimulating the learner to engage in the educational virtual experience. Our preliminary findings show that a range of affect responses can be invoked through direct interaction with SAMAL learning scenarios which serves to extend the use of educational games as a supplementary learning tool and offers a new novel arena for learning.

Keywords: affective learning, smart ambience learning design, immersive learning scenario

Introduction

With the emerging application of Virtual Reality (VR) technologies in the higher and secondary education, little is known about the interplay between immersive virtual reality, emotion and learning of the learners. The CityU Smart Ambience for Affective Learning (SAMAL) project aims to develop innovative designs of learning VR scenarios (which we called SAMAL scenarios) that tap into the affect components of the learner. The design and the instructional flow of these learning SAMAL scenarios was created with the intent of looking into the effects of emotion upon learning.

Much has been written about how emotions affect cognition and memory [1], as well as how emotions attached to the success/failure of academic performance impact learning [6]; but little has been researched about the association between immersion in VR and emotions and learning. The SAMAL project aims to achieve this and more specifically to see if immersive / virtual reality environment can help to evoke emotions suitable for learning, and thus stimulate the learner to learn.

The correlation between emotions and learning are linked, as emotions influence learning. Literature links emotions to success/failure in school. Emotions within the educational setting most often relate to achievement (success/failure) and the associated feelings such as pride/happiness and sadness/shame [6]. Moreover, engaging in achievement activities result in emotions, based upon the perceived controllability of the activity and the value that the student places on it. For example, if a student has succeeded in controlling the activity and places positive value upon it, then positive feelings such as enjoyment will be the resulting feeling; and the opposite holds true if success is perceived as not being attainable. Features of the SAMAL design are linked to how the students can actively participate and control their movements within the virtual environment in order to reach their target, and experience the challenges of animal survival. Successes can lead to positive feelings resulting in greater learning about animal survival from this unique learning media. In the SAMAL design, the focus is placed upon creating a learning environment where the student can learn through a process of action based trial and error, whereby kinesthetic physical interaction with the virtual characters and environment are simulated. Through this process students can gain a deeper understanding/achieve successes of animal survival. This kind of experiential learning is linked to Kolb's theory of experiential learning cycle. Kolb postulates that learning occurs in four stages: concrete experience, reflection, abstract conceptualization, and then active experimentation, which then leads back to a new more formulated concrete learning [4]. Kolb's experiential learning cycle is shaped by earlier theories of Dewey, who stressed that effective learning is grounded in the experience and interaction, Lewin who gave emphasis to active based learning, and Piaget who linked intelligence to the interaction between the person and the environment [2]. SAMAL's trial and error learning approach incorporates aspects mentioned in the above.

Targeted to learners in tertiary and secondary education, the SAMAL project looks into the affective responses from the students as they engage in the virtual environment of SAMAL. Learner's interaction with immersive and affectively evocative virtual scenarios stimulates a release of energy in the body. This kind of kinesthetic body release taps into the feeling and cognitive state of the individual [3]. The SAMAL Learning Environment offers a new platform for learning- one that stimulates the learner to engage in the educational virtual experience through immersive interaction with the virtual characters, activities and environment, resulting in affect states that positively impacting learning.

In this paper, we focus on the instructional flow of the design and rationale of the SAMAL environment as well as to evaluate affective outcomes based upon the objective of determining the learning impact of emotion for learning topics in Life Science.

1. Instructional Design for SAMAL

SAMAL aims to stimulate the learners to learn more by invoking their affects through participating different virtual scenarios. We make use of 3D stereo projection to provide immersive feeling, cameras and motion sensors to detect learners' movements and gestures, and scent dispenser to provide olfactory stimulations. The layout of the SAMAL learning environment is shown in Fig. 1. It consists of two projectors, a silver screen, a wii-mote controller, a nunchuk and a wii-fit board. Polarized filter is placed in front of each projector for generating the stereo animation onto to the silver screen; while the wii-mote controller, nunchuk and wii-fit board are used as 3D interaction devices. Cameras and microphones are mounted on the walls to capture visual and audio input of the learners.

Before we illustrate the design of virtual scenarios, we first highlight the instructional plan for SAMAL learning as follows:

1. At the beginning of tutorial, the SAMAL instructor provides an introduction to what is SAMAL and states the learning objectives of the SAMAL Project: The instructor will explain that the students will experience two different SAMAL activities that relate to Life Science topics. The instructor will highlight the educational purposes of this activity and the interactive components of the virtual reality experience. The instructor will indicate to students that some of them will be players and some will be watchers.
2. Students will be provided with 3D glasses in order to view the 3D projections.
3. A demonstration of the two SAMAL activities, namely, the Animal Jumping Scenario

and the Hummingbird Flying Scenario will be carried out by the SAMAL instructor, introducing how to operate the wii-mote controller, the nunchuk and the wii-fit board in order to control the flight of the hummingbird virtual character and the jumping movements of the virtual animal characters.

4. In the first exercise, the Animals Jumping Scenario, students who volunteer to be participants will try out the learning scenarios themselves based on the learning objectives of this activity. Players will move and control the wii equipment in order to accumulate and release energy for jumping. The other students will observe the players, observing, giving advice and support.
5. In the second exercise, the Hummingbird Flying Scenario, students who volunteer to be participants will try out the learning scenarios themselves based on the learning objectives of this activity. Players will move and control the wii-equipment in order to navigate and reach the flower for gaining sustenance. The other students will observe the players, observing, giving advice and support.
6. After participating in these scenarios, the students (both the players and the watchers) will complete our questionnaire devised to determine the effectiveness of the SAMAL activity and affective outcomes.

In the following, we will describe the design and the design rationales of these virtual learning scenarios.

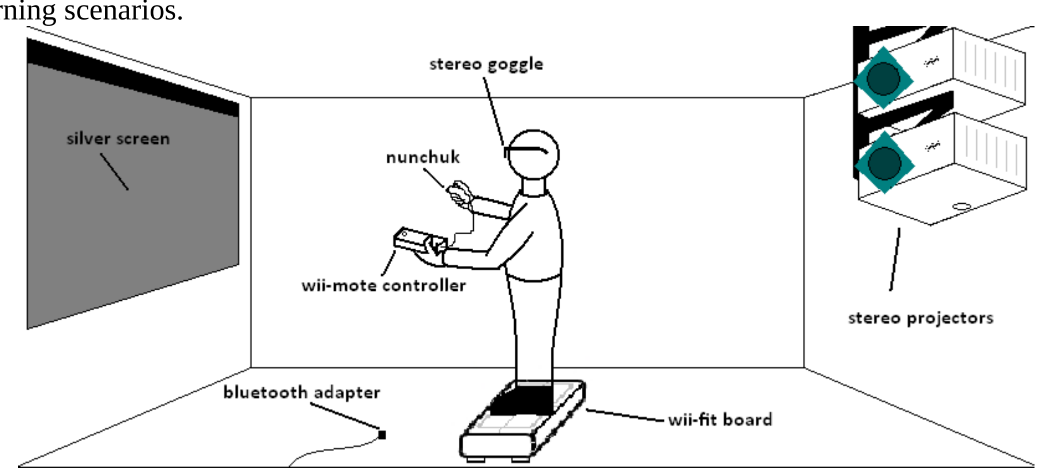

Figure 1. Layout of SAMAL learning environment

2. AMAL Experience of an Animal Jumping Game

The objective of Animal Jumping scenario is to allow students to experience the jumping ability of different animals when they have the same scale as human beings. Furthermore, to let learners compare the difference between animals and humans, there are five different kinds of animals for learners to choose for the comparison. In SAMAL, the animal jumping scenario involves visual and interactive stimulations to facilitate the learners to put themselves into different kind of animals which then competes and compares with the jumping power with human beings. We separate the design into two aspects that focus respectively on the ‘visual” and the “interactivity” experience for the learners.
“Visual” Design:

- The selected animal is scale up to 1:1 and shown side-by-side with human beings such that the students can easily compare the jumping power, and hence the jumping height, of the designated animal with human beings.

- To simulate that the exertion of energy is needed for jumping, an energy bar is shown on the screen to indicate the energy accumulated for the jumping process.

"Interactivity" Design:

- A pressure sensor (the wii-fit board) is provided for the player to measure his/her own body weight. The body weight affects the jumping power based on the equation, according to Newtonian mechanic.
- Motion sensing device such as the wii-mote and nunchuk controllers are provided, so that the player can kinesthetically shake the wii controllers to store energy for the jumping process. The faster the player shakes the wii controllers, the longer the bar (indicating the higher the energy level). The player can then initiate the jumping process by pressing a button on the wii-mote.

Fig. 2 shows a side-by-side comparison of a fish and a human. Fig. 3 shows the jumping process of both a human and a fish with the same amount of energy. Since a fish has different appearance and structure from human beings, there is a difference of the jumping height. The final heights reached by the fish and the human being will be shown on the screen (Fig. 4). After several trials, the player will gradually learn that the jumping power of the human being and the selected animal maintains a certain ratio.

Figure 2. Side-by-side comparison

Figure 3. Jumping Process

Figure 4. Comparison of jumping heights between a fish and a human

3. SAMAL Experience of an Animal Survival Game

A game that enables the learner to experience the survival for an animal is developed based on the navigation of Hummingbirds in search for food. The choice of a Hummingbird as an example is chosen because the bird has to flap its wings rapidly in order to hover in the mid-air. It also needs to fly forward and backward [7] for food or escape from danger. In the Hummingbird Flying Scenario, students will act as a hummingbird, trying to overcome the difficulties in flight controlling and food hunting, like how to reach the flower for nectar (food) and avoid flying into the obstacles (trees, fences and etc. in the scene). The kinesthetic rapid shaking of the student arms echo the flapping of wings of the hummingbird. The use of the body heightens the immersive experience. The students control the flying direction and speed by carefully controlling the pressure of the legs and flapping the arm to control respectively. It is important to note that in SAMAL we DO NOT seek to accurately simulate the physics or the biology of the flying bird. The activities are designed mainly to give the students a personal experience of the challenges of seeking for food to survive and the affect that evoked in the process of overcoming these challenges. In SAMAL, the hummingbird flying scenario involves visual and interactive stimulations to facilitate the students to put themselves into the hummingbird and try to survive by food navigation and feeding.

"Visual" Design:

- A scene of countryside with trees, flowers, fences, pools, grass, mountains and sunshine is designed to provide a pleasant and enjoyable simulated environment so as to draw the students into the scene.
- A hummingbird perching in its birdhouse at the beginning (Fig. 5).
- An energy bar is shown on the screen indicating the existing energy level of the hummingbird; this bar aims to give a sense of urgency as the energy is depleting that energy (hence food) is needed for survival. The energy level decreases continuously once the activity started, once it drops to zero, the hummingbird will be depleted. In other words, the students have to replenish the dropping energy.

"Interactivity" Design:

- The player controls the direction of the hummingbird flying by stepping and moving on a pressure sensing device (the wii-fit board). The wii-fit board is divided into four regions: namely 'Top-Left', 'Top-Right', 'Bottom-Left' and 'Bottom-Right'. If the player exerts pressure on the 'Top-Left' and 'Bottom-Left', the hummingbird will go left and vice versa depending on the pressure exerted on wii-fit board.
- The hovering in the air of the hummingbird (Fig. 6) is controlled by a motion sensing device (the wii-mote and nunchuk controllers). The player is asked to shake the wii controllers vigorously with the hands, like the flapping of wings, and, if done properly, the hummingbird will take off, fly and hover in the air.
- When the hummingbird succeeds in reaching the flower and sucking the nectar (Fig. 7) from the flower, the energy bar will lengthen showing the increased level of energy. This design aims to demonstrate a paradox of the survival of a hummingbird that in fact happens in real life for all kinds of birds: the more the hummingbird flies around to seek for food (and consuming more energy), the more frequent it has to eat to refill the used energy.
- If the player succeeds in controlling the hummingbird to reach all five flowers before energy depleted, the player had successfully survived in this environment as a hummingbird (Fig. 8). Otherwise, if the hummingbird runs of energy, an 'energy depleted' screen will be shown to indicate that the player had failed.

Figure 5. Perching in birdhouse

Figure 6. Flying towards flower

Figure 7. Sucking nectar (food) from a flower

Figure 8. Energy replenished – bird survival achieved

4. Affective Outcomes of the SAMAL Designs

In our evaluation of the effectiveness of SAMAL learning scenarios, we devised a questionnaire to see if SAMAL promotes or stimulates appropriate affective states as the result of immersing and interacting with SAMAL. It also looked at the correlation between affect and learning between players and watchers to see if the interactive immersive experience offered to players promotes greater affect and thus promotes greater learning for players versus watchers.

The questionnaire asks the students to respond to a list of feelings that they felt while engaging in the two activities Animal Jumping and Hummingbird Flying. Note that students could select more than one feeling, making the responses higher than the total number of students. It also asks students to indicate how much they think they have learned as a result of engaging in through these two SAMAL experiences. In this initial study, we extended an invitation to various local upper secondary students from the Science and Art streams to visit and to “learn” with SAMAL in the format of a tutorial. After engaging in the SAMAL tutorial students were asked to fill in our questionnaire. 104 students participated in this initial study: 31 players having the role of active immersion and 73 watchers who participated on an observational level. The feeling states for players and watchers correlated with the degree of learning is shown in Tables 1 and 2 below.

Table 1 denotes the feeling states for players and then provides a cross correlation between feelings and learning. Overall, most players reported feelings on the positive end of the spectrum. 61.29% players responded that they were curious and also happy, as well as excited and interested (both at 54.84%). 19 out of the 21 players (90.48%) indicated that they had 'learned a lot'. In summary, there was a strong correlation between having positive feelings and learning for players.

There were also more players responding that they had both positive and negative feelings whilst engaging in the activity (29.03%) whereas only 1.37% of the watchers reported that they had both positive and negative feelings while viewing. This correlates to the above data showing 9 players, or (29.03%) report that they felt frustrated while engaging and according to student feedback some players replied that they could associate with the challenges that the bird had in flying and controlling flight as it is difficult to fly, thus felt frustrated while in playing the player role.

For the watchers as seen in Table 2, the three top responses were interested (69.86%), curious (56.16%), and awed/amazed (43.84%). This data indicates that there is positive feeling states of higher intensity (ie) happy and excited associated with the players who have had an immersive VR experience with SAMAL than for those who were in the watching position, who noted positive feelings of a lower intensity (ie) interested, curious and awed/amazed. The same holds true for learning, as 52 out of the 73 watchers (74.29%) indicated that they had learned a lot which is still positive but not as high as for those players.

Table 1. The Range of Affect States for Players Correlated with Learning

31 people in total		**Player**		
Feeling	**Responses**		**Q4: Learnt a lot**	
Happy	19	61.29%	18	94.74%
Curious	19	61.29%	16	84.21%
Interested	17	54.84%	15	88.24%
Excited	17	54.84%	17	100.00%
Awed/Amazed	11	35.48%	10	90.91%
Frustrated	9	29.03%	7	77.78%
Insightful	6	19.35%	5	83.33%
Irritated	2	6.45%	1	50.00%
Bored	0	0.00%	0	0.00%

Table 2. The Range of Affect States for Watchers Correlated with Learning

73 people in total		**Watcher**		
Feeling	**Responses**		**Q4: Learnt a lot**	
Interested	51	69.86%	41	80.39%
Curious	41	56.16%	30	73.17%

Awed/Amazed	32	43.84%	29	90.63%
Happy	29	39.73%	23	79.31%
Excited	20	27.40%	16	80.00%
Insightful	13	17.81%	12	92.31%
Bored	3	4.11%	0	0.00%
Frustrated	0	0.00%	0	0.00%
Irritated	0	0.00%	0	0.00%

5. Conclusion

Higher affective states promote greater learning, little is still known about the interplay between immersive virtual reality, emotion and learning. This pilot project is among the first of its kind to look into if immersive virtual learning scenarios making use of VR technologies may be a viable tool in education to evoke positive affects in for learning. Based upon the design which promotes interacting with the VR characters and environment, SAMAL allowed the students to experience from an affect sense what it is like for animals to survive, thus increasing students learning interest in the topic. In our case, this project focuses on the concepts of animal survival. Students may cognitively understand survival needs through various learning; however an immersive VR educational programme/activity that offers to students an opportunity to fully immerse in survival tactics gives them a deeper understanding of the concept of survival, as the students can 'feel' the experience in their body, and feel the emotions of survival in this real time activity. Students can connect to the bird, as they perceive themselves as that bird (full immersion) in the VR scenario.

Our data showed that there was a difference in both emotions and learning between players who had an immersive experience and watchers who were more in the passive position. Overall, most players reported feelings on the positive end of the spectrum, providing feedback that SAMAL was a positive affective experience for most. However, there was a marked difference between those who played (active immersion experience) and those who watched (observing more passive experience), indicating that an active immersive experience results in a stronger affect state and also provides greater learning for those who participated in this study.

SAMAL allows the user to 'get into' the scene and interact with the VR characters/ environment actively. Active participation, along with being immersed through the senses and psychologically are features of virtual immersive environments that can promote learning [5]. This SAMAL project extends the use of educational games as a supplementary learning tool which can offer a new novel arena for learning. SAMAL enables students to learn though an immersive interactive experience, tapping into the affective state of the learner, thus stimulating learning in a unique way.

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Applying a Three-Dimensional Computer Game to Facilitate Learners' Using a Compass to Solve Orientation Problems: A Case Study

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Abstract: Recently, limited research examines how 3D game-based context influence students' acquisition of both cognitive and procedural knowledge, such as using a compass to solve orientation problems. The purpose of this study was to explore the implementation of a computer game for learning how to use compass. A three- dimensional (3D) computer game named *Treasure Hunting* was developed by the researchers. A male and female volunteer of grade 3 and 4 were recruited to take the treatment. The results of the post test and the retention test showed that the students in a 3D game-based environment were able to acquire the compass-using skills. The results also provided some practical suggestions to science educators or instructional designers interested in implementing game-based learning as an alternative way to enhance students' conceptual understanding.

Keywords: Game-based learning, science education, virtual reality, game.

Introduction

Instructional problems of a superficial understanding still prevail in current education. Educational researchers recognize that students can get superior test scores but possess shallow and isolated understanding of the targeted knowledge. Take science education for example, Tsai (1998) pointed out that students were inclined to use rote memorization to acquire scientific knowledge, which later hindered the usage or application of the knowledge in an appropriate context. To remedy the shadow learning problem and enhance learning performance, many educators seek solutions from technology, particularly digital game-based learning (GBL) (Annetta, Minogue, Holmes, & Cheng, 2009; Tuzun, Yilmaz-Soylu, Karakus, Inal, & Kizilkaya, 2009).

The three-dimensional (3D) virtual environment in games, according to Wann and Mon-Williams (1996), "provide the user with access to information that would not otherwise be available at that place or time, capitalizes upon natural aspects of human perception by extending visual information in three spatial dimensions" (p. 833). Findings from Tuzun et al.'s study (2009) on implementing a computer game for learning geography indicated that 3D environment together with GBL could not only promote students' learning outcomes but also enhance their engagement in the learning activity. Although several studies were conducted to investigate the influences of integrating 3D environment and GBL on cognitive learning, such as geographical information (Tuzun et al., 2009) and genetics (Annetta et al., 2009), limited research examined how 3D game-based context influence students' acquisition of both cognitive and procedural knowledge, such as using a compass to solve orientation problems. Therefore, the aim of the present study was to investigate whether the 3D game-based environment could be employed to facilitate students' learning a compass. A 3D computer game named *Treasure Hunting* was developed by the researchers and it includes inquiry tasks, challenges and time limitation. Two students were recruited to play the game, take the post test and retention test in this case study. Discussions and suggestions about game design were also proposed.

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Methodology

Participants

A male student of 3rd grade and a female student of 4th grade volunteered to participate in this study. They had not received any formal instruction about using a compass and had no prior knowledge about using a compass.

Procedure

The students were first informed the aim of the study and then took the treatment individually. Each participant's playing process together with audio were recorded by screen capture software for later analysis. The treatment stopped whenever they successfully achieved the goal in the game. Following the game was an interview conducted to probe the players' understanding as well as their feedback about the game. Questions prompted included, 1) what is the purpose of using a compass? 2) How do you guide a person to use it? 3) How did you feel while playing the game? 4) How did you react when attacked by the enemy? 5) Did the attack by the enemy or eating food influence your searching diamonds, and How? After three weeks, each student was interviewed again to examine how much the targeted knowledge he or she retained.

Instrument

The researchers developed a game named, *Treasure Hunting*, by using an authoring tool *Virtools Dev 3*. To connect the game goal and educational goal, the player in the game had to search three diamonds in order to complete the inquiry-based missions. Since these diamonds were located in a vast virtual environment, searching all the diamond within limited time required the players to utilize the orientation bases (to gain information about the directions of diamonds) as well as a compass. To provide an exciting and emotionally

Countdown
Display the time remained.

3D Environment
Includes continent, forest, enemy, and statues.

Avatar
Players can use the keyboard to search the diamonds in the game environment

Figure 1. The interface of *Treasure Hunting* game

Compass
Allows players to determine the direction of the target destination.

Orientation Base
Offers the directions of diamonds.

Energy Bar
Displays the avatar's energy status.

appealing experience, challenges such as enemy attacks and time limitation were imposed on the players. The participants had 10 minutes to complete the task and the time was displayed through a countdown shown on the top-left area of the screen, as illustrated in Figure 1. An enemy would appear and attempt to kick the player whenever the first diamond was found. When under attack, the avatar's moving speed would decline and the energy bar on the right part of the screen would become empty. The player had no way to avoid the attack unless the avatar ate sufficient food to speed up the movement so as to run away from the attack. During the playing process, each student's behaviors would be saved into a log file for further analysis.

Results and Discussion

Both participants took three times to win the game. In their last trials, Andy spent nine minutes 25 seconds and Betty spent about seven minutes to complete the task. The users' behavioral logs that recorded frequency for five main behaviors in each trial were shown on Table 1. As shown, both players employed the orientation bases and set the compass more than three times in their successful trials. This may indicated that they did rely on using the compass to find the diamonds, rather than searching by lucks. Although Betty used the compass more than three times in her first trial, most usages were wrongly operated according to the analysis of the video record.

Analysis of video clips and users' behavioral logs could explain the causes to failure in their first two trials. Andy tended not to utilize orientation bases (to gain information about the directions of diamonds) and the compass in his first trial. He tried to find diamonds by lucks instead, which was displayed as low frequency in the behaviors of setting compass and using orientation bases in Table 1. In the second trial, his strategy to deal with the enemy' attack was running away, which certainly drove him away from the path to get the diamond. Regarding Betty, the unfamiliar usage with the compass hindered her achieving the task in the first two trials. For instance, she either forgot to turn the compass housing to align with the directional arrow or inaccurately aligned the compass needle with the orientation on the compass housing. However, in the second trial she seemed to realize that eating more food would speed up the character's movement, which allowed avoiding the enemy's attack. With experiences from the first two trials, both players became more acquainted with the usage of the compass and could complete the task in the third trial. This implied that the 3D game-based learning environment provided an context for the players not only to construct their understanding to compass usage but also to gain practical experiences in using a compass.

Table 1. Frequency table of playing behaviors

	Set compass	Orientation bases used	Food	Attacked	Diamond found
1st (Andy)	2	1	6	6	1
2nd (Andy)	2	4	5	1	2
3rd (Andy)	4	5	7	5	3
1st (Betty)	6	3	6	7	2
2nd (Betty)	5	4	9	3	2
3rd (Betty)	5	3	8	3	3

After completing the game, an interview was conducted to investigate their experiences in playing the game and to probe their understanding about using a compass. Both participants expressed that they had anxious feeling while walking a long way without finding the diamond. They doubted that they might use the compass in a wrong way. For example, Andy said that, "Where is the diamond? I have been walking a long way but still cannot find it". Similarly, Betty impatiently murmured to give up playing since she could not see the diamond and suspected that she might misuse the compass. This finding indicated that the 3D game-based learning context was able to offer learning experiences as richly situated and immersive as the real-life context provided, which helped learners to reflect their learning process/strategies, and construct solid and deeper understanding.

When asked the feeling about being attacked, Betty indicated that the enemy's attack was frustrated and made her move slowly by taking out all the energy. Andy expressed that, "It was exciting to be chased by the enemy and I had to eat food [to increase the moving speed] so as to prevent the attack." This implied that the challenge component of game design might promote the players' emotional involvement and decrease a sense of boredom. To investigate the participants' understanding about using a compass after the treatment, a post-test and retention test were conducted through two interviewing questions including 'what is the purpose of using a compass?', and 'how do you guide a person to use it?' Both participants could explicitly describe the aim as well as demonstrate the process of using a compass while asked to do so. As Andy described, "the purpose [of using a compass] was to help one head to the right direction". "The compass can tell me right direction", said by Betty. The retention test took place after three weeks. Both students seemed to have difficulty explaining the usage of a compass without seeing a compass. But, when displaying a compass they could demonstrate the way to use a compass accurately and fluently. This implied that the 3D game-based learning environment could facilitate the students' acquisition of compass-using skills in a certain degree.

Discussion and conclusion

The purpose of this case study was to explore whether the 3D game-based environment could be employed to help students learn how to use a compass. The findings showed that the 3D game-based context is an ideal and situated environment for students to acquire and practice the targeted skills. This is in agreement with Annetta et al.'s (2009) study claiming that:

> The practice of learning a video game is an enculturation practice that involves not only learning the mechanics of game play, but learning how to negotiate the context of play, the terms and practices of a game's players, and the design choices of its developers (p. 79).

In addition, during the game-playing process the students encountered the same difficulties as those that might occur in a real-life learning environment, such as feeling astray, failing to remember how to use compass, and feeling frustrated during the long searching process. The difference is that all the difficulties they dealt with took place in a virtual environment that prevents them from generating a sense of embarrassment by making mistakes in front of many students. Further, failure is free and students can take time to remediate it, which makes education more efficient (Baek & Parker, 2009).

One suggestion about game design was proposed in the present study. The researchers found that an instructional video clip was offered to guide compass usage in the beginning of the game. But, both players tended not to browse it or browsed it incompletely, especially in the first trial. Even though the researchers tried to keep the clip concise and short, the players could not wait to play the game immediately. Thus, it is suggested that game designers can embed essential instruction into the initial level of the game to make sure that the users become acquainted with the rules before playing the game. In addition, it is also suggested that future studies can examine whether the players can transfer what they learn in the game context to a real-life context by asking them to use a real compass to find an objects. Further, in the field of science education, many studies have been conducted to investigate how students' self-efficacy (Schmidt & Ford, 2003) or epistemological beliefs (Tsai, 1998, 1999) influence their knowledge construction. It is an interesting topic for future researchers to investigate how 3D computer games can influence the learning of students with either low self-efficacy or naïve epistemological beliefs.

The ultimate goal of game-based learning is to encourage players to think and explore during game-playing process and then reaches conceptual changes after playing. This is a formidable challenge since the participants, especially during the first time playing, tended to employ a trial-and-error strategy to achieve the task. Thus, maintaining appropriate level of challenge may inform the players the fact that their way 'do not work' and take the approach that the designer would like to transmit instead. In addition to level of difficulty, the game design should pay more attention to incorporate components that may create conceptual conflict and promote cognitive accommodation.

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The Impact of Animated Worked Examples on Students' Cognitive Load During Problem Solving in Game-Based Learning

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Abstract: This study investigated the impact of animated worked examples on students' cognitive load during problem solving in a game-based environment. Participants were 45 college students and divided randomly into experiment group and control group. After solving the problems in the first round of game playing, the experiment group was given animated worked examples while the control group was given static worked examples. After the second round game playing, they completed cognitive load index. Results showed that there was no significant difference on cognitive load between the two groups. Discussion and possible reasons were provided.

Keywords: Problem solving; game-based learning; worked example; cognitive load theory

Introduction

Most of the existing instructions on problem solving are presented using a combination of graphics and words or purely words. Mayer argued that procedural knowledge (such as problem solving) should better be instructed using animations with narrations [1]. Van Gerven, Paas, Van Merrienboer, and Schmidtsuggested that worked examples could promote acquisition of complex cognitive skills for adults by reducing their cognitive load and irrelevant information [2]. In this paper, we design two types of worked examples, one with graphics and words and the other with animations and narrations, to test whether animations and narrations-based worked examples could reduce their cognitive load.

2. Literature Review

a. Game-Based Learning

Computer games have been used for training in many different environments, such as academic [3], business [4], and medical [5]. Researchers pointed out that games are widely accepted as a powerful alternative to traditional ways of teaching and learning, with the merits of facilitating learning by doing [6]. In addition, problem solving may be effectively improved by computer games [1].

b. Problem Solving

As Mayer [1] defined, problem solving is cognitive processing pursuing to accomplish a goal without obvious solutions. Researchers suggested that problem solving is more like a conscious, deliberate process governed by a naturally occurring sequence of steps [7]. Recently, the researchers agreed that problem solving is cognitive processing directed at achieving a goal when no solution method is obvious to the problem solver [1].

c. Worked Example

A number of researchers investigated the efficacy of using worked examples in classroom instruction and provided evidence in the effectiveness of worked example instruction [8]. According to Sweller, Van Merriënboer, and Paas, a worked example is a procedure that focuses on problem states and associated operators (i.e. solution steps), enabling students to induce generalized solutions or schemas [8].

d. Cognitive Load Theory

According to the results of worked example studies, and Sweller and Chandler developed the cognitive load theory to explain the limitation of cognitive resources during problem solving [9]. Sweller also used the schema theory to demonstrate the cognitive architecture in designing worked example instructions [10]. According to Vygotsky, there is a zone between what learners can do by themselves and with assistance [11]. The effective worked examples instruction should provide appropriate help and involve in the zone of proximal development [12].

3. Methodology

a. Participants

Our research sample consisted of 45 undergraduates, randomly divided into the experimental group with 22 students and the control group with 23 students. This research was intended to compare the effects of two different combinations of information representation methods (animations+narrations vs. graphics+words) on cognitive load, so we adopted a true-experimental design with random classification of participants into the experimental and control groups and test of their performances before and after the experiment.

b. Computer Game

SafeCracker, a puzzle-solving game was decision by Wainess and O'Neil since it does not require special background knowledge or extraordinary visual-spatial skill [13]. A player in SafeCracker is a candidate for a position as a head of security development at a world famous firm of security systems, therefore needs to accomplish a task given by the boss.

Figure 1: Interface of SafeCracker

c. Worked Example

In the experimental group (animations+narrations), participants were given worked examples presented with videos and narrative explanations about how to solve the puzzles edited using digital teaching material production software. On the other hand, the participants in control group (graphics+words) were given worked examples presented using PowerPoint. The worked examples for the two groups are completely the same in terms of contents but presented in different ways. In terms of the interactivity of the learning materials, participants in both groups are allowed to go to the previous or the next page, and only the participants in the animations+narrations group can pause or resume the video at will.

d. Procedure

First, the researcher explained the goal of the game. After providing an introduction of the game, participants began the first round of the game for 15 minutes. After first round game playing, participants in the experimental group were given worked examples presented with animations and narrations, and participants in the control group were given worked examples presented with static graphics and words using PowerPoint. All of them were given 10 minutes to watch the worked examples. Then, participants were asked to play the second round for 15 minutes. After the second round game playing, participants were required to fill out a cognitive load questionnaire to measure their cognitive load.

e. Instrument

The instrument we used to measure participants' cognitive load was adapted from NASA-TLX (Task Load Index). The Cronbach alpha of NASA-TLX was .81.

4. Results

Table 1 shows the descriptive statistics of cognitive load of the two groups. The result of independent t-test shows that there was no significant difference between two groups, t(43)=0.157, p=0.876.

Table 1. Descriptive Statistics of Cognitive Load

	Mean	Standard Deviation
Experiment Group	63.227	11.988
Control Group	62.696	10.645

5. Discussions and Conclusion

The results indicated that the difference was not significant, meaning that the effects of the two types of multimedia worked examples on learners' cognitive load are not significantly different. Two following is possible reasons. First, conveniences of instant replay of the two worked examples were different. Participants in the control group would directly access the worked examples to find answers when they encountered any difficulty in the game. Because the worked examples they were given were created by PowerPoint, they could easily and directly jump to a particular page. In contrast, participants in the experimental group had to spend much time on seeking the video section they needed. Second, learning styles may affect learning effectiveness during problem solving [1]. Third, the two groups spent differently on watching worked examples. Although all participants were given 10 minutes to watch our worked examples, we found that participants in the experimental group had to spend nearly 10 minutes on watching all the three worked examples just once. They did not even have enough time to watch any of the examples again. In contrast, most participants in the control group spent about 5~6 minutes on viewing all the worked examples, so they still have time to review any of them 2~3 times. Future researchers can also design fading worked examples, i.e. incomplete worked examples, to lead learners to solve problems on their own. We suggested that worked examples with animations and narrations could be made into several clips, one clip for one step. Besides, an index of worked examples, including those presented with graphics and words could be provided at the first page of the handout to allow participants to easily find the needed section. Therefore, the future researchers take convenience for learners into consideration in design of learning materials.

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Collaborative Process Among Learning Support Agents in Game-based Learning Environment

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Abstract: Many studies and systems that use "pleasure" and "fun" as inherent elements in games to improve a learner's motivation have been developed in the field of learning environments. However, there are still few studies of situations where many learners gather at a single computer and participate in a game-based learning environment and where a computer designs the learning process by controlling the interactions (such as competition, collaboration, and learning by teaching) between learners and others who are learning by observation alone. Therefore, in this study, we propose a method (involving interaction control between learners) that generates interaction between learners intentionally to create a learning opportunity that is based on the knowledge understanding model of an individual learner. In this paper, we explain a game-based learning environment called "Who becomes the king in the country of mathematics?", in which we have incorporated a "learner support agent" to support each learner and a "game control agent" to control the game. Furthermore, we explain an example of collaborative process among learning support agents.

Keywords: game-based learning environment, interaction among students, motivation, pedagogical agents, junior high school

Introduction

In recent year, the popularity of computer games have grown enormously. The population using such games has increased by not only by the development of portable games, which users can play anywhere and anytime, but also by new types of game software which involve various new techniques such as the functions of comfortable manipulation, touch screens and speech recognition.

As a result, many studies and systems that use "pleasure" and "fun" as inherent aspects of games to improve a learner's motivation have been developed in the field of the learning environment [2, 4, 12, 13, 14, 15]. WEST is a game-based system that lets students learn elementary arithmetic skills [3]. In this system, the player tries to go to his hometown by making operational expressions that include different operations with three numbers given by roulette and by deciding on an advanced number. JULASSIC is a game-based education system that helps foreigners learning Chinese character idioms [8]. In this system, a fighting type game is introduced, and the player is enabled in the play with a computer-created player, too. Competing elements, puzzle elements and clever rules are planned for these learning environments. In them a computer designs a situation where a learner must come up with the most suitable method in each scene. The controls in these systems help the learner to concentrate on the game environment, and as a result, they improve his motivation.

It is believed that an action is not recognized for its learning activity when the action itself becomes the purpose of the learner in a game. Therefore, research is being carried out on games that develop a real world "edutainment" in which learning is advanced in a real world which has become in the game a ubiquitous learning environment. Furthermore, workshops and special sessions about "edutainment" have been held recently in international conferences, and various arguments have been presented for these games, not only from technical points of view, but also from pedagogical, social and ethical points of view [5].

If we think about these games from the viewpoint of learning, there are the following implications for effects which they have. The first is that there is a need to improve motivation based on the pleasure and the fun that the games provide. The second is that the players acquire skills and knowledge by achieving the purpose of the game. Therefore, in this study, we try to design and develop a game-based learning environment that connects the effect of the game with learning. In other words, we build a learning environment in which the learner regards the game as having a "purpose" and the learning as being a "means" to that purpose.

There are many studies and practice lessons about games that use "pleasure" and "fun" as inherent elements. However, there are still few studies of situations where many learners gather at a single computer and participate in a game-based learning environment and where a computer designs the learning process by controlling the interactions (such as competition, collaboration, and learning by teaching) between learners and others who are learning by observation alone. Therefore, in this study, we propose a method (involving interaction control between learners) that generates interaction between learners intentionally to create a learning opportunity that is based on the knowledge understanding model of an individual learner. Furthermore, we implement this method with an agent system that incorporates a "learner support agent" to support each learner and a "game control agent" to control the game.

In this paper, we first consider the relation between pedagogical agent (PA) and game based learning environment. Secondly, we explain fun and learning volition in a game. Moreover, we describe the concept of a game-based learning environment that incorporates four viewpoints for the fun of the game, the rules and flow of the game, and an educational control method. At last, we illustrate the example of a collaboration process between the learning support agents and the game control agents.

1. Pedagogical agent and game based learning environment

Pedagogical Agent (PA) is defined as a agent that has some function about learning, education and training support. Therefore, the kinds of PA are various. For example, the PA was classified as follows by Dellenbourg from the viewpoint of the purpose to use it [6].

+ Sub-agent … the agent that carries out some kind of tasks for learner or group.
+ Co-agent … the agent that performs some learning activity with learner or group.
+ Super-agent … the agent that monitors the learning activity of learner or group and support her/him or group.

Moreover, Baylor arranges the characteristic of PA as follows from a point of view designing the effective PA; educational role, characteristic of media, human characteristic, type and quantity of educational feedback, and necessity of multiple Pas [1].

We can arrange the advantage for incorporating PA into learning support system as follows. At first, we can expect the re-use of each component from a developmental point of view. Secondly, we can expect adaptive support for learner or group by improving the power of collaboration among agents. Furthermore, we can expect the deepening of the understanding and the improvement of the learning volition for learning object by the development of interface technology. Based on the characteristic of this PA, we think the

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game based learning environment is better to use as a field of studying PA. So, we'd like to study the research task such as the agent function and learning effect, and collaborative protocol among PAs as a domain of game based learning environment.

2. Fun and learning volition in games

It is said that the "fun" of a game depends on the situations in it. Users of games have classified this fun differently [9, 10]. Koster has stated the following four propositions with regard to the fun of games [9].

- Fun is the act of mastering a problem mentally.
- Aesthetic appreciation isn't always fun, but it's certainly enjoyable.
- Visceral reactions are generally physical in nature and relate to the physical mastery of a problem.
- Social status maneuvers of various sorts are intrinsic to our self-image and our standing in a community.

Based on these propositions, we classified fun in an education game into the following four types.

- **Fun when a player achieves a goal**
  In other words it is the good feeling a player has when he has achieved a goal. For example, "a player solves a certain problem," or "a player wants to beat competing other player, and he wins." We believe that the basic fun in a game comes from the good feeling of achievement.
- **Fun from what a player was unable to predict**
  In other words, fun is the intellectual or aesthetic feeling which occurs at the time of an unpredictable happening. For example, in the context of a story, it is a situation in a scene that the reader was unable to predict.
- **Elation when a player faces a challenging problem**
  In other words it is the surging feeling when a player faces a challenging problem or goal--for example, before a player steps on a roller coaster, or when a player considers whether he can solve a difficult problem or achieve a difficult goal.

- **Honor for the player**
- It is the feeling of satisfaction when a player receives social praise or honor, such as "the player is praised" or "the player achieves first place." However, the player does not always feel fun at the time of receiving the honor.

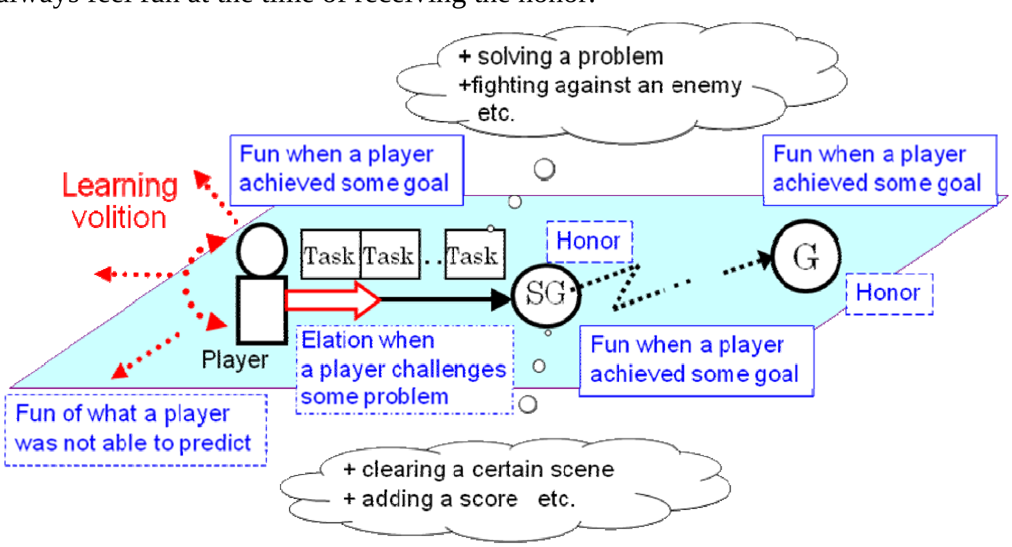

Figure 1. Fun and learning volition in an educational game

These four "funs" in an educational game lead to the maintenance and improvement of a learner's motivation, and we believe that they give a game and the learning from it advanced power (see Figure 1). Therefore, in the design of a game-based learning environment, it is important that we incorporate these four viewpoints of fun into the scenes or phases of the game and learning that comes from it.

3. Fun and learning volition in games

In a game-based learning environment, it is effective for the maintenance and the improvement of a learner's motivation to develop the support that fun brings to the game. Therefore, we set three design indicators in consideration of the 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) in the development of the learning design in the game-based learning environment. These are the following.

I. Setting a time limit and the number of problems (acquisition of a good feeling by a player when he achieves a goal).
II. Preventing a player from getting tired by having to prepare too much for a questions form for a problem (such as by a time trial, or having to check answers for other players) (acquisition of fun by being unable to predict something).
III. Setting a bonus point and various posts according to order (acquisition of honor for a player).

We made a learning design in the game-based learning environment based on the three indicators explained above.

a. The outline and rule of "Who becomes the king in the country of mathematics?" game

This game is a board game with roulette in which there are four players. 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.

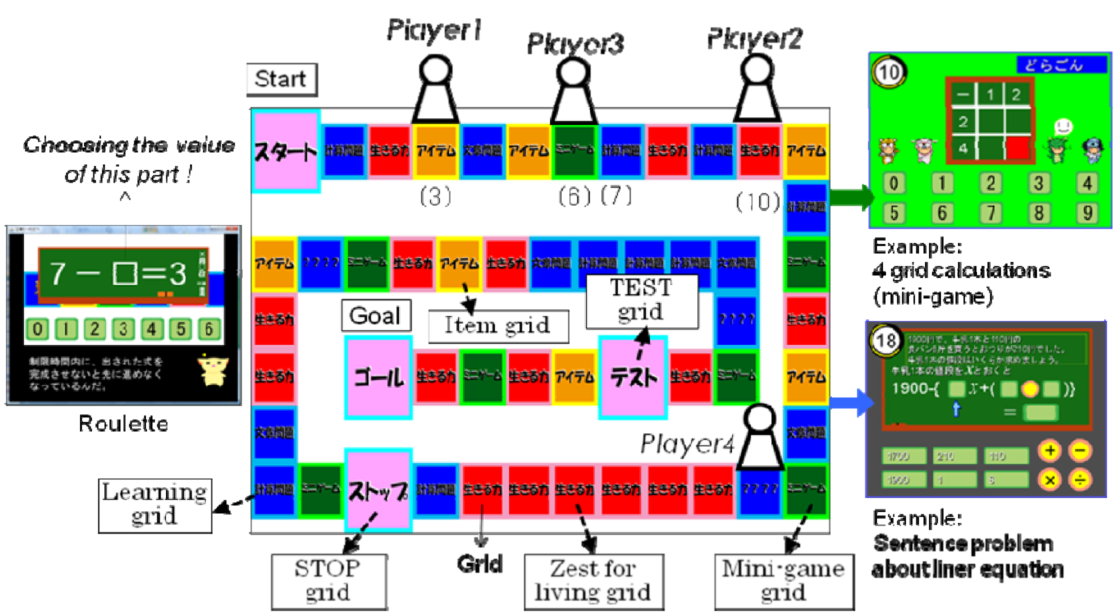

Figure 2. Image of game-based learning environment for linear equation

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 game-based learning environment, there are a "Learning grid," a "Zest for living grid," an "Item grid," a "Mini-game grid," and a "Special gird" (see Figure 2). 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.

b. The method for educational control in the learning environment

The learning control in this game-based learning environment is performed by two kinds of agents (a "learner support agent" and a "game control agent") (see Figure 3). 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 in terms of the following five states.

Understanding state 0:

Because all learners do not carry out a problem of a learning item, the agent cannot recognize the state of the learner.

Understanding state 1:

Because other learners carry out a problem of a learning item, the agent recognizes that the learner may understand it by observing the situation.

Understanding state 2:

Because the learner makes one more mistake, although he carries out a problem of a learning item, the agent recognizes that the learner does not understand this learning item

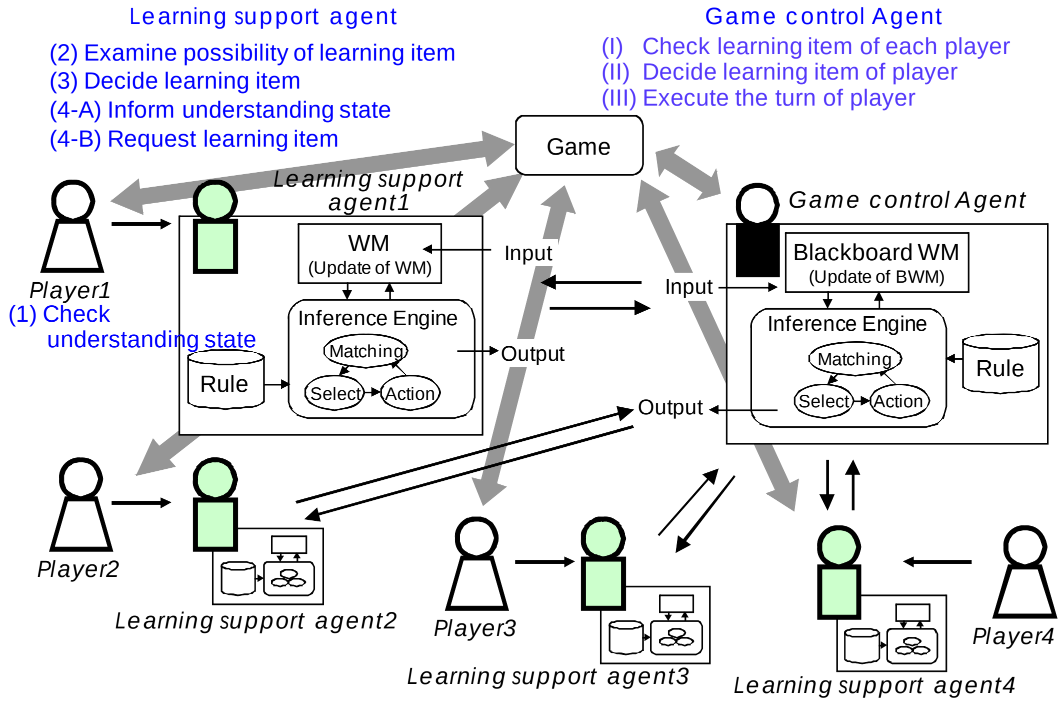

Figure 3. Framework of educational control in this environment

Understanding state 3:

Because the learner solves all problems of a learning item correctly, the agent recognizes he understands the learning item.

Understanding state 4:

When the learner succeeds in a challenge such as a "time trial" or "check answers with each other,"the agent recognizes that the learner understands the learning item deeply.

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.

4. Collaborative process among learning support agents

In recent year, various kinds of agent-based learning systems have been developed in the field of the learning environment [1, 7, 11]. In this chapter, we describe the example of the collaboration process between the "game control agent," who sets the problem of the learner, and the "learner support agent," who supports each learner. We consider the situation in Figure 2 where "Learner 1" stops at (3), "Learner 3" stops at (6), and "Learner 2" stops at

(10). The turn is that of "Learner 1." The state of understanding of the learning items for each learner is as follows.

Learner 1: (Learning item 1 = understanding_state 1)
(Learning item 2 = understanding_state 1)
(Learning item 3 = understanding_state 3)
(Learning Control Type = First_half)

Learner 2: (Learning item 1 = understanding_state 1)
(Learning item 2 = understanding_state 2)
(Learning item 3 = understanding_state 1)
(Learning Control Type = Latter_half)

Learner 3: (Learning item 1 = understanding_state 2)
(Learning item 2 = understanding_state 1)
(Learning item 3 = understanding_state 1)
(Learning Control Type = No_control)

Moreover, each "learning support agent" maintains the values of this situation (Figure 4). Before the turn of learner 2, "learning support agent 2" has already demanded the "trial of learning item 3" from the "game control agent." Furthermore, "learning support agent 3" demands the "trial of learning item 2" from the "game control agent" before the turn of learner 3. At this point in time, "learning support agent 1" estimates that the state of understanding of learning item 3 for learner 1 is "3," and learner 1 observes the solution process of learner 3 for learning item 1. Therefore, "learner support agent 1" demands the "trial of learning item 2" from the "game control agent". The "game control agent" recognizes that the learning control of learner 1 is the "First_half" type and decides to intervene in the scene of the game. Learner 2 is at the top of the game at this time, and the learning control is the "Latter_half" type. In addition, the learning control of learner 3 is "No_control." For these reasons, the "game control agent" decides on "learning item 2" as a learning item of learner 1 by considering a request from the "learning support agent" of learner 3. The "game control agent" notifies "learning support agent 1" and "learning support agent 3" of his choice. After having made these preparations, the "game control agent" expresses that the answer of the

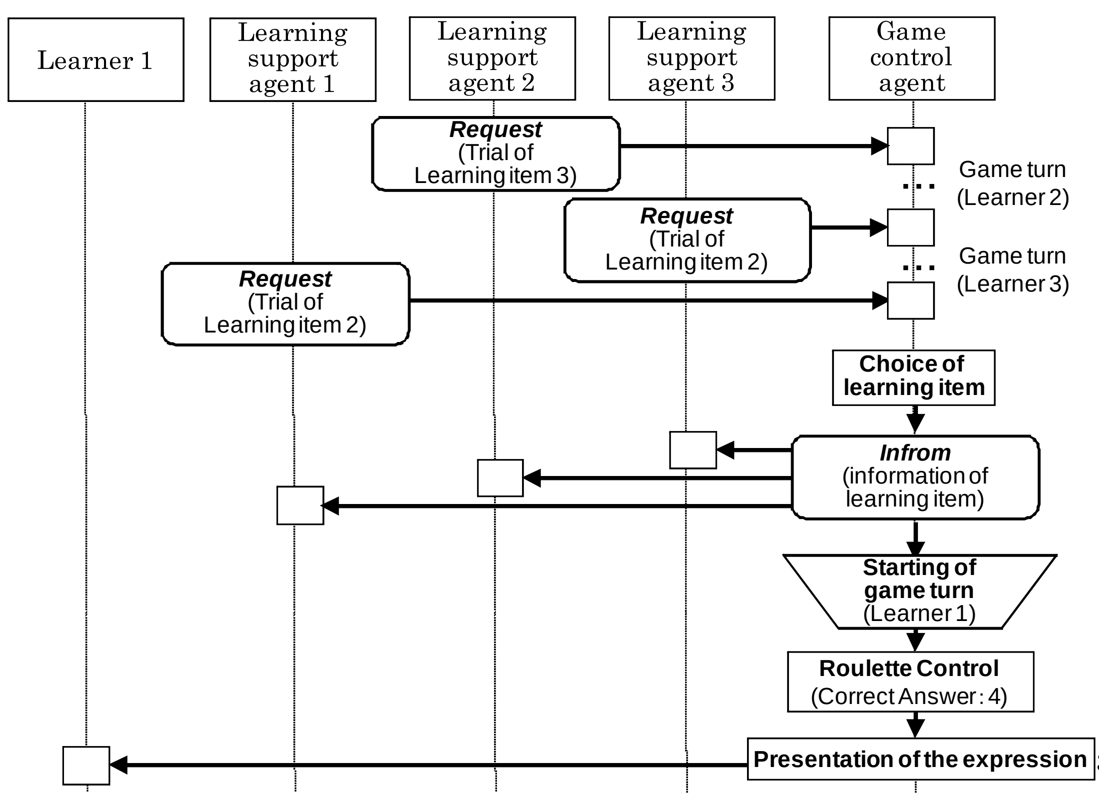

Figure 4. An example of collaboration process among agents

roulette will become "4" in learner 1's next turn and waits for an answer input from learner 1.

5. Conclusion

In this paper, we illustrated the design ideas of a game-based learning environment that incorporated four viewpoints for fun in the game, and we showed an outline of our game. Furthermore, we explain an example of collaborative process among learning support agents. The results from the development and practice show that it will be a problem in the future to provide a learning form and an expression method for learning contents because the tendency of learners is to not learn content that they cannot understand. In addition, it is necessary to consider a method for creating collaboration between agents through blackboard memory. Furthermore, we tried to analyze the content of interaction between learners during game enforcement and to examine the timing of the interaction and the support it provided.

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Workshop

The First International Workshop on Real Education In Second Life

Workshop Organizer

Advisors

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Preface

Second Life, an online 3D multiuser virtual environment (MUVE), ever since its development in 2003, it has been drawing special attention from many researchers and educators because of its capability to motivate learners to engage in series of purposeful educational investigation without losing interest and passion. As various kinds of exploration and implications have been emerging, more efforts should be devoted to make further understanding about the reasonable integration of learning theories and Second Life learning infrastructure.

This is the first workshop focusing on the educational explorations in Second Life. We have accepted four research papers and one interactive proposal from three countries. The half-day workshop will provide a forum where international participants can share knowledge, experiences and concerns on related educational issues in Second Life and explore directions for future research collaborations.

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Development of a virtual campus on Second Life: A case study of NCU Wonderland

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Abstract: Since Second Life (SL) was created, many educators have applied their teachings to this virtual platform. They have created lots of scenarios, games and tools in Second Life. However, the created scenarios, games and tools are rarely shared by other users. It is a pity that the resources in Second Life cannot be shared by users. Therefore, this research aims to create flexible and practical 3D learning environments and teaching aids. To achieve this goal, 3D learning environments and 3D teaching and learning resource center are built in Second Life. The teaching methods and teaching aids developed under these environments can be shared among users. In addition to 3D learning environments, there is also an excellent teaching exhibition hall. It is expected that these developments can help educators make the best use of Second Life.

Keywords: Second Life, NCU Wonderland, teaching aids, strategic alliance

Introduction

Second Life, a popular 3D virtual platform is developed by Linden lab in 2003. The difference between Second Life and other online games is that Second Life does not have fixed scenarios. Users can create any scenarios as they wish. They can sculpt objects, write Linden scripts and create animation objects in Second Life. Because of its flexibility, Second Life is used for education by many international institutes. However, the teaching resources created in Second Life cannot be shared by other users. Therefore, this research aims to build 3D learning environments and teaching aids to integrate the teaching resources created by other educational institutes.

Second Life is widely used in education field nowadays. [1] The teaching methodologies applied to Second Life teachings are game-based learning, task-based learning, authentic learning, etc. Students can get new knowledge by completing their tasks. Lin (2008) proposed that online businesses and community providers should put time and effort into ensuring that their customers are satisfied with information and system quality, as these were identified as the key contributors to member satisfaction when using virtual communities. [2] Thus, this research also considered teachers and students' needs when creating the teaching materials in Second Life. Brenda (2008) proposed that Factors such as proper training and orientation, appropriate strategies for integration and criteria for determining value-added activities should be taken into consideration when people apply their teachings to Second Life. [3] Therefore, this research also took training and orientation, appropriate strategies for integration into consideration when developing the teaching environments and teaching aids in Second Life. However, Baker et al. (2009) pointed out that many of the potential benefits and uses of virtual worlds in teaching still remained verified. To examine the potential benefits of teaching in virtual worlds, the real world teaching methodologies are applied to virtual worlds in this research. [4]

This research aims to integrate the teaching resources in Second Life and combine the educational organizations which use Second Life for education in Taiwan to form a strategic alliance. The strategies used to form a strategic alliance in this research are technique development strategy, promotion strategy and alliance strategy.

Technique development includes developing teaching aids and learning environments. The new teaching aids are created based on the already existed ones. As for the learning environments, they are created based on the authentic learning theory.

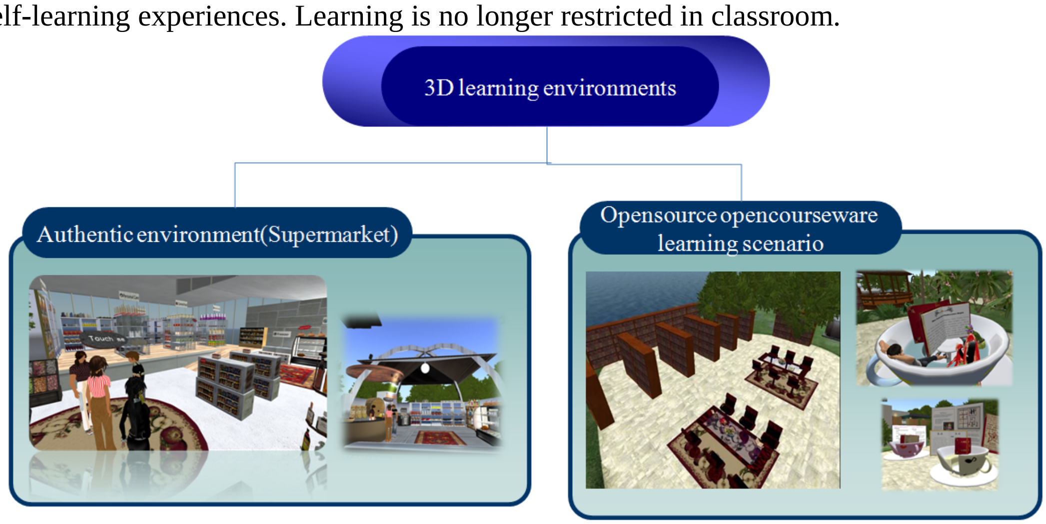
Promotion strategy includes holding Second Life workshops, contests and trainings. To make more people use NCU Wonderland, Second Life movie contest and runway walk are held regularly. Moreover, training courses are held to solve the problem that Second Life is not easy for a beginner to use[5]. After attending the training courses, students will be more willing to use Second Life for learning.

The purpose of forming an alliance is to promote NCU Wonderland and make it worldwide. NCU Wonderland, developed by NCU, is now used by Department of Applied Chinese Languages and Literature at NTNU, Department of English at NCU, Department and Graduate Institute of Accounting at NCUE for language teaching. These universities form a strategic alliance to promote teachings in Second Life. In the future, the teaching aids and learning environments will be promoted to the universities in Asia. It is hope that the strategic alliance can make learning in Second Life become more and more popular.

1. NCU Wonderland

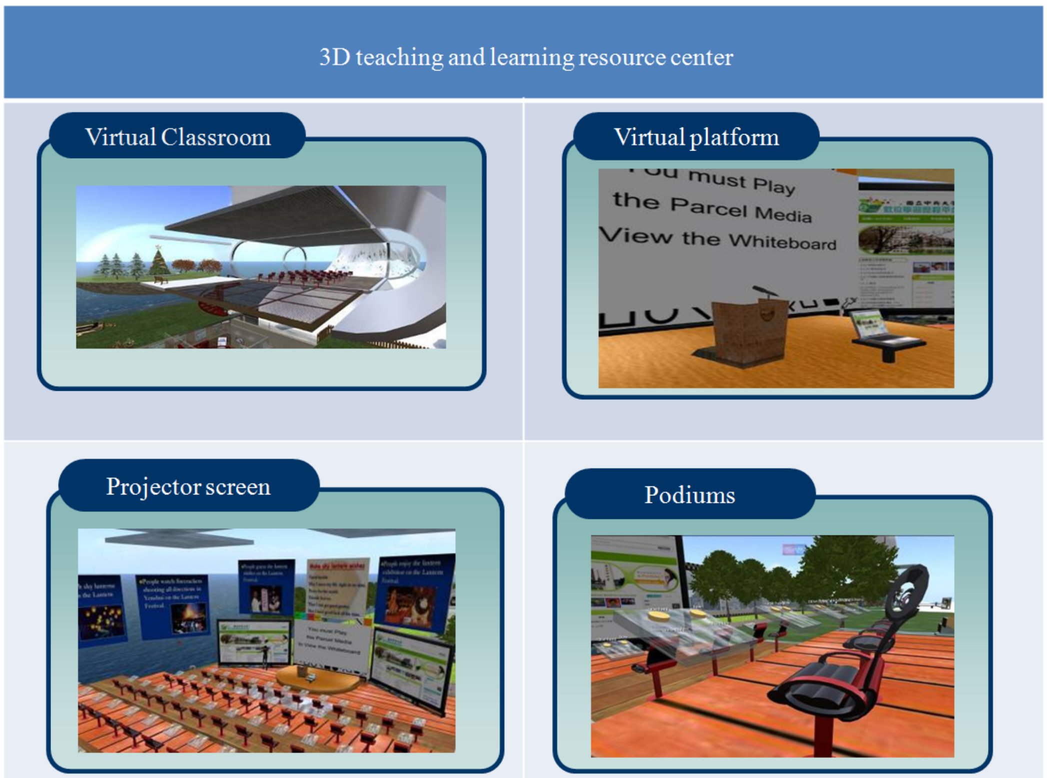
NCU Wonderland, a 3D virtual campus, has been built by National Central University (NCU) since 2007. (http://slurl.com/secondlife/NCUKSL/48/91/27) The purpose of building NCU Wonderland is to provide teachers and students with better language learning environments. The environments in NCU Wonderland include 3D learning environments and 3D teaching and learning resource center.

The 3D learning environments in NCU Wonderland simulated the learning environments in real world. A shopping mall was built for students to practice English in authentic environment. Students can discuss their learning with other global users instantly in this environment. Besides, an Opensource opencourseware learning scenario was built for students to do self-study. Students can choose the knowledge they want based on their self-learning experiences. Learning is no longer restricted in classroom.



For developing 3D learning and teaching resource center, the teaching resources created in NCU Wonderland are listed as follows.

- Virtual classroom: The virtual classroom which simulates the real world classroom will help students get used to virtual learning environments quickly.
- Virtual platform: Teachers can teach on the platform and switch his slides here.
- Projector screen: Usually, there are one projector and one projector screen in traditional classroom. However, there are ten projector screens in these virtual learning environments. Students can see the projector screens from different directions.
- Podiums: There are podiums in front of students' seats. Students can raise their hands and vote in their seats.

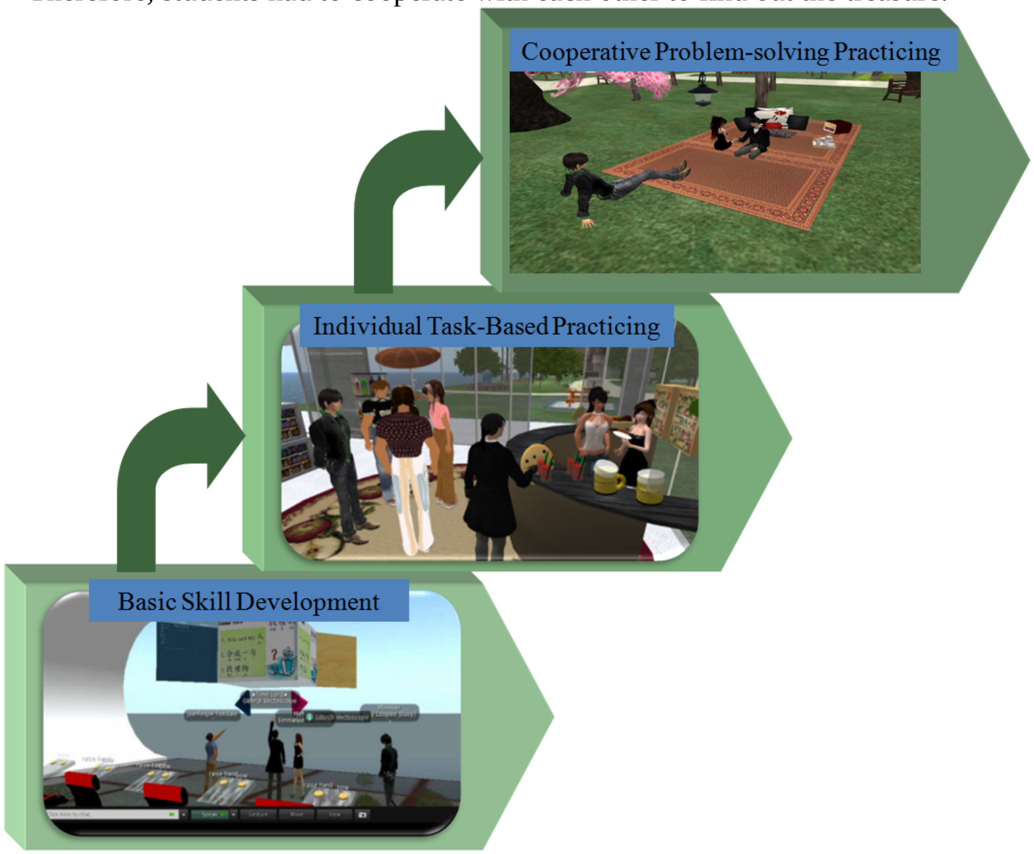


2. Instructional and learning activity design

A CFL (Chinese as a foreign language) teaching has used NCU Wonderland for its teaching environment. The teaching methodologies used in this environment were as follows.[6]

- Basic Skill Development: Owing that most students were Second Life beginners, the instructor first taught Mandarin Chinese in the virtual classroom in NCU Wonderland. The basic skills such as Chinese characters and words and functional sentences were taught in this stage. They were presented by web PPT.
- Individual Task-Based Practicing: After students were familiar with Second Life, they were asked to buy products in the shopping mall in NCU Wonderland. The instructor would teach the Chinese naming of each product first, and then asked students to buy the designated products by themselves. In this way, students would have chance to practice Chinese with clerks. The authentic learning environment would facilitate students' language learning.
- Cooperative Problem-solving Practicing: Finally, students were asked to find the treasure hidden in virtual living lab, another e-learning platform owned by Institute for

Information Industry in Second Life. Before students started to find treasures, they were assigned a task. They would get a clue after they complete their tasks. When the clues were put together, students would know where the treasure was hidden. Therefore, students had to cooperate with each other to find out the treasure.



Based on the above teaching methodology, a series of teaching aids were developed.

- Web PPT：The slides for teaching were uploaded to the web server through the shared media function of Second Life viewer 2. In this way, the instructor could switch their slides at any time and saved the charges for uploading slides. In addition, there were spaces for instructors to show their personal websites on the sides of the cube. Instructors could interact with students through these websites.
- The settings for buying products in the shopping mall: The products in the supermarket were provided with voice. Students could listen to the Chinese naming of each products before they purchased them. If they decided to buy the product, they would get an object so that they could pay for the product and practiced Chinese with clerks.
- HUD for collaborative learning: Students could take pictures in Second Life and uploaded these pictures to a php sever. They could wear HUD for collaborative learning to share their pictures with their classmates. Even if students were in different places, they still could see the same picture and discussed it with each other.

Teaching aids		
Web PPT	The settings for buying products in the shopping mall	HUD for collaborative learning
		

There were also other teaching activities held in NCU Wonderland. [7]

Course title	Go shopping in a shopping mall
Objectives	Students will be able to: 1. understand the meanings of each vocabulary and phrases. 2. use the sentence pattern in the lesson exactly. 3. realize what makes shoppers buy more products in a supermarket. 4. understand the terms used for sales promotion.
Pedagogy	1. authentic learning 2. task-based learning
Course length	1. entire activity lasts for 6 weeks 2. each procedure step takes from 10 minutes to 2 hours
Learning materials	1. Article: Who Decides What You Buy? 2. Learning materials: vocabulary, pronunciation, grammar, sentences and dialogues were taught by projecting slides or playing videos. 3. Supplementary materials: could be found on NCU eP websites.
Roles	1. Instructor: Irene 2. Tutor: Joanne 3. Students: 21 university students
Scene	

Procedure	Part I. Before-session procedure 1. Students share their experiences of shopping in a supermarket. 2. Students read article "Who Decides What You Buy?" and discuss with their classmates which factor will influence their purchase decision. 3. Introducing and practicing the operation of 3D virtual worlds in Second Life. 4. Instructor explains the experimental objectives and evaluation methods. 5. Instructor conducts a pre-test questionnaire. 6. Instructor conducts a pre-learning questionnaire. Part II. In-session procedure 1. Instructor introduces the article "Who Decides What You Buy?" and the factors that marketing specialists use to make shoppers buy more products. 2. Instructor explains meanings and usage of vocabulary, idioms and phrases. 3. Instructor introduces grammar patterns. 4. Instructor summarizes the article and asks comprehension questions. 5. Tutor helps students discuss with each other and buy something from shopping mall. 6. Students form in-class discussion about shopping issue. Where to buy? How to buy? What to buy? Why to buy? Who to buy? Part III. After-session procedure 1. Instructor gives students a post-learning assessment. 2. Instructor conducts a post-test questionnaire. 3. Instructor shows some products to students and asked them to go to the supermarket on NCU wonderland. 4. Students discuss the best location in the supermarket to place those products with their groupmates.
URL	http://slurl.com/secondlife/NCUKSL/48/91/27

3. Discussions and future research

By using the teaching aids to do language teaching in NCU Wonderland, NCU successfully cooperated with other Universities. The 3D teaching environment in NCU Wonderland can fulfill different people's needs. Universities which have used Second Life for teaching have formed a strategic alliance in Taiwan. The universities in this alliance can share their techniques and resources and learn from each other. However, people still encountered some difficulties when using Second Life for teaching. For example, some students were not familiar with Second Life viewer or Second Life crashed while students were learning. These problems will be solved in the future. It is hoped that NCU Wonderland can satisfy more and more users in the future. To achieve this goal, NCU will try hard to improve the 3D learning environments and develop more and more useful teaching aids.

Acknowledgements

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A Study of Visitor's Learning Needs and Visit Satisfaction in Real and Second Life Museums

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Abstract: The purpose of this study is to explore visitors' learning needs from visiting museum exhibitions and satisfaction for their museum visits in the real and virtual NCKU museums. A real exhibition, called Ancient Locks, is represented in an online game, Second Life. Two groups of visitors, a total 50 students viewed, by invitation, the exhibition either on-site or online, and then they completed a survey regarding their needs and satisfaction for their museum visits. As a result, a significant difference in the participants' responses to levels of satisfaction (F = 25.089, p < .001) appeared. The study also explored visitors' differing learning needs. Conclusions and discussions are included at the end of this study.

Keywords: Second life, Visitor satisfaction, Visit needs, NCKU museum,

Introduction

In recent years, the most popular online game is Second Life (SL) in which multiple game players simultaneously enter SL to experience a truly realistic virtual world. SL has continued to incorporate more and more interactive activities for the players. Beginning in 2009, some researchers, collaborating with the National Cheng Kung University Museum (NCKU Museum), have attempted an exhibition in SL. By receiving a one-year research grant from the National Science Council, the researchers selected a real exhibition, Ancient Locks and displayed it in SL. This study explores museum visitors' satisfaction with, and need-fulfillment from, the NCKU SL Museum. The literature review provides a brief introduction to the SL environment, its design tools, and its interactive methods, followed by a discussion of the differences between real and virtual museums in SL. The last section of the literature review summarizes previous studies of museums in SL. [Note: The web address of its SL landmark is http://maps.secondlife.com/secondlife/HITHOP/219/224/22.]

1. Museum Research in Second Life

The following paragraphs introduce the SL environment as it refers to the Second Life official website. The sub-sections discuss creation of virtual objects, the features of the SL programming software, LSL (Linden Scripting Language), methods and outcomes of interaction and involvement activities in SL, and finally, the differences between real and virtual museums in SL.

a. SL and its Design

Initiated in 2002, Second Life (SL) allows multiple users to simultaneously connect to a 3D virtual world. More and more academia and enterprises are now entering SL; they are seeking alternative learning and business environments for facilitating different learning activities and marketing. With a free-registration account, SL users, also called avatars, may login and, become a different, virtual, human being, animal or other character. However, users under the age of 18 are prohibited from entering SL-normal version, which is for adults. Users, between ages 13 and 17, may obtain their parents' or guardians' permission to enter Teen SL. In addition, Linden dollars are the users' (or avatars') daily currency and are exchangeable with USD in SL (250 Linden=1 USD). Some SL avatars spend their real-world currency to purchase more than one virtual SL island. For educational institutions, the island costs 700 USD per 65,536 square-meters. Island owners pay a monthly maintenance fee of 147.5 USD. For new SL avatars, rental of a region (195 USD per 65,536 square-meters) on an avatar's island allows developing familiarity with the SL interactive environment.

Only the owners of islands have authority to write code, called LSL (Linden Scripting Language, developed by Linden Lab), for constructing 3D objects in SL. Such language is similar to object-oriented programming languages (e.g., C++) and some 3D modeling tools. Since the LSL functions vary, the interactive effects in SL sometimes surprise avatars. For example, if avatars come close to a virtual door, it will be automatically open as they have often seen in the real world. LSL programmers are encouraged to employ some 3D modeling tools, to ease construction of virtual buildings, machines, scenes, transportation modes, and so on. As in the real world, copyrighted images, photos, videos or audio clips are protected by SL. Any SL object can be also tagged "no copy" (i.e., not allowed to be copied), "no mod" (not allowed to be modified) or "no trans" (not allowed to be transferred). Overall, an avatar's SL 3D world is very similar with the real world.

b. Interactive Activities in SL

Most objects are created through LSL. Hence, avatars can become involved with a variety of activities, such as chatting, holding seminars and concerts, learning mathematics and other subjects, and conducting scientific experiments, by interacting with the virtual objects or other avatars in SL [6, 11, 16]. More importantly, the avatars can use one of the interactive SL features, Instant message (IM), to talk with other avatars, as in the real world. SL offers two kinds of chatting features, local and global chats. Within 25 meters between two avatars, they can hear each other. Otherwise, they can shout to be heard if an avatar is within 100 meters. In other words, distance differentiates the volume of avatars' voices Private conversations and group meetings are, however, not restricted by distance [13].

In addition, SL avatars can interact with others from different countries, since their real backgrounds are diverse. They have opportunities to understand other avatars' social norms in reality by exploring exotic buildings and rituals. The most significant benefit is increasing the SL avatars' international viewpoints for the real global-oriented world. However, most avatars are English speakers. Asians, especially Chinese, are hesitant to enter SL. Recently, a simplified-Chinese version of the SL web site, Chinese 3D Virtual Community Website, has been established; consequently an increasing number of Chinese have become involved in SL activities [8]. If an avatar owns an island, that individual can even provide services for selling and trading real products, or start a new business in the SL free market.

2. Virtual Museum in Second Life

a. Comparison of Real and Virtual SL Museums

An expanded number of virtual buildings for different purposes have appeared in SL. Enterprises, such as BP, BBC, Cisco, Coca Cola, Dell, Disney, Google, HP, IBM, Motors, SONY, SUN Microsystems and Toyota, entering SL to construct virtual offices conduct international marketing of brands, and/or provide alternative service channels to sell their products [2, 15, 18, 19].

Educational institutions use the site to recruit international students and enhance institutions' (Harvard Law School, New York University, Midwest College/Alliance Library, University of Kansas Medical Center, Stanford University and Virginia Tech/ICT Library) degree of global visibility [1, 3, 7, 9, 10, 14, 15, 18, 21]. In Taiwan, the Chilee Institute of Technology's Play Center Island and National Central University's Wonderland have both constructed virtual campuses in SL. Many learning activities and research projects are already conducted there.

SL has the reputation of being a valuable venue for promoting cultural events, since avatars can simulate the real experience of touring foreign villages or interacting with virtual objects in SL museums [20]. Some SL museums directly copied their real in-world museums, such as the Bolinas Art Museum, the Holocaust Museum in the US, the Natural History Museum in the UK (Figure 1 NHM) and the Louvre Museum in France (Figure 2 LM). Some SL museums are only appeared in the virtual world, such as the Bayside Beach Galleria Museum of Contemporary Art (Figure 3 BBGM-CA), the Crescent Moon Museum, the Fort Malaya History Museum, the International Spaceflight Museum (Figure 4 ISM), the Paris 1900 (Figure 5), the Second Life Computer History Museum, the Star Trek Museum of Science, the Splo Interactive Science Museum and the Xibalba Maya Museum. The Nomilly Exhibition Hall in Playcenter of Taiwan is the only museum displaying Taiwanese folklore activities and antiques (Figure 6). Overall, the constructors or designers of the SL museums have carefully considered how avatars can interact with virtual objects when they visit SL exhibitions. However, even if the appearance of the SL museum can be very much like the real one, realistic building materials do not appear realistic if the avatar closely approaches the museum. Also, due to budget or time constraints when constructing an SL museum, virtual exhibition content is sometimes not as rich as in a real museum,. (Resources: http://www.nhm.ac.uk/; http://www.youtube.com/watch?v=_zWioQSoUW0; http://library.thinkquest.org/08aug/01151/spread.html; http://secondlife.com/destination/paris-1900)

Figure 1NHM

Figure 2 LM

Figure 3 BBGM-CA

Figure 4 ISM

Figure 5 Paris 1900

Figure 6 Museum of Taiwan 1950s

b. Research on SL Museum Exhibitions and Visitors

To identify a type of SL museum, for future researchers, after conducting several interviews with SL museum designers and developers, [20] summarized a list of characteristics: scale, setting, persistence and evolution, media richness, visitor engagement, social interaction, intended purpose, collection types, and target audiences. By observing the virtual International Spaceflight Museum and the Splo Science Museum, [22] discovered the intended purposes of designing and building museums in SL. Finally, these researchers considered educational purposes as important to effectively motivate educators or designers to continuously devote time to creating virtual and interactive objects in SL. Some suggestions' intents were to ensure the success of future museum buildings' educational purposes in SL (p.266): (1) a demonstration of how virtual worlds can be used for learning; (2) a collection of related information from around the real world; (3) a financial accounting, and (4) a team of collaborative programmers, artists, and experts. Some examples of virtual and interactive objects designed in SL are well presented in two museums as introduced in the following paragraph.

The International Spaceflight Museum (ISM) appears in SL as a virtual museum [4, 20]. Many visitors from the real world who have an interest in spaceships are motivated to voluntarily and collaboratively spend time collecting information and constructing virtual objects to create as many interactive activities as possible in the ISM. These aspects include: an auditorium, small conference areas, and group discussion spaces. ISM currently presents its rich media and social interactions: a solar system simulator, a planetarium, and a rocket ride into space. Visitors are even able to teleport to a planet to explore different spaceships. Splo is another virtual museum, developed by Exploratorium to achieve social, contextual and educational purposes [5, 17]. Visitors to Splo closely watch a solar eclipse, fly through the solar system, scan their own bodies or change gravity.

Despite efforts, predicting visitors' needs, to enhance the level of satisfaction when visiting the museum, is sometimes difficult. [12] suggested developing an adaptive museum by considering visitors' abilities, interests, preferences or history of interaction. Based on visitors' previous learning, museum guides should provide appropriate amounts of detail Different language options (e.g., English and Greek) for museum guides should also be available to produce a unique personalized museum visit for each visitor.

3. Research Methodologies

To achieve this study purpose, a survey, developed and then distributed to the SL avatars, targeted those who had visited the Ancient Locks exhibition in the NCKU SL museum. A group of real visitors' responses to the survey were also collected to compare learning needs with the avatars and their different levels of satisfaction.

a. Participants and Fields

Two groups of participants were invited, via recommendation, to view the real NCKU or the virtual SL museums. Participants were either senior undergraduate students or graduate students with design, multimedia or information management backgrounds. The Ancient Locks exhibition at the real NCKU museum is currently open to the public. The visitors to the real museum could obtain souvenirs immediately after their visits and at the completion of the survey. The virtual NKCU museum exhibition has appeared in SL for less than a year. The visitors of the SL exhibition received 200 Linden dollars upon completing the survey.

b. Survey Questions

This study explores visitors' levels of learning needs from visiting the real and virtual NCKU museum and satisfaction for their museum visits through a two-section survey. Besides questions of visitors' demographic backgrounds, the first section, regarding learning needs, contains three, 0 to 9 point-scaled questions and two open-ended questions.

The second section collects data of visitors' levels of satisfaction with their visits through a five-point Likert-type scale (0 very unsatisfied to 9 very satisfied). Both sections were available for evaluating the current use of the interactive components, such as visitors' message posting and movie self-broadcasting, provided at the NCKU museum or in the NCKU SL museum. The survey had questions in both Chinese and English, and was both paper and online versions (http://miniurl.com/51287). For SL avatars, the questions were (Real visitors completed a version of survey with similar questions later comparison.):

- SL visitors' learning needs
  - The audio effects in the exhibition
  - The video effects in the exhibition
  - The animated effects in the exhibition
  - Other suggestions pertinent to interactive components
  - Other overall suggestions for the exhibition in SL
- SL visitors' levels of satisfaction
  - The representation of the overall exhibition design
  - The explanation of the exhibited content
  - The responses of the exhibition guide
  - The hardware facilities represented in the exhibition
  - The software features in the exhibition

c. Data Analysis Methods

Reliability and validity analyses, followed by descriptive analysis, were first conducted for all survey questions. One-way Analysis of Variance (ANOVA) revealed significant differences between SL and real visitors' responses to the survey questions regarding levels of satisfaction with their museum visits. A comparison of their different learning needs determined any significance in responses. Coding of SL and real visitors' written responses to the two open-ended questions explored differences in learning needs.

4. Research Results

a. Descriptive analysis results

In total, the numbers of participants entering the real NCKU museum (Group 1) and the SL museum (Group 2) were 26 and 24, respectively. Since participation in this study was by recommendation, all of responses to the survey were valid. Hence, the reliability and validity tests re-confirmed that the survey questions regarding visitor's learning needs could be differentiated from the survey questions regarding visitors' levels of satisfaction. The participants' responses were further analyzed in Table 1) The overall reliability in this study is significantly high (Cronbach alpha = .689). Table 2 summarizes the participants' background and their responses to the two sections of the survey questions.

Table 1 Reliability and Validity Test Results

Constructs	Reliability	Validity
Levels of satisfaction	.853 (valid n = 47)	r = .086
Learning needs	.749 (valid n = 50)	

Table 2 Summary of Participants' Background and Responses

Items	Group 1	Group 2	All
Gender			
Female	15 (57.70%)	12 (50.00%)	27 (54.00%)
Male	11 (42.30%)	12 (50.00%)	23 (46.00%)
Age mean (standard deviation)	22.17 (2.01)	22.70 (2.07)	22.43 (2.04)
Learning needs	5.41 (2.32)	5.03 (2.47)	
Audio effects	5.00 (2.81)	4.92 (2.76)	n = 50
Video effects	4.65 (3.05)	5.04 (3.53)	Mean = 5.23
Animated effects	6.58 (2.48)	5.13 (2.74)	SD = 2.38
	7.18 (1.01)	5.52 (1.27)	
Levels of satisfaction	7.23 (1.07)	5.71 (1.57)	
Overall design	7.15 (1.12)	5.33 (1.66)	n = 47
Exhibited content	7.62 (1.24)	5.24 (2.28)	Mean = 6.44
Exhibited guide	6.46 (1.36)	5.70 (1.99)	SD = 1.39
Hardware facilities	7.46 (1.53)	5.43 (1.83)	
Software features			

As Table 2 suggests, the numbers of female and male participants are about the same. The Group 1 participants' responses to learning needs for their on-site NCKU museum visits were not as high as expected (M = 6.58; SD = 2.48). They thought that the animated effects of the exhibited content should be enhanced, even though other effects (audio and video) were already presented in the real museum. The participants in Group 2 had even lower levels of learning needs for any effects (M = 5.03; SD = 2.47), since they visited the Ancient Lock exhibition by entering the media-rich SL environment but not much familiarizing with such environment. For the Group 1 participants' levels of satisfaction, their responses were higher (M = 7.18; SD = 1.01) than the Group 2 participants, visiting the SL site (M = 5.52; SD = 1.27). Other than the listed learning needs, the participants' responses to the two open-ended questions are worthy of further analysis. The analysis results are shown in Table 4 of the next section.

b. Comparison Analysis Results and Learning needs

Based on the descriptive analysis results, the two groups of participants had different levels of satisfaction from their museum visits. Consequently, One-way ANOVA examined the differences and established a significant difference in the participants' responses to the levels of satisfaction with museum visits (F = 25.089; p < .001; Table 3). However, no significant difference appeared in the responses of the two groups' participants to their learning needs during their visits. However, they did declare their learning needs by responding to the two open-ended questions. Table 4 shows the codes of their responses to one of the open-ended question, with suggestions pertinent to interactive components. Apparently, many Group 1 participants asked for a 3D animated or simulated movie. They even expected to find copies of ancient locks, so that they could try using copied ancient keys to unlock them. Group 2 participants already registered avatar accounts in SL 3D space, so many of them expressed their willingness to visit the exhibition but asked for more sophisticated or mature designs, such as better audio and video effects. However, they were disappointed with their computers' refresh rate. Sometimes a lag in loading images occurred when moving quickly from one virtual place to another. These participants suggested a need for the exhibition guide to offer the same services as they expect when visiting a real museum. A large touch-sensitive screen was an expectation for the display of images of the ancient locks in the NCKU SL museum's exhibition.

Table 3 Response Comparison for Levels of Satisfactions and Learning Needs

Constructs	*F*-value	*p*
Levels of satisfaction	25.089	.000
Visit needs	.319	.575

Table 4 Other Suggestions to Interactive Components

Group 1	Group 2
3D animated or simulated effects (7 responses)	Delicate design (5 responses)
Interactive virtual reality (5)	The guide's services (3)
Copied ancient locks (2)	Computer memory space (3)
Others - explanation of movie content, numbers of computers, smoothness of animation (5)	Others – real image, large and touchable screen, more small animations (5)

c. Exploring Visitors' Experiences

The two groups of participants should have perceived different experiences in viewing the Ancient Lock exhibition, since the groups represented visitors to different locales: on-site or in SL. Group 1 participants expected to find more historical background for the ancient locks. However, Group 2 participants expected a large-scale exhibition, containing rich knowledge content and exhibited objects. Some Group 2 participants noticed the design outlook of the NCKU museum building and the indoor decoration of the exhibition. They suggested all virtual objects to be as real as possible. They also believed that the exhibited objects, virtual ancient locks, should be large enough so that they could easily play with them with their avatars' virtual hands. Overall, many participants (Group 1: 8 responses, Group 2: 11 responses) actively provided useful suggestions for the exhibition. These are important references for three aspects: modifying the Ancient Locks exhibition in SL for this study, designing the NCKU SL museum's other virtual exhibitions, or preparing future exhibitions at the real NCKU museum. A series of scheduled, semi-interviews, to be conducted soon, may provide rich descriptions of participants' thoughts, feeling, and opinions.

5. Conclusions and Discussions

This study explored two groups of visitors' learning needs from visiting museum exhibitions and satisfaction for their museum visits in the NCKU museum in real-life or in Second Life. All participant visitors received invitations enter the Ancient Locks exhibition hall and then completed a survey at the end of their visits. As a result, a significant difference appeared in the responses to levels of satisfaction with their museum visit, but not for their learning needs. However, different groups had different learning needs and provided suggestions according to their responses to two open-ended questions. These results show that visiting museum exhibitions could become a serious leisure activity for more and more people [20]. Finally, this study concluded that the functions provided in the real museum could become supplements to the virtual museum and vice versa. In other words, the real and the virtual museums can exist coincidently, so that the visitors' diverse expectations could be achieved, such as studying and manipulating copied ancient locks and their interaction with 3D virtual ones.

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Applying a Role Reversal Strategy in Second Life Virtual Interview Training

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Abstract: Technology has changed the ways we do things. Traditionally, counseling used to be in a face-to-face environment to help those in need. But today, there are more and more new technologies being applied to counseling. One of the developing trends of counseling is cyberization. College students are facing the need of counseling on their job-hunting, so this project is proposed aiming at using a 3D-based environment to help college students on virtual interview training. We constructed an interview scene in Second Life and used role reversal strategies to proceed with virtual interview. Four students recruited to participate in the pilot study thought that the virtual interview can provide them with the opportunity to practice and be less afraid in the real situation.

Keywords: Career counseling, Second Life, role reversal strategy

Introduction

With the development of technologies, immersive environments have become more matured. The early age of the Internet technology could only transfer texts, but with the advance of technologies, we could now transfer multi-media data such as images, videos, voices and animations [1]. These days, both software and hardware relating to computer technologies are more advanced and are now capable of transferring 3D objects through the Internet. The 3D virtual reality environment is bringing more and more people to use the immersive environment as a tool to different kind of activities. Traditionally, counseling helps people to solve their problems through face-to-face conversation. Today there are other varieties of technologies which could be applied in counseling, such as eMail, bulletin board, instant messaging, video conferencing, and so on. Virtual reality is a novel technology, and adding it to the counseling tool kit may be one of the future trends.

Counseling is a very broad category that covers many sub-fields. Among the various counseling sub-fields, career counseling is an important subject for undergraduate students especially for seniors. For seniors, letting them have the chances to prepare the resume and to have the interview rehearsal experience will be helpful for them. However, letting each student has a real interview rehearsal costs a lot for the students. Virtual reality platform, such as Second Life, provides the realistic environment for them, where the students can have interview rehearsals as many as they wish.

Solely providing an immersive environment for the students is not enough for them to have the interview rehearsal. Further interactive strategy is needed to realize the activity. Role playing is a general pedagogy and also a commonly used counseling technique. Role reversal is one of the ways we could use in role playing. Through exchanging roles, students can experience different thoughts and feelings of the opposite role. In career counseling, by using reciprocal role reversal strategy, a student as the job seeker can have a chance to play the interviewer. S/he can perform an interviewer in a realistic environment experiencing the interviewer’s view and concerns.

In this research, we tried to let students exchange their roles in Second Life. With virtual interview, students can understand the thoughts of both job seeker and interviewer, in hope to help students complete their interview successively in the future.

2. The Internet Counseling and the Second Life

Counseling is an important subject, which covers on various fields. Traditionally, the format of counseling used to be in face-to-face environment. Technology has changed a lot of ways we do things. There are now a wide variety of technologies being used in the Internet counseling, either synchronous or asynchronous communication, each with its own advantages. The common tools used in the Internet counseling including telephone, eMail, chat, instant messaging (IM), video conferencing [2]. The advantages of the Internet counseling cover on convenience, efficiency, and anonymous. Beyond the traditional text or graphical user interface technologies, immersive environments, like second life, become more matured. With the development of virtual reality, it may now be a new choice for the Internet counseling.

Second life is a 3D virtual environment connected by the Internet, where users can socialize, interact and create using free objects, voice, and text chat. It was first put out by the Linden Lab in 2003, and soon gained a lot of members around the world. Except the entertainment it brought to the users, it also has a great value on commercial and educational applications. Commercially, it attracted corporations to use Second Life as a platform for commercials, exhibitions and services. Educationally, scholars tried to use Second Life as a tool of teaching and research [3]. Second Life has great potential on educational fields. The 3D virtual reality environment acts as a great tool for teaching simulations and role playing activities. According to the research of NMC [4], three most possible items used in educational applications of Second Life are art performance, role playing and teaching simulations. Our research tried to use Second Life for virtual interview training. Students can play different roles in immersive environments for job-hunting counseling.

3. Role Reversal Interview Environment in the Second Life

Our research used Second Life for virtual interview training. The students can use the e-portfolio system for preparing their resume, and then by reversing roles for the virtual interview. Students can have their virtual interview in Second Life by playing the roles of interviewer and job seeker. Three students playing the role of interviewer can team up to design their company’s logo, mission statement, job opportunity, qualifications wanted, and interview questions according to career route map developed by their department. Students playing the role of job seekers will have to prepare their resume and autobiography, and respond to the posted job opening that they are interested in and complete virtual interview in Second Life.

a. Construction of the Interview Environment

Our researcher team constructed a scene for virtual interview training. There are three floors in the scene as described below:

- First Floor- Lobby

The first floor is the lobby which includes the front desk, a recreation area and a reading area. Users can see the function of “Join club” at the front desk, allowing students to join local clubs. “Main contact” is to provide users with help if they have any questions. The recreation area provides a space for users to gather and chat, and by the use of sofa, table and coffee machine, user can practice basic operations of moving around in Second Life. The reading area provides students with website links to career life via SLOODLE platform [5].

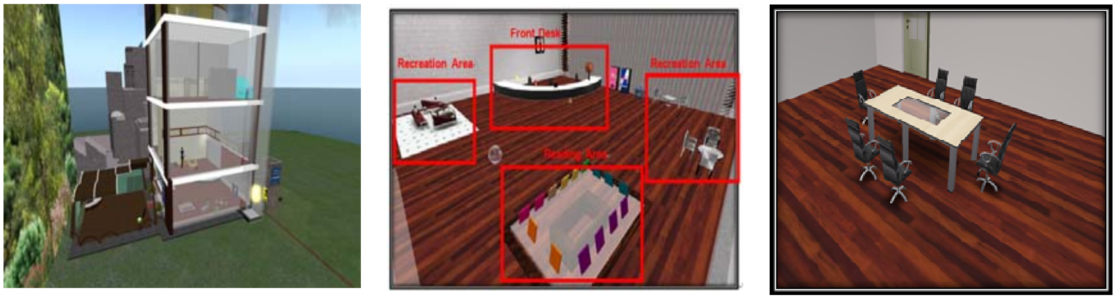

Figure 1: The Screenshots of the Virtual Interview Environment

- Second Floor- Landmark Information

The users can be teleported to other sites in the second floor with a focus on virtual clothing by landmark. Most of the landmarks that the researchers provide are free malls, but students can search for other malls in Second Life world. Users can choose any outfits and accessories that they think are appropriate for interview.

- Third Floor - Main Interview Training Scene

There are two meeting rooms at the third floor. These are the main scene for virtual interview. Users could choose from two different types of meeting room: one is decorated as a formal meeting room with a more serious atmosphere, the other with a more relaxing surrounding.

b. Facilitating the Students to have the Role Playing Activities

In this career counseling activity, the students were divided into two groups. One group played the job seekers, and the other group played the interviewers. To facilitate the job seekers preparing the resume, an ePortfolio platform was applied. The main content of the resume included self-introduction, educational background, work experiences, career goal, autobiography, and school year report cards. Students could fill in the required information in the form, which could be completed like regular resume in a simple way. To facilitate the students who played as the interviewers preparing the interview plan, a career route map developed by the students' department was used. The students played as the interviewers could have a clearer career path according the career route map. In this study, the students who played the interviewers need to study the career route map before have the interview.

4. Pilot Study

a. Procedures

For preliminary test of the constructed virtual space in Second Life, four seniors from the Department of E-Learning Design and Management, National Chiayi University, Taiwan were invited to participate. Among them, three are male and one is female. Two students played as the interviewer and the other two as the job seeker. Through the platform on Second Life, they used voice call to have the one to one virtual interview and completed their resume by the built-in Second Life text system. The study last for two weeks. At the first week, students learned the basic skills of Second Life, the implementation procedures of this study, before completing their resume and interview questions. The on-line virtual interview was held at the second week through voice call. A debriefing session after the virtual interview was arranged to gather data on the potential of Second Life as a tool for virtual interview.

b. Results

Students reflected after the virtual interview on the advantages of this interview included:

- Having the opportunity to practice responding to question in a short period of time in an appropriate way
- To come up with questions for interview in the perspectives of interviewer
- By coming up with interview questions in the first place, students can think about how they are going to answer it
- Being an interviewer can have the chance to listen to different answers, helping students to develop multiple ways of thinking
- They are less afraid in using the virtual interview environment

Regarding the Second Life environment, there are some problems that need to be overcome:

- Second Life needs higher processing power of hardware. Computers with not enough memory or processing speed might not be able to run the program
- Students need more scaffolding in preparing the resume and the interview plan
- Nowadays resumes are aesthetically designed. They are hard to be shown on Second Life

5. Conclusion and Suggestion

The development of technologies makes virtual interview on immersive environments possible. In this research, we tried to have virtual interview training on Second Life. Using the role reversal strategy, students got the chance to play the role of interviewer and job seeker so that different perspectives and feelings of such roles could be experienced. The construction of the environment just completed and is now ready for more pilot tests. On our next step, we will have students from different departments to participate in the virtual interview training on Second Life.

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Authentic Theurgy: Ceremonial Magic in Second Life

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Abstract: In this paper we describe an interactive, experiential learning activity developed for teaching the sociology of religion to undergraduates. The activity begins with basic instruction in using the virtual world Second Life and culminates with the students' performance of a role play of a Pagan religious ritual. We focus our discussion on fun.

Keywords: Second Life, magic, experiential learning, fun, paganism, sociology, role play, religion, gaming

Introduction

This paper considers the case of an immersive educational experience in Second Life and discusses the importance of fun as a vital component of learning while considering whether real educational value is achieved.

As educators expand into virtual worlds the importance of understanding the processes of digital domains increases. This leads to questions such as whether experiences in a virtual environment are authentic in themselves and whether there is real educational value in online interactive media, including games and shared virtual environments such as Second Life. An important aspect of education that is sadly often overlooked, especially at tertiary level, is fun. Csíkszentmihályi posited that people are most happy and attentive when in a state of flow[1]. From this we deduce that in order to achieve ideal educational value activities should induce flow.

1. The Fun of Flow

Recent work[2] has shown how Second Life can be used to increase the measurable learning achieved with similar time and resources. This work also indicated that learning can be achieved through complementing physical environment activities with virtual environment activities in a structure fostering a flow experience that would be prohibitively resource intensive in a physical instructional environment alone. In addition to the resource efficiency of such activities, these experiences are more likely to be enjoyable.

There is not yet an established model for judging enjoyment in virtual worlds, although Sweetster and Wyeth have suggested a flow based approach[3]. While the study of enjoyment is in its infancy in Virtual Worlds it has a long history in media studies[4]. However there is an important fundamental difference between enjoyment of media in general and of enjoyment in education in virtual worlds: enjoyment is taken for granted in media studies[4]. Once the audience loses enjoyment they simply stop engaging with the media. Students do not have this luxury. Rather, they must endure whatever media and content their educators put before them. Sadly educators generally prioritize content over fun.

Castronova[5] has postulated the growth of the fun society. He sees this as being driven by the huge numbers of people now playing online games. Games are designed to make people happy. In game worlds the number one priority of the game designers is that the gamers have fun. If they have fun they will pay their subscription fees. If no fun is generated players will switch to another game. In the pursuit of this happiness, large numbers of people spend a huge number of hours learning how to do things in the game world. Usually these are things which have no relevance outside of the game world, how to beat the troll guarding a particularly desirable weapon, how not to get eaten by the dragon in order to get the gold. We already know that people will play if it is fun. What we need to do then is to change the content from simply the kind of mindless repetition of intrinsically meaningless make work so often seen in games to engaging educational content.

If we employ this mechanism in education many will balk at the idea of prioritizing fun at the same level as content. But in fact this apparently counterintuitive idea will enhance learning by inducing flow and hence increasing engagement. In the single minded immersion of flow the emotions are employed to produce completely focused motivation. By inserting content that relates to the learning outcomes we seek we produce accidental learning. Accidental because students will be primarily motivated by a desire for fun, but the high level of focus seen in flow will have the secondary effect of increasing attention and the assimilation of content. The fun of flow has the power to engage the emotions to enhance learning outcomes. In order to test this we produced an activity that sought to prioritize fun.

2. The Activity

The activity was to role play a Pagan circle ritual in a purpose built ritual environment as part of a first year undergraduate sociology unit. We constructed the environment in the University of Tasmania's (UTAS) region in Second Life. The environment in the UTAS region was the site for five two hour classes and for the performance of the role play, which was shown during a lecture for the unit.

This activity was one of a number of assessment options available to the students in a thirteen week, first year undergraduate Sociology unit. All other options consisted of the writing of a 2000 word essay. This was the first occasion on which any option other than writing an essay was offered for this unit.

Students undertaking this option were required to attend ten hours of instruction in excess of that which was required for the essay options, additionally, students were required to practice using Second Life in their own time, to keep a weekly journal and to write a 1500 word essay. The essay question cited Katz's quote "To type is not to be human, to be in cyberspace is not to be real; all is pretence and alienation, a poor substitute for the real thing"[6] and required students to argue whether they felt this was an accurate assessment. Despite this substantial extra load, and the prospect of the performance of the role play of the ritual before an audience of hundreds of other students, of the three hundred students enrolled in this unit four did select this option. All students undertaking this option were female. One student was from a Pagan family. One student was a regular World of Warcraft player. None had any experience with Second Life.

The first two hours of teaching were inworld instruction in the basic skills necessary for using the virtual world Second Life. Subsequent classes involved instruction in basic concepts of Paganism, sociological theory, and practice and performance of the role play.

3. Development of the Ritual Environment

a. Landscaping

The production of the environment and associated course materials required one hundred hours development time. While this may seem like a lot of time, it is significantly less than would be required to organize a ritual role play outside of the virtual world. Much more expense would be involved in having to produce physical versions of all the magical tools, robes, statuary, and effects employed. Moreover the environment can be utilized repeatedly.

Development commenced with landscaping the environment, which took the form of a gum tree covered mountain by the sea, and which was a generalized representation of the Tasmanian natural environment, replicating typical Tasmanian geographic features and native Australian plants and animals. Sound effects were employed to enrich the experience, including those for natural features, such as the sea, as well as appropriate animal sounds.

figure 1. The ritual mountain

b. Religious Items

The ritual area included four elemental pentagram altars located at appropriate compass points for performing a Pagan circle ritual in the Southern Hemisphere, viz. Fire at North, Water at East, Air at South and Earth at West. A set of ritual tools (Sword, Cup, Dagger, Pentacle) representative of present day Pagan practice was constructed, each including detailed appropriate symbols and colours. Ritual robes and a script for the ritual were provided. Appropriate statuary was also developed.

figure 2. The Fire altar

c. Scripting

Because of the interactive nature of the ritual, custom scripting was required. A programmer experienced in the Linden Scripting Language used in Second Life was employed for ten hours.

4. Content

d. Introduction to Second Life

The students were introduced to Second Life in an empty space with a plain flat ground. The first activity was the creation of avatars. Each student visited the Second Life website and created a user account and selected an avatar. Over an hour was spent on the customization of avatars in class, though the students spent much more time than this at home changing their avatars' outfits and hairstyles.

The students initially unanimously expressed that Second Life was simply a game and would have no real world effect on them. After only three hours instruction time students were advised that they should take their avatars' clothes off. All students immediately indicated that they would be too embarrassed to remove their avatars' clothing. This provoked much discussion regarding the reality of activities undertaken in a virtual world and the relationship of avatars to their human operators.

Following on from this was a treasure hunt activity which taught the students the basics of receiving items, opening boxes, obtaining and using landmarks, using camera controls, using Second Life’s voice capability to communicate, teleporting and selecting objects. Some parts of the hunt required students to act cooperatively in order to achieve the goals.

The students were required to visit the Second Life Marketplace and buy their own robes, for which funds were supplied. This enabled them to understand the purchasing mechanism whereby residents acquire items and provided a means for the introduction of concepts of digital currencies, copyright issues, making one's living from the sale of virtual items and security issues.

e. Formal Instruction

A two hour session on ancient and modern Pagan theology was enthusiastically participated in by the students. Content covered included a general historical and theological overview of Paganism, with more detailed coverage given to; the concept of the four elements, the nature of deity in Paganism, Hermetic Qabalah, the Enochian, Thelemic and Golden Dawn systems of theurgy and Ancient Egyptian religion. Following this the students were keen to begin the ritual role play.

figure 3. The Air altar

A two hour session was devoted to sociological theory, with a focus on gaming and virtual world theories. The nature of avatars and their relationship to their human operators was a key part of the content of this section and included the work of Mark Stephen Meadows[7] and Tim Guest[8].

f. The Role Play

The ritual the students role played was specifically written for this activity and included elements from various traditions in order to explicate the syncretic nature of Neo Paganism. The ritual took the form of a procession around and up the mountain to arrive at the main ritual area at the summit.

Each of the four students adopted a particular element and wore robes which they had customized to show colours appropriate to their element. During the deosil ascent each person stopped in turn at each of the elemental altars. Each altar contained symbols and colours associated with its element. At each altar each student performed a short preparatory ritual, spoken aloud, in the Golden Dawn tradition, comprising the Qabalistic Cross and the tracing of a pentagram in the air. The gestures were accomplished by the use of a custom made animation which was triggered by a collision generated by the students' avatars standing in the correct position on the altar. Once this animation was completed an object appropriate to the element in question appeared before the altar and the participant was given a copy of that object for use later in the ritual.

Students were immediately aware when they had arrived at the altar of their own element by means of the matching of the colours of their robes with the accoutrements of the altars. This repetition of stimuli facilitated the assimilation of information.

After having moved through all four elemental altars in sequence the group proceeded to the ritual area on the summit of the mountain. The movement up the mountain symbolized the move from mundane to sacred space, with each stop at an altar focusing the attention until by the time the group arrived at the summit their attention was particularly well focused on the performance and significance of the main part of the ritual.

The summit ritual space was a flat bottomed, circular caldera with high sides creating the feeling of a semi enclosed space. Each quadrant of the area was arrayed with the set of symbols and colours of a particular element. There was a central pentagram altar with a fire at its midpoint.

figure 4. The angel of Earth, Uriel

On arriving at the summit the students each stood at the cardinal direction associated with their element and arranged in front of them the ritual tools they had received from the four altars. After an ancient Greek banishing formula was declaimed, each student in turn used an Enochian formula to invoked the angel associated with their element. As each student said their ritual formula a twelve metre angel appeared behind them. Once all four angels had been invoked the group used a Thelemic formulation to invoke the Egyptian god Thoth. As they did this a fifteen metre tall statue of Thoth appeared and then spoke to the group. There followed a short closing formulation and then the group processed back down the mountain, back into mundane space.

5. Outcomes

a. Student Reactions

All students repeatedly remarked that it was an unusual experience to be having fun in a subject at university. This was reflected in their high level of engagement with this class. At the completion of each two hour session they invariably did not wish the class to end. Fortunately the lab was often available and so classes continued on for up to an extra hour on each occasion.

Although the performance of the ritual was filmed on the day of the performance, some sections were missed. The students were asked to return for a two hour session so that these missed sections could be recorded. Despite having been advised that this was completely optional all the students attended that session, the main topic of discussion among them being how they could get to engage in the activity again. All students volunteered to perform the ritual for an upcoming conference. And all were very keen to see the machinima of the event.

One of the four students has become a regular user of Second Life having joined a role play community. Confidential student appraisals of the activity were conducted, however the results are not yet available.

b. Learning Outcomes

It is too early to ascertain completely the efficacy of learning effected by this activity as the students are yet to submit all their written work. The work completed so far, their journals and their essays, indicate they have an understanding of how socialization occurs in virtual worlds, avatar/human relations, theories of society and of personality, the nature of the real, and that the concept of learning as fun was quite novel to them.

Learning has been demonstrated by the students' inworld activities. They all can now clearly articulate the concept of the four elements and know the relevance of the order of the elements taught to them. Each one is able to relate the properties of their particular element. An understanding of the Qabalistic concepts of the macrocosm and the microcosm, and their relationship to each other, is also clearly demonstrated by the students. All students quickly and easily assimilated the concept of The Great Chain of Being and of all things, including humans, being part of a system in which no one part had a privileged position.

All students initially held the view that Second Life was "just a game" and that participating in it would not have a real effect on them. They have all now moved to the view that actions in a virtual world can have real world consequences and are aware that they became socialized to the culture of Second Life. Moreover they have come to see Second Life as more than a game, as a place with its own culture, and to be able to discuss the benefits and shortcomings of that culture.

Notions of embodied presence, and the nature of self provoked much discussion in class. The notion of participating in a culture of one's choosing, one that fits better with one's values and means of expression and that one has a meaningful part in shaping, rather than the only option being to experience the culture one was born into, was exceptionally appealing to all participants.

c. Future Modifications

This activity has been scheduled to be run again next semester. Some modifications will be made as a result of what was learned this semester.

The ritual will be amended in order to achieve a good balance between being interesting for the participants and also more engaging for spectators. Having each person conduct the preliminary ritual at each altar, while engaging for participants, was too slow paced for audience engagement. Amending the ritual so that only the student adopting the role of that particular element performs the ritual at that altar should speed up the performance and increase audience engagement. Having shortened this part of the ritual, time will be made available which can be used to lengthen the closing section as it seemed too perfunctory.

Because the environment has already been developed and will be reused, time will be available to develop more accoutrements and to improve the interactive nature of the ritual. The ultimate goal is for the ritual to be able to be performed without the lengthy instructional period. Ideally we seek to make the ritual experience available to all residents of Second Life to partake of, for it to be able to be performed without the instructor's presence being required. This will require more inworld interactivity and the provision of information inworld rather then in class. Planning is underway to facilitate this.

Conclusion

We have presented an instructional activity that integrates experiential learning not otherwise achievable with traditional lecture and discussion based instruction. This was achieved by providing foundational knowledge concerning the target content, theoretical discussion of the use of virtual worlds such as Second Life, and an experiential interactive exercise using Second Life itself.

Our results highlight the importance of fun as a factor in learning and in improving student engagement. This activity produced a high level of engagement on behalf of the students undertaking it. Although all written assessment is not yet completed for this unit we can discern from the written work that has been completed, and from the students' participation in the activity in Second Life that they have assimilated the majority of the content in which they were instructed.

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Around the Worlds - Testing the SVECTAT Method

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Abstract: In this paper, we present a plan for parallel testing of the SVECTAT (Shared Virtual Environment Complementing Task Achievement Training) method in different countries and with different target languages. The method is mission-oriented and is focused on the immediate application of language learning content from classroom exercises in actual communicative activities using the medium of Second Life. It provides a path from strong scaffolding toward open-ended, self-directed experiential learning. The proposed test will gather data regarding the broad applicability of the method and provide indications regarding its management and implementation.

Keywords: Language learning, language teaching, mission-oriented learning, experiential learning, applied learning, scaffolding, self-directed learning, Second Life, SVECTAT

Introduction

Language learning and language teaching, across different locales and different languages, face certain common challenges and limitations. Two of these are the daunting gap between classroom activities and real world independent, authentic communications, and the finite resources available in formal teaching situations, particularly those of time and individual attention.

The SVECTAT (Shared Virtual Environment Complementing Task Achievement Training) method has shown value in addressing these challenges and limitations. In multiple tests, practicing and carrying out communication tasks through the medium of Second Life has lowered the learner's sense of stress and risk, while increasing the learning value of the instructional time. Of particular significance is the learner-reported value of being able to practice content in a classroom exercise, and then immediately enter the virtual environment of Second Life to apply that content in independent communication with authentic users of the target language (English).[1]

Testing to date, however, has been in a single institution, with one set of instructors and one target language. Testing groups have been small, and testing time brief. Here, we present a plan for testing the SVECTAT method more extensively, to evaluate its broad feasibility, applicability, and effectiveness. We will achieve this by arranging parallel tests in different countries, carried out by different teams, teaching different target languages.
This paper will summarize the background, theory, and testing results to date of the SVECTAT method, explain the planned parallel test methodology, and discuss specific areas of interest and concern, followed by a conclusion and references.

2. Background, Theory, and Testing to Date

a. Background

As previously reported[2], the SVECTAT method was conceived at a graduate school of science and technology in Japan to address the particular needs and challenges faced in the teaching and learning of English there. Particularly notable among these were, for students, lack of opportunity for independent authentic use of English and of time for classroom study, and, for teaching staff, availability of equipment and space, as well as individual time with learners.

b. Theory

The SVECTAT method draws on theories of situated learning[3], experiential learning[4], mission-based learning[5], and flow[6], in which learners complement focused classroom based, instructor led activities with more open ended, learner directed experiences gained via the medium of Second Life. Utilizing this immersive shared virtual environment provides an enjoyable opportunity for learners to approach and interact with speakers of English in a public social venue.

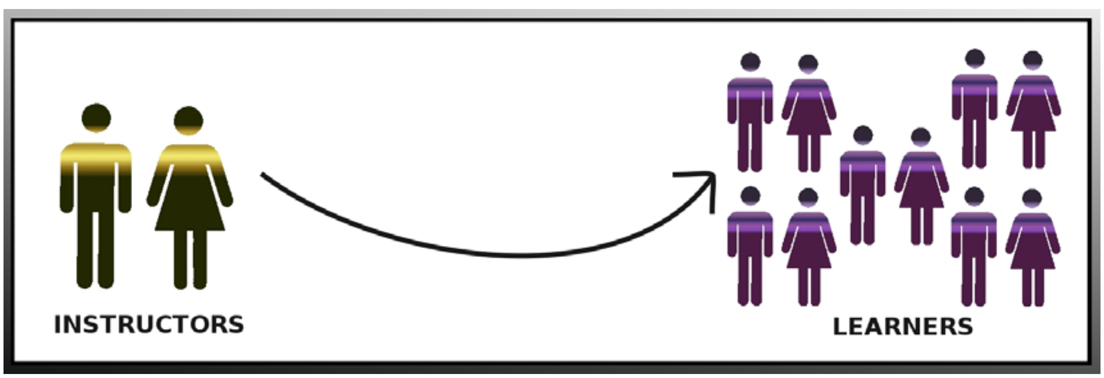

Figure 1a. First Phase – Explanation and Modeling

In Figure 1a., two instructors provide explanation and modeling of a target communication task to a class of (e.g.) ten students, face to face in the shared physical environment of the classroom.

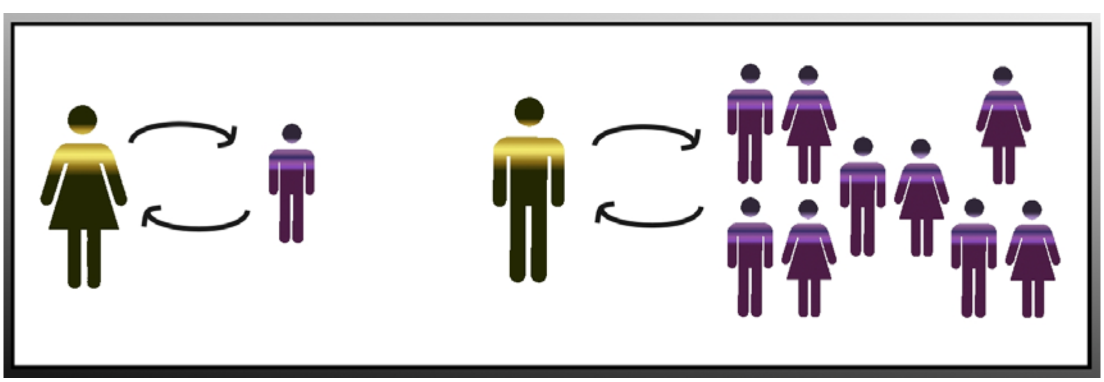

Figure 1b. Second Phase – Role Playing

In Figure 1b., one instructor supports students in practicing the target communication task with one another in the shared physical environment (classroom), while the other instructor engages students one at a time, in a separate room, in role playing of the task.

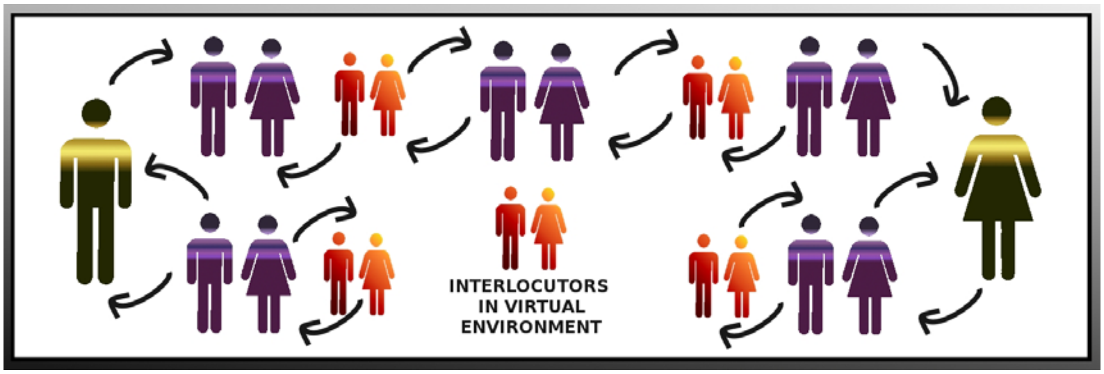

Figure 1c. Third Phase – Application in authentic communications

In Figure 1c., the two instructors support all the students in simultaneously utilizing Second Life to enter public social venues to apply their new learning in carrying out the target communication task in authentic interactions with unknown interlocutors in the shared virtual environment.

While role-playing communicative tasks one-on-one with instructors is important and valuable, it is also time and effort intensive for both parties. Complementing this serial activity with the parallel one of all learners simultaneously carrying out the same tasks in Second Life is highly time and effort efficient for both parties. To replicate the individual application opportunity afforded by Second Life with face to face communications would require the recruitment of a number of persons equal to the number of students to act as interlocutors in the shared physical environment. Since this is simply not feasible in most language teaching situations, the significance of the SVECTAT method is considerable.

c. Testing Results to Date

We first conducted a controlled test in February of 2009, in which twelve subjects, divided into three groups, participated in a three-hour workshop, evaluating their own self-assessed ability in a list of communication tasks using a pre- and post-test instrument. The control group received modeling, instructions, and task achievement exercises solely in the classroom. A second group received modeling and instructions in the classroom, and carried out the tasks first in classroom role-playing, then in Second Life. The third group both received modeling and instructions, and carried out the tasks in Second Life.

The result of this first test showed that while the third group achieved far lower results than the control, the second group, complementing classroom activities with virtual-world application, achieved the same learning results as the control but in half the instructional time.[2]

The second test, held in March 2010, following the indications of the first, involved a single group of twelve subjects, who received modeling and instruction, and then face-to-face role-playing practice, in the classroom, then carried out the same tasks in Second Life. The testing period was twelve hours over two consecutive days, and was followed by a two-hour presentation and discussion among participants, instructors, and guests.

The result of the second test showed improvement similar to the first in self-assessed ability to carry out communicative tasks with tangible results, adjusted for time.

In the post-exercise discussion, participants explicitly expressed their sense that the educational value they experienced lay in being able to immediately apply what they had learned in the classroom to authentic communications "in the real world" (i.e., with strangers in a public venue using the medium of Second Life).[1]

A third test was held in June and July of 2010. This was intended to gather data on the improvement in self-assessed ability gained during more instructional hours held over a longer period of time, specifically, in eight weekly ninety-minute sessions. Logistical difficulties presented serious challenges, such as unreliable computer and network performance, low subject numbers (only four), and unsuitable arrangement of space and furniture. Learners were physically unable to comfortably share a single psychological space with one another. Assessments and reported results indicated that immersion and flow were not sufficiently established.

3. Planned Methodology and Areas of Interest & Concern

Methodology

3.1 Instructional Activities

Three instructional phases are involved in the SVECTAT method:

- First, instructors explain and model content, emphasizing the mission orientation and objective result to be achieved in a given task
- Second, one learner at a time leaves the classroom to carry out a specified task in face to face role playing with an instructor, while the remaining learners practice the task in face to face role playing with one another
- Third, learners who have completed individual face to face role playing enter the virtual environment of Second Life at a public social venue, and attempt to carry out the same task in authentic communication with a stranger

3.2 Evaluation & Assessment

The method is structured to allow evaluation compared with other teaching activities, using a self-assessment instrument given to learners before and after an activity. These assessments are then compared to evaluate and assess the learning achieved.

The instrument consists of a list of ten communication tasks, each with a tangible, objective result (e.g., receiving contact information from a stranger, making an appointment, receiving an item, etc). Subjects assess their own ability to successfully carry each task out, according to the ratings and criteria in Table 1.

Table 1. Evaluation Matrix for Self-Assessment Instrument

Rating	Criterion
0 - NA ("Not Able")	Cannot succeed even with guidance
1 - Competent	Can succeed with guidance
2 - Confident	Can succeed without guidance
3 - Independent	Able to provide guidance to others

3.3 Testing Partnerships

We have received agreement from professors at three tertiary institutions, one each in Australia, Taiwan, and Turkey, to carry out testing of the SVECTAT method in collaboration with our team in Japan. The target language in Taiwan and Turkey will be English, while in Australia the target language will be Japanese. Subjects will be students of the respective languages in the relevant departments.

We intend to develop the specific arrangements and logistics of the tests in discussion and collaboration with the teams at the partner institutions, to achieve a consistent parallel structure that also fits the needs and limitations of the different locations.

d. Areas of Interest & Concern

We will be interested to see whether and how quantitative results and reported subjective assessments vary when the method is used by different instructors, in different countries, with different students, and for different target languages. We anticipate receiving valuable feedback for refining and improving the theory, structure, and presentation of the method.

We anticipate that, while the method offers, in theory, a significant savings of classroom time used by learners and instructors, there will be challenges, some shared with our own early tests, others specific to the various locales, teams, and students. One example is provision of one Second Life capable computer and network connection per learner for the third phase. Another is the comfort and confidence of the instructors in using Second Life, and in familiarizing their students with its use. Likewise, instructor comfort and confidence using role playing and task-based language teaching will be a challenge.

4. Conclusion

We have presented a plan for testing the SVECTAT method of language learning in different countries, carried out by different teams, teaching different target languages. This paper has summarized the background, theory, and testing results to date of the SVECTAT method, explained the planned parallel test methodology, and discussed specific areas of interest and concern.

The results of the proposed testing will measure the method's value in overcoming the learner's gap between relatively comfortable classroom activities and authentic, independent communication experiences in the target language. We anticipate that the method will increase the effectiveness of a given amount of teaching time and instructor-learner interaction. We look forward to carrying out the plan presented here, and reporting on the results.

Acknowledgements

We thank Mitsuru Ikeda and Shungo Kawanishi for their guidance and support.

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Workshop

Workshop on Open Technology, Open Standards and Open Knowledge in Advanced Learning

Workshop Organizer

Kiyoshi Nakabayashi (Faculty of information and Computer Science, Chiba Institute of Technology)
Fanny Klett (IEEE Fellow)
Maggie M. Wang (Faculty of Education, The University of Hong Kong)

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Preface

Open technology and open standards play inevitable role in today's growth of ICT-based education. Open technology and open standards are not just technical components but provide an open infrastructure to share open knowledge to evolve technology enhanced education. Based on this point of view, this workshop provides an opportunity to share information, experience and knowledge on the cutting edge activities such as R&D towards open technology and standards, open system implementation based on the open standards, application and practice of open knowledge sharing on open technology-based platforms, open knowledge exchange between e-learning and neighboring field such as knowledge management, human resource development, and informal learning based on the open technology and standards. It is our great pleasure to be able to organize this workshop with the distinguished papers under the above mentioned scope. We hope this meaningful event will be an opportunity to deepen the understanding of this cutting edge field and encourage further research activity in the future.

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The Effects of Programming Using Collective Intelligence

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Abstract: A programming education has a favorable influences on creative and logical thinking and problem solving abilities of students. However, students typically have spent too much effort in learning basic grammar and using the model of programming language, which negatively affect their eagerness in learning. In this respect, the purpose of this study is to investigate problem solving and learner's attitude towards collective intelligence in the context of secondary school students' programming classes and to verify the possible application of a new instructional method. The result of collective intelligence showed a positive effect in the attitudes of the students towards learning and problem solving.

Keywords: Collective Intelligence, Programming Attitude, Problem Solving Ability

Introduction

Information has become the most important element in knowledge-based societies. The Internet which was brought about by the development of information and communications technology has caused many changes all over the world particularly in the educational environment. Interests on computers have increased because it can change the traditional learning environment.
Learning how to use computers has been developed differently compared with traditional face-to-face learning in which teachers and learners share limited time and space. The emergence of Internet in the change of educational environment had become a system of administering knowledge which is implemented and eventually brings a significant change inside the classroom. In the Center of cultural phenomenon, a new paradigm of Web 2.0 has been created and called "User participation in the open space". The Web 2.0 provides the foundation that users can interact directly, and have a variety of sharing and spreading of knowledge by a direct connection. The aforementioned phenomenon can be explained by "*Collective Intelligence*"[1].

1. Literature Review

1.1 Scratch Programming Language

The effect of existing programming education has shown a limitation coming from its methodology. Scratch is an easy-to-learn and intuitive Educational Programming Language (EPL) that helps improve the problem solving ability of the class [4][9].
Scratch is developed by the Lifelong Kindergarten Research Group at the MIT Media Lab(http://llk.media.mit.edu)[10].

Scratch is a new programming language that makes it easy to create your own interactive stories, games, music and animations and share your creations with others on the web[13]. Scratch is designed to help young people (ages 8 and up) develop 21st century learning skills. As they create and share Scratch projects, young people learn important mathematical and computational ideas, while learning to think creatively, reason systematically, and work collaboratively. They can create many different types of projects with Scratch[10][14].

1.2 Collective Intelligence(CI)

The *Collective Intelligence*(CI), also called "The wisdom of crowds", or "swarm intelligence"[5], has been recognized as a new value with the advent of Web 2.0.
Collective Intelligence is a shared or group intelligence that emerges from the collaboration and competition of many individuals. Collective Intelligence appears in a wide variety of forms of consensus decision making in bacteria, animals, humans, and computer networks.

Collective Intelligence can also be defined as a form of networking enabled by the rise of communications technology, namely the Internet. Web 2.0 has enabled interactivity and thus, users are able to generate their own content. Further, The *Collective Intelligence* draws on this to enhance the social pool of existing knowledge[2].

Pierre Lévy (1994) has defined *Collective Intelligence* as "distributed everywhere, and is given the value of continuous, real-time adjustments, and the practical ability to bring intelligence"[1]. Lévy and de Kerckhove consider *Collective Intelligence* from a mass communications perspective, focusing on the ability of networked ICT's to enhance the community knowledge pool[2].

The cyberspace is a venue where various people meet and interact with each other. Furthermore, it is where diverse knowledge and information are being discussed. In effect, the more participants joined in cyberspace discussion, the greater the value and space of knowledge will uncover.

Also, James Surowiecki(2004) has defined the *Collective Intelligence* as a moving power in the economy and society. In some situations, a smart group discussion will lead to a wise decision and is better than it could have been made by any single member of the group. For this reason, a man does not need to dominate this group. He said that "The wisdom of crowds" and the like[3].

According to Don Tapscott and Anthony D. Williams(2008), *Collective Intelligence* is mass collaboration. In order for this concept to happen, four principles need to exist. These are openness, peering, sharing and acting globally[6][10][11].

1.3 Design of Collective Intelligence Programming

In this study, the content of *Design of Collective Intelligence Programming* is based on the *Problem-Based Learning model*. And we used modification and supplementation. The validity of *Collective Intelligence Programming* contents according to was 10. Test results were valid. The following Table 1 is *Collective Intelligence programming* contents.

Table 1: *Collective Intelligence Programming* contents

<table>
<tr><th>Sessions</th><th>Subjects</th><th colspan="2">Contents and Tools</th></tr>
<tr><td>1</td><td>How to use Web2.0 Tools</td><td colspan="2">Wiki, Mind Map tools, Messenger Program et al.</td></tr>
<tr><td>2</td><td>How to use Scratch</td><td colspan="2">Block, Sound, Motion, et al. (Scratch)</td></tr>
<tr><td>3</td><td>Problem recognition</td><td colspan="2">Learning Objectives and Problem Set (Wiki)</td></tr>
<tr><td>4</td><td>Problem solving planning</td><td colspan="2">Current contents arrangement (Mind manager),
The establishment of a plan to solve the problem.</td></tr>
<tr><td>5</td><td>Searching</td><td>Data Searching and Data Saving</td><td rowspan="5">Wiki, Messenger Program, Scratch's Web</td></tr>
<tr><td>6</td><td rowspan="3">Solution</td><td>Creative ideas and programming</td></tr>
<tr><td>7</td><td>Programming Analysis and Exchange</td></tr>
<tr><td>8</td><td>Applications of Programming</td></tr>
<tr><td>9</td><td>Presentation and Evaluation</td><td>Discussion, Sharing, Review</td></tr>
<tr><td>10</td><td>Publication</td><td colspan="2">Online Publication and Print (Scratch's Web site)</td></tr>
</table>

Also, *Collective Intelligence Programming Learning* has the following effects[8].

- Learners can solve problems by implementing algorithms.
- Teachers are facilitators in programming learning.
- Interaction between learners for effective problem solving.

Figure 1 shows the environment for *Collective Intelligence programming Learning*.

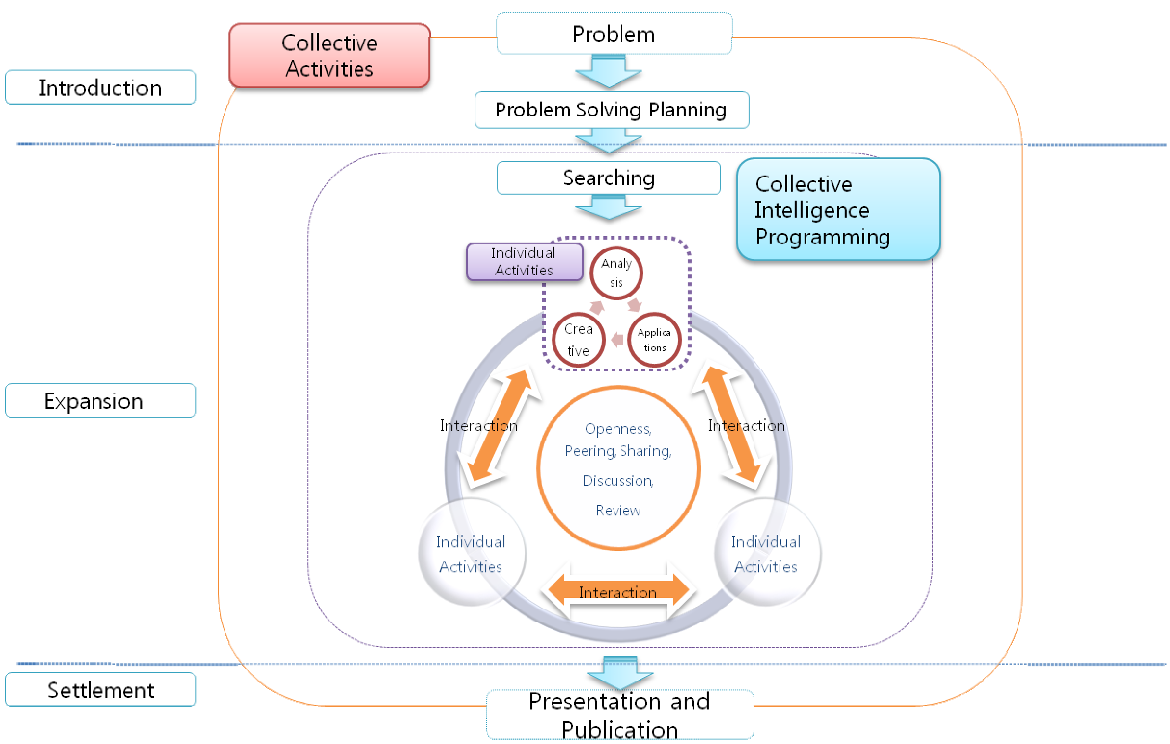

Figure 1: *Collective Intelligence Programming Learning*

2. Methodology

2.1 Samples

There were 73 students in the secondary school who participated in this research. Table 2 presents two research variables (Treatment and Control Group) with the gender information of the variables.

Table 2: General Information of Participants

Group	Subject		Total	
	Male	**Female**		
Treatment Group(G_1)	22	14	36	73
Control Group(G_2)	22	15	37	

2.2 Design

They were divided into a Treatment Group (G_1), which consisted of students using the *Collective Intelligence programming learning* and Control Group(G_2),which had students using the *Traditional Programming Learning* for comparison. Table 3 illustrates the design of the study.

Table 3: Design

Treatment Group(G_1)	O_1	X_1	O_3
Control Group(G_2)	O_2	X_2	O_4

O_1, O_2: Pre-test (problem solving ability, programming attitude)
X_1: Collective Intelligence Programming Learning
X_2: Traditional Programming Learning
O_3, O_4: Post-test (problem solving ability, programming attitude)

In order to measure learners' achievements, pre- and post-tests were performed before and after the five-week (March 15th to April 16$^{th)}$. They learned the way of using Scratch for two sessions. Subsequently, they learned simple a game programming project in a different way for a total of 8 sessions.

2.3 Test items

- *Problem Solving Ability* test items was conducted by the OECD PISA(Program for International Student Assessment) in 2003. Problem solving ability test items had 19 questions in the area of public. We were used modify 12 questions. Question has been verified of expert group. The result of the pilot test reliability was Cronbach's alpha = .824(n=73).

- *Programming Attitude* test items was conducted by Cho (2008) in the attitude of programming[15]. We were used modify and supplement. Programming attitude test items were verified by the expert group. The result of the pilot test reliability was Cronbach's alpha = .921(n=73).

3. Analyses

In this study, we used SPSS 12.0 for statistical analysis. And the pre-test and post-test was conducted for the analysis of the *Problem Solving Ability* and *Programming Attitude*. Based on this, Independent-Samples t-test and Paired Sample t-test were conducted.

3.1 Problem Solving Ability(PSA)

Pre-test results of *Problem Solving Ability* are shown in Table 4. As the table shows, there are no statistically significant difference between the two groups in either part(p>.05). Therefore, G_1 and G_2 are in the same group.

Table 4: Pre-test results of *Problem Solving Ability*(n=73)

Group	n	Mean	S.D.	df	t	p
Treatment Group(G_1)	36	80.28	11.956	71	.572	.569
Control Group(G_2)	37	78.65	12.365			

P<.05

Post-test results of *Problem Solving Ability* are shown in Table 5. As shown in the table, there are statistically significant differences between the two groups(p<.05). And the mean of the Treatment Group was higher then the Control Group. Therefore, *Collective Intelligence Programming Learning* shows positive influence in enhancing students' *Problem Solving Ability*.

Table 5: Post-test results of *Problem Solving Ability*(n=73)

Group	n	Mean	S.D.	df	t	p
Treatment Group(G_1)	36	87.11	10.725	71	2.234	.029
Control Group(G_2)	37	80.86	13.022			

To know statistically significant difference between the two groups using Paired Sample t-test. As the result are shown in Table 6.

Table 6: Pre-test and post-test Paired sample t-test of PSA(n=73)

Group	**n**	**Pre Problem Solving Ability – Post Problem Solving Ability**			
		Mean	**S.D.**	**T**	**p**
Treatment Group(G_1)	36	-8.677	5.448	-7.525	.000
Control Group(G_2)	37	-3.515	3.895	-3.461	.001

The results of analyses show that the Treatment and Control Group's *Problem Solving Ability* has improved ($p<.05$). However, the Control Group's improvement of mean was lower than the Treatment Group. The results of the study show that *Collective Intelligence Programming Learning* has positive influence in enhancing students' *Problem Solving Ability.*

3.2 Programming Attitude (PA)

Pre-test results of *Programming Attitude* are shown in Table 7. As can be seen, there are no statistically significant difference between the two groups in either part($p>.05$). Therefore, G_1 and G_2 are in the same group.

Table 7: Pre-test results of *Programming Attitude*(n=73)

Group	**n**	**Mean**	**S.D.**	**df**	**t**	**p**
Treatment Group(G_1)	36	58.67	12.708	71	.427	.671
Control Group(G_2)	37	57.46	11.428			

Post-test results of *Programming Attitude* are shown in Table 8. As can be seen, there are statistically significant difference between the two groups($p<.05$). And Treatment Group's mean was higher then Control Group. Therefore, *Collective Intelligence Programming Learning* was positive influence in enhancing student's *Programming Attitude*.

Table 1 8: Post-test results of *Programming Attitude*(n=73)

Group	**n**	**Mean**	**S.D.**	**df**	**t**	**p**
Treatment Group(G_1)	36	66.31	10.601	71	2.980	.004
Control Group(G_2)	37	58.24	12.417			

To known statistically significant difference between the two groups using Paired Sample t-test. As the result are shown in Table 9.

Table 2 9: Pre-test and post-test Paired sample t-test of PA

Group	n	Pre Programming Attitude – Post Programming Attitude			
		Mean	S.D.	T	p
Treatment Group(G_1)	36	-7.639	7.579	-6.048	.000
Control Group(G_2)	37	-.784	2.359	-2.021	.051

The results of analyses show that the Treatment Group's *Programming Attitude* has improved. But Control group's *Programming Attitude* has not changed($p>.05$). The results of the study show that *Collective Intelligence Programming Learning* has positive influence in enhancing students' *Programming Attitude*.

4. Conclusion and Discussion

Web 2.0 has attained attention in terms of the flexibility and diversity providing users with various teaching and learning materials. Programming education has favorable influence on creative, logical thinking and problem solving abilities of students. However, students typically have to spend too much effort in learning basic grammar and the usage model of programming language, which negatively affects their eagerness in learning. In this respect, the purpose of this study is to investigate problem solving and learner's attitude of the *Collective Intelligence programming learning* on Secondary school student's programming classes and to verify the possible application of this now instruction method. In the results, the *Design of Collective Intelligence Programming learning* was positive influence in enhancing learner's *Programming Attitude* and *Problem Solving Ability*. In particular, the *Programming Attitude* of students has changed from negative attitude to positive attitude. Through this research, the researcher findings to be bases for a more active participation of student's in computer field.

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Design of a Performance-Oriented Learning Ontology

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Abstract: E-Learning is increasingly being used by various organizations as an emergent approach for enhancing the skills of knowledge workers. Different from school environment, learning in organizations is built on practical tasks and work situations with the aim of serving organizational goals. This study incorporates performance measurement into learning ontology to clarify organizational goals and individual learning needs, and link them to e-learning applications. The key idea lies in a Key Performance Indicator (KPI) model, where the organizational mission and vision are translated into a set of key performance targets for driving learning towards the goal of improving work performance.

Keywords: Ontology, performance, e-learning

Introduction

E-Learning is increasingly being used by various organizations as an emergent approach for enhancing the skills of knowledge workers. Different from school environment, learning in organizations is built on practical tasks and work situations with the aim of serving organizational goals. To facilitate this requirement, a performance-oriented learning ontology is proposed in this study. This ontology uses performance measurement to clarify organizational goals and individual learning needs, and links them to e-learning applications. The key idea lies in a Key Performance Indicator (KPI) model, where organizational mission and vision are translated into a set of key performance targets that drive learning towards the goal of improving work performance. To demonstrate the effectiveness of the approach, a prototype workplace e-learning system has been developed with relevant experiments used to evaluate the effectiveness of the approach.

1. Background

Companies and other organizations face a permanent change due to various emerging challenges including globalization, economic pressures, and the changing nature of work. To be successful, employees of organizations have to learn continuously to cope with the change. E-Learning, as an emerging approach for enhancing the skills of knowledge workers, is increasingly being used by organizations [8]. However, most existing e-learning studies are based in educational institutions [5]. Different from school environment, learning in organizations is built on practical tasks and work situations with the aim of serving organizational goals. As a result, most e-learning applications fail to meet the needs of learners and ultimately fail to serve the organization's quest for success in the knowledge economy [11, 12].

In this study, we propose a performance-oriented learning ontology to improve e-learning development in the workplace settings. Ontology is a formal representation of a set of concepts and their relationships in a domain using machine languages and semantic annotations [2]. It supports human-computer communication on a semantic basis. This study incorporates performance measurement into learning ontology to clarify organizational goals and individual learning needs, and link them to e-learning applications. The key idea lies in a Key Performance Indicator (KPI) model, where the organizational mission and vision are translated into a set of key performance targets for driving learning towards the goal of improving work performance. The KPI model helps an employee identify performance measures for his/her position, capabilities to be developed to improve the performance, knowledge topics relevant to the capability, and learning resources under the knowledge topic. This conceptualization makes organizational goals accomplishable by showing a clear picture to each individual as to what is important and what they need to learn.

2. Conceptual Framework

Performance measurement is used by organizations as a procedure to improve performance by setting performance objectives, assessing performance, collecting and analyzing performance data, and utilizing performance results to drive further development. Key Performance Indicator (KPIs) used in this study are financial and non-financial metrics used to help an organization define and measure progress towards organizational goals [7]. A set of KPIs can be set up to represent a set of measures focusing on different aspects of organizational and individual performance that are critical for the success of the organization [9]. The KPI framework should be designed based on an organization's structure and job system. The KPI framework consists of three levels: organizational level; business unit level; and position level. KPIs at the *organizational level* are defined according to business goals and strategies of the organization. Based on the organizational KPIs, the KPIs at the *unit level* for each business unit can be derived. Based on the unit KPIs, the KPIs at the *position level* for each job position within the unit are defined. In this study, we focus on KPIs at the position level which have a closer relationship with e-learning in the workplace.

The KPI framework has special meaning to workplace learning which involves organizational strategy, structure, and systems. KPI bridges the gap between an organization's mission and its employees' targets, making organizational goals accomplishable. KPI can be used to help employees set up rational learning objectives according to the knowledge gap. It can be used as a systemic scheme to organize and manage learning resources and activities in line with work context and performance requirement. Further, KPI can be used to identify each individual's work context and expertise to support social learning and knowledge sharing towards the goal to improve work performance [12].

In this study, ontology is used to conceptualize the KPI-oriented learning environment into a machine-readable format. Ontology is a formal representation of a set of concepts within a domain and the relationships between those concepts; it is defined as "formal, explicit specification of a shared conceptualization" [2]. Ontology creates a machine-readable conceptual basis for communication between humans and computers. Ontology-based technologies are applied to e-learning systems by providing mechanisms for semantic annotation of learning resources and activities, reuse and combining of course materials, and enabling better searching and navigation [4]. The KPI learning ontology is constructed based on the four concepts *Position, Key Performance Indicator (KPI), Capability, and Knowledge Component (KC)*, with their relations. As outlined in Figure 1, an employee at a *Position* is assessed by a set of *KPIs* required by the organization; to improve the performance relevant to a specific *KPI*, the employee needs to develop relevant *Capabilities*; to develop a capability, the employee needs to learn relevant knowledge, which can be represented as a number of *KCs*. In addition, recursive relationships between different KCs and different positions are also outlined. For example, one KC can be linked to another KC based on relations such as "part of", "sequential", and "inhibitor"; a position (e.g., junior tester) can be a prior of another position (e.g., senior tester).

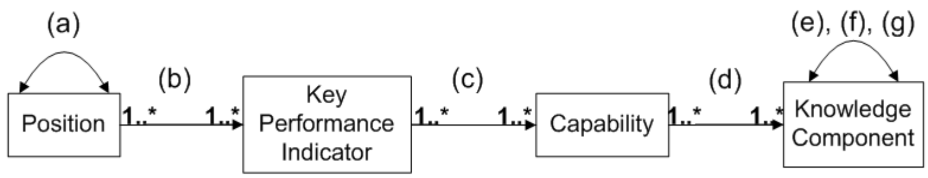

Figure 1. Main concepts with relation cardinalities

3. System Design

Based on the proposed conceptual framework of the performance-oriented approach, we have designed a performance-oriented learning ontology, which lays the foundation for further development of a workplace e-learning system. As it is infeasible to make the design applicable to all company situations, we use the case study approach to investigate the mechanism to operationalize the approach from both an understanding-oriented and an action-oriented perspective. The ontology and system was designed for the Testing Unit of PEANUT SOFTWARE, a selected medium-sized company in Mainland China, which sells and markets technology products including consumer electronics, computing and communication products. There are four departments in the company: Development, Customer Service, Consulting, and Back Office. The Development department consists of two units: R&D and Testing. Testing is an important and mandatory part of software development, clearly essential for evaluating the quality of software products by identifying defects and problems. The design of the system is based on intensive communication with the stakeholders, i.e., software testers, the manager of the Testing unit, the manager of the training sector, and executives in the company.

3.1 Design of KPI-Oriented Learning Ontology

To develop the prototype system, a KPI-oriented learning ontology is constructed for the Testing Unit of the selected company. For performance measurement to be effective, the measures or indicators themselves must be understood, accepted, and owned by employees as well as their managers. Therefore, the building of a KPI-oriented system needs cohesion and integration of different strategies as well as tight cooperation among managers and employees from different units and at different position levels. The construction of the ontology in this study is based on intensive collaboration between the system designers and training managers and experts of the company. Regarding the software testing profession, IEEE standards for software testing introduced in [1] have been used as an important reference for construction of the ontology.

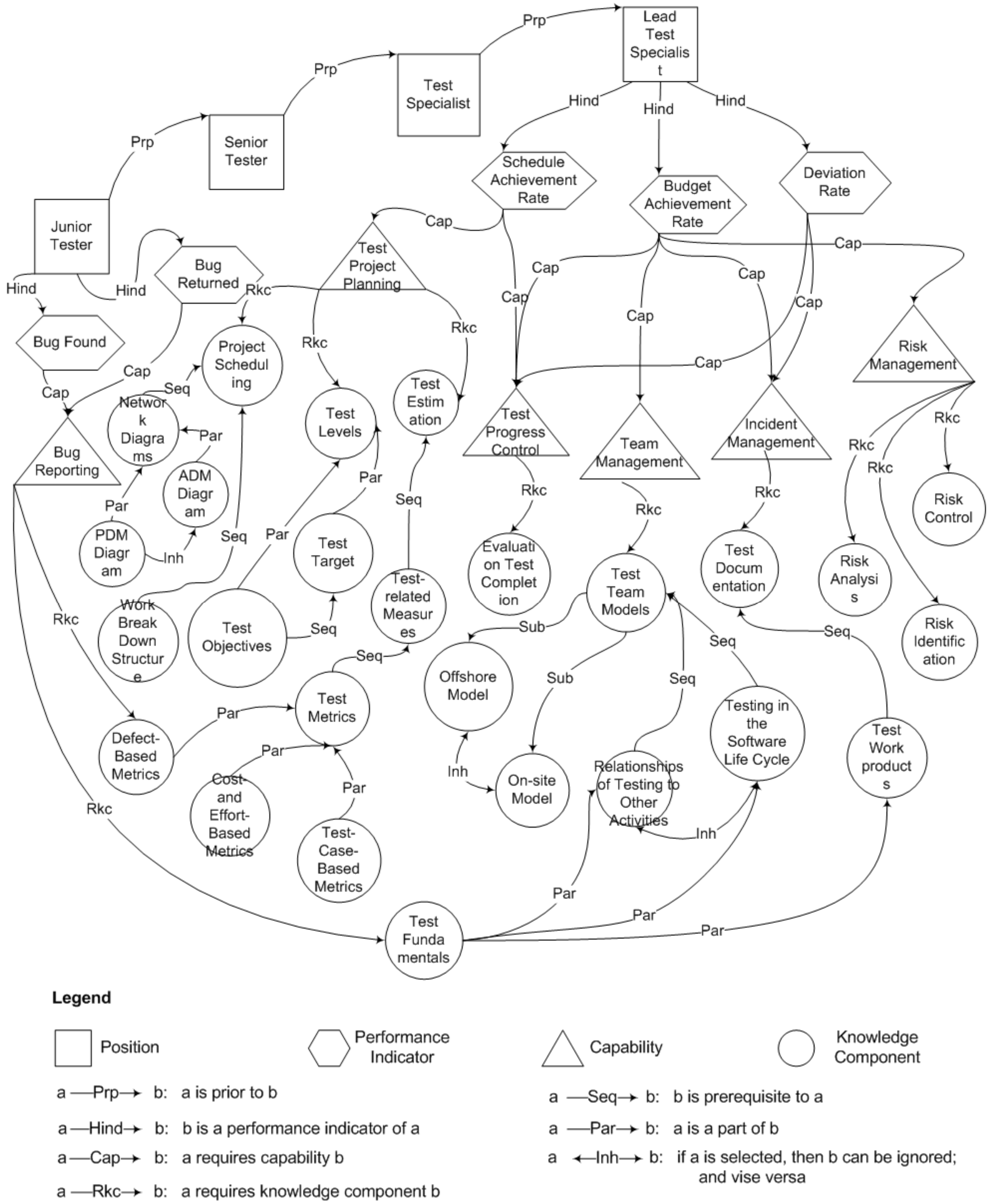

Figure 2. Learning ontology for the Testing Unit

The company defines “Productivity”, “Quality”, and “Organizational Capacity Construction” as its organizational KPIs. For the Testing Unit, its chief function is to find bugs in software products. Therefore, the Testing Unit defines “Bug Found” as one unit KPI in line with Productivity, “Bug Returned” as another unit KPI in line with “Quality”, and “Artifacts Reused” as the indicator to improve “Organizational Capacity Construction.” Based on the defined unit KPIs, the manager and experts of the Testing Unit set KPIs for each position: Junior Tester, Senior Tester, Test Specialist, and Lead Test Specialist. As shown in Figure 2, “Bug Found” and “Bug Returned” are specified as the KPI items for the position Junior Tester. To improve the performance on “Bug Found”, the employees need to develop the capabilities including “Bug Reporting” and others. To develop the “Bug Reporting” capability, the employees may need to learn relevant knowledge “Test Fundamentals”, “Defect-based Metrics”, and so on. The main responsibility of Senior Tester is to design test cases, therefore the corresponding KPI are defined as “Test Coverage” and “Reusable Test Case Rate.” In order to improve the performance of “Test Coverage”, employees should develop capabilities in “Programming” and “Test Case Design.” To improve the capability of “Test Case Design”, employees may need to learn the knowledge “Specification-based Design”, “Black-box Design”, and so forth. Due to the space limitation, Figure 2 presents the details only for Junior Tester and Lead Test Specialist.

Based on the specified KPI framework, each employee is given a set of KPI values for assessment of his/her job performance; to improve the KPI values, each employee may assess his/her knowledge status relevant to his/her position by taking tests or quizzes; based on the test/quiz results, the system will recommend personalized learning resource or activities for the employee. For impartiality and objectivity reasons, the company uses 360 degree feedback to assess employees’ performance. An employee’s performance can be assessed by performance records from daily work as well as by peer evaluation from the employee him/herself, his/her supervisor, and his/her subordinate or peers. Each appraisal is given a certain weight. As a result, a set of KPI values is calculated to evaluate the employee’s work performance.

Based on the ontology specified above, the goal of performance-oriented learning can be achieved by setting up rational learning objectives, accessing relevant knowledge artifacts, and directing individual learning processes through appropriate reasoning mechanism. In addition to the individual learning process, social networking is also facilitated in the learning environment. Learners are able to share and evaluate learning resources, discuss their learning problems or experiences at forums, and conduct peer evaluation of work performance. Each employee is provided with a KPI identification, i.e., a set of KPI values that indicates his/her expertise and proficiency level, stored in the learner’s profile. Learners, including domain experts, are able to get familiar with each other based on KPI identifications and contribution to the learning community.

4. System Implementation

To demonstrate the effectiveness of the designed approach, a prototype of the workplace e-learning system has been built up using Java programming tools. We use computational languages and tools to implement the ontology in the e-learning system. OWL-DL (Description Language) is used to define the KPI-based learning ontology. To support the reasoning services, instruction rules are bound with the ontology using DL safe SWRL (Semantic Web Rule Language). To implement both OWL ontology and SWRL rules, we use OWL-API to access Pellet [10] as the semantic reasoning tool.

Moreover, to enable domain experts and training managers to construct and maintain the learning ontology, tools for ontology editing and visualization are necessary. In this study, Protégé together with “SWRL tab” and “Jambalaya tab” plug-in are employed. Protégé is a free open-source ontology editor developed by Stanford Medical Informatics (SMI) at Stanford

University [6]. Protégé holds a library of plug-ins that adds more functionality to the environment. “SWRL tab” is a plug-in for protégé, which provides a SWRL Editor that supports the editing of SWRL rules. “Jambalaya tab” is another plug-in for Protégé to visualize the OWL ontology.

5. Evaluation

The evaluation is focused on the effectiveness of the proposed approach as demonstrated in the developed system. Therefore, we used experiments and comparative analysis for evaluation of this study. Experiments were conducted to compare the developed KPI-oriented e-learning system with another traditional e-learning system without KPI support. Two parallel prototypes were used for evaluation — the KPI-oriented learning system (System A) and another traditional e-learning system without KPI support (System B). System B has similar functions to System A in terms of user management, learning resources, assessment management, and communication tools, but without KPI-oriented facilities. The interfaces of the two systems are also similar to ensure that no design-related factors other than the KPI-oriented facilities affect usage and perception of the systems.

The evaluation examines the effectiveness of an e-learning system developed for a workplace setting, which is different from other e-learning systems developed for educational institutions. Therefore, Donald Kirkpatrick’s model [3] was utilized, which evaluates training programs at four levels: reaction (how participants react to the learning system); learning (knowledge learning or skill development by using the application); behavior (transfer of learning into change of behavior by using the system); and result (organizational and individual outcome as a result of the training program).

24 employees who were currently working or had previously worked with the Testing Unit of the company participated in the experiments. The participants were divided into two groups of 12 - the treatment group that used the KPI-based system and the control group that used the traditional system. The data collection process can be divided into four stages. *First*, the participants finished the pre-test. *Second*, after using the system for four weeks, participants completed the post-test and the 1st questionnaire for evaluation of the workplace e-learning system on Reaction, Learning, Behavior, and Result level. *Third*, the two groups were asked to swap systems and use the systems for two weeks; at the end of the stage, the 2nd questionnaire was used to determine participants’ preference towards the two prototypes concerning all the aspects of the system. *Finally*, interviews were conducted for qualitative feedback from the participants.

- Results and Findings from the Surveys

Based on the results obtained from the 1st round evaluation, it was found that the KPI-oriented system was perceived to be more effective in terms of meeting individual learning requirement and functional support for learning (Reaction); the KPI-oriented system was perceived to be more helpful to learners in obtaining knowledge and skill (Learning); the KPI-oriented system was perceived to be more helpful in enabling learners to integrate learning into practice and transform individual learning into collaborative learning (Behavior); and the KPI-oriented system was perceived to lead to better outcomes in improving work performance and bringing benefits to the company (Result). On the other hand, the results of the pre-test and post-test scores indicated that there was no significant difference between the two groups in the pre-test or post-test scores. The results are understandable, as other factors associated with the learners (e.g., their learning capability and effort) as well as their learning environment (e.g., Internet accessibility, speed and cost) may have affected the results.

As a supplement to the 1st round evaluation, the 2nd round evaluation was conducted by swapping the learning systems between the two groups. 20 out of 24 participants completed the 2nd round evaluation. The results of the evaluation, that is, the participants' preference between the two learning systems, is shown in Figure 3. The results show that a majority of the participants preferred the KPI-oriented learning system concerning all the aspects of the system.

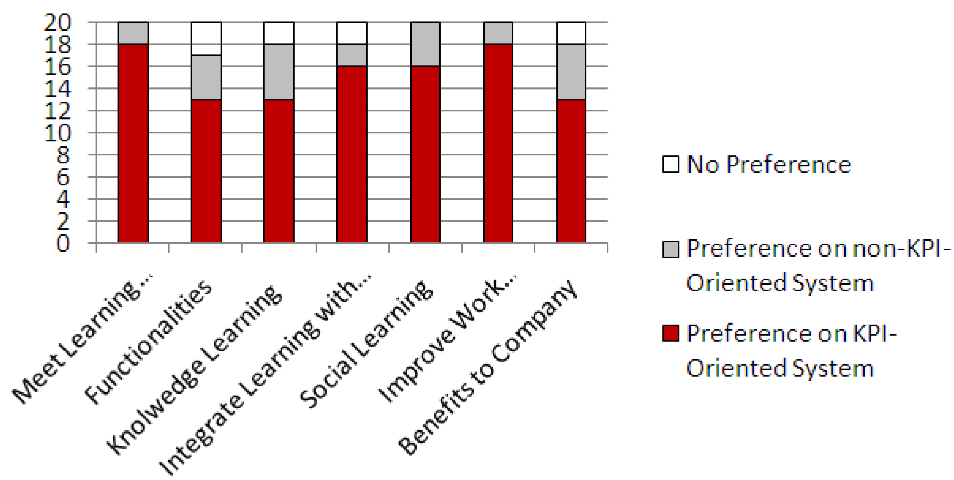

Figure 3. Preference on the learning systems

- Findings from the Interviews

20 participants who finished the experiment and two rounds of questionnaires were interviewed for their feedback on any aspect of the e-learning system. The findings from the interviews showed a more positive evaluation of the KPI-oriented system, especially in terms of providing a clear picture of what needs to be learnt in order to develop specific skills. The learners also gave positive comments about the KPI-oriented system concerning its facilities for effective communications, knowledge sharing, and discussion. As for the training managers, their major concern was cost, which may affect the benefits to the organization from using the learning system. The cost refers to setting up the KPI framework and developing the KPI-based learning system. As a result, the developed e-learning system may not necessarily bring significant benefits to the company in the short term. However, the training managers gave positive comments on the KPI-oriented learning system since they felt that it provided flexible ways of learning and assessment. They also felt that the knowledge contributed by employees can be harnessed and well organized around the KPI model; this may enhance further reuse, aggregation, and sharing of the knowledge asset, and can be regarded as another type of productivity.

6. Conclusion

The main contribution of this work is investigating the mechanism of a performance-oriented e-learning environment by constructing and implementing a KPI-oriented learning ontology. The designed learning ontology has gone beyond learning content by including learning objectives and assessment in line with the KPI framework. The construction of the performance-oriented learning ontology needs shared conceptualization of the stakeholders and professional knowledge from domain experts. The construction of the ontology is also an evolving process where cooperation from designers, employees, training managers, domain experts, and executives is needed in different stages of the project. The results of the study point to the success and benefits offered through ontology technology for developing a performance-oriented e-learning environment in the workplace. It is found that ontology provides a semantic paradigm for designing a performance-oriented learning environment that can operate.

The generalzability of the research findings should be noted that the study was conducted with a software company and within the software testing section, and that the learning ontology designed in this study is only for this specific learning environment. However, the proposed performance-oriented approach implemented with ontology-based technology can be directly applied to other organizational contexts by modifying the content of the ontology.

Acknowledgements

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Competency Proficiency Ontology

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Abstract: Expressing and exchanging competency information is a key issue to enable connections among not only different information systems, also across social and cultural systems. In order to facilitate these connections, competency information and proficiency information must be separated, but be linked together and packaged., In this paper, based on analyzing practical information, a competency proficiency ontology is designed and applied to actual competency proficiency information.

Keywords: Competency, Proficiency, Standard, Information Model, Level

Introduction

The concepts of ability or competency, as applied to human activities may be described by various terms, such as “Knowledge”, “Skill”, and “Competency”. These terms are indispensable for operating human resources (HR) management as well as for other systems, such as learning management systems, and related business information systems. In order to operate efficiently and effectively, these systems rely on the use of information and communication technologies [1].

Although in recent years improvements in methodology and technologies to support human development such as e-Learning, learning supports tools, collaborative learning technologies, and personnel data management, have been recognized, there has been debate and discussion regarding the objects of educational objectives, and specifically how competency and educational objectives may be represented within systems that rely upon information and communication technologies. The challenges of expressing semantics of competency and educational objectives have been documented in various implementation settings [2,3] including e-Portfolio studies and practice [4]. It has been suggested that semantic approaches have potential to facilitate the transfer and exchange of competency information and data across various types of systems and to support interoperability and activities such as subsequent analysis and comparison at a more granular level [5].

For a few years, several research and standards projects have tried to specify structural expressions of competencies. SkillsNET developed several sets of skill data schema, its data base and practical application. Competency is specified with knowledge, tools, indispensable resources, tasks and so on. Hirata and Brown designed a competency architecture from an ontological viewpoint for ETSS (Embedded Technology Skills Standard) a Japanese national project [6,7]. DIN (German Institute for Standardization) officially published PAS 1093: Human Resource Development with special consideration of Learning, Education and Training; Competence Modelling in Human Resource Development, which was initiated by Stracke and colleagues [8]. PAS 1093 specifies information and data models of competency by three dimensions: The first dimension defines the relation and structure between competences and activities, the second dimension focuses on the levels of competences, and the third dimension covers the observation and measurement of competences and activities. This general framework of PAS 1093 facilitates adaptation for various applications and implementations according to given situations and needs. The European Commission has supported and funded two European projects WACOM and eCOTOOL that have developed a competence model based on PAS 1093. And also the Technical report "ISO/IEC Information technology - Learning, education and training - Conceptual reference model for competency information and related objects" will be published soon by ISO [9]. With this project, ISO/IEC SC36 has tried to develop a common view for competency information.

From these and other research projects, the finding is that the concept of level is one of several priority issues that can help to specify competency information. Essentially it has been suggested that it would be better to divide information related to level from other information used to denote competency meaning itself. To further work in this area, a competency proficiency ontology that is used within several skills standards and industry competency models in Japan is considered and applied to a European case study.

Ontology is defined as “a formal, explicit specification of a shared conceptualization” [10, 11]. A “shared conceptualization” implies an abstract understanding or model that is consensually accepted by a group, “explicit” means that the concepts and related constraints are clearly defined, and the word “formal” means that the ontology is machine-readable [11]. Using an ontological approach means that vocabularies, definitions, and structures are in place to support the exchange of queries and assertions among agents. In the next sections of this paper, a proposed competency proficiency ontology will be discussed.

1. Features of Competency Information

The most essential feature of the concepts of ability or competency within information and communications systems is that they are represented in a variety of ways, making it challenging to support interoperability [7]. From the viewpoint of ontological engineering, which is to divide elements, to derive meanings and to make clear relationship between classes/modules, we conducted reviews of skill and competency representations and how they are expressed within various systems. There seems to be at least five representation types of skill and competency information in e-Learning and human resources management [12]. The features of skill and competency representations may be organized into the following different types:

1. **title** - a representation by only a title of competency. This type is most simple one. It is just information as only title, so it is no need to express and to deal with the meanings, not semantics, of skill and competency on information technologies,
2. **title and connection** - competency information which is expressed and defined with relationship of skill and competency titles. These relationships provide contexts and meaning rather than a single title.
3. **description** - the combination of title and descriptive explanation written in natural language. Explanation is may be simple or complex, and provides additional data about a skill or competency such as state, prerequisite requirement, result, purpose, etc.,
4. **structured definition** - defined with preliminarily configured data set. This type is eliminated from redundant description and context dependency expression, and adds structured data flame to title information. A structured data flame specifies data elements and data attributions as a format. Contents of description for skill and competency are described and implemented system by this format.

5. **application** – competency information are used with many other information in applications. Applications which are build with information technologies provide practical services. In practical, competency information are packaged and composted with deferent ways. For example. A competency are expressed by skill and knowledge information, and job or tasks in job descriptions, or course search application.

Of course there are many other ways to differentiate between various representations of competency and skill. In this paper, based on research noted above, it is suggested that it could be useful to distinguish competency information from discrete representation types and to separate out proficiency level information. At the time of exchange or migration of this information between IT systems, these disparate pieces of information should be connected and packaged together. In the next section, a preliminary review of features of skill or competency proficiency information is provided. Additionally, essential components of proficiency concepts will be discussed as a competency proficiency ontology to support interoperability. Then the ontology is applied to the European Qualification Framework (EQF).

2. An Ontology of Competency Proficiency

2.1 Categories of Measurement Types

There are many different types of measurement categories that are used to describe proficiency. Human judgment may be used to categorize, divide, or segment competency and skills and to label them using measurement types such as class, rank, degree, level, stage, grade or degree.

A skill or competency proficiency may be expressed by one or more measurement categories. A measurement category is a way of measuring that is used consistently within a system to describe a skill or competency proficiency. For example, in academic grading systems a pass-fail grading system may be used [13,14]. Typical expressions of proficiency may include values such as "“pass” or “fail”, or “distinction”, “pass”, or “fail”. This means that in different situations, systems may record two or three optional values depending on how the pass-fail grading system has been implemented. Other types of proficiency include grade or stage, such as “first grade”, “second grade”, and “third grade”.

There are various ways to express competency proficiency. In other words, competency proficiency is composed of different types of measures. As this paper focuses on a way of expressing competency proficiency from the viewpoint of ontological engineering, informational elements of a competency proficiency ontology as they are currently used within several skills standards and industry competency models in Japan are considered and applied to a 2-part European case study.

2.1.1. Measurement range

Generally, a measurement range could be formulated using an explicit set of numbers, letters, designations, etc. For example, one could have a measurement range from “1” (rank) to “5” (rank) or "beginner license" to "expert license". In the former, the competency proficiency is segmented by a total of “5” ranks, and there may be a stipulation that integers and no decimals will be used. So an instance will be a value out of “5”, in which “5” expresses the total number contained within the measurement range. In the latter case, the competency proficiency is segmented into 2 licenses. So the instance is value out of “2”, in which the number “2” expresses the total number available within the measurement range. So competency proficiency needs to include the concept of "measurement range" which indicates the total number of ranks, grades, degrees, levels, etc. that are used for the competency proficiency that is being considered.

2.1.2. Segmentation value

It is not enough to express a competency proficiency using only measurement range. The concept of "segmentation value" corresponds to the value number as it occurs within the measurement range. A segmentation value indicates allowance of a certain number or string. In the above cases, numbers from "1" to "5" are allowable values within the former measurement range, and nominal data of "expert" and "beginner" are allowable values in the latter example.

In addition to the measurement range, the segmentation value not only indicates the relative placement of the competency proficiency within the measurement range, it also may include other attributes. For example, the measurement range may have different meanings depending on the system in which it is used. In some systems "1" may be the highest attainable level of proficiency, in others "5" may be the highest attainable level of proficiency. Therefore, additional explanation, rules, pattern information may be required and included as segmentation value attributes.

2.1.3. Segmentation value character

Segmentation value is expressed not only as integer numbers, it may also be expressed as continuance number, and nominal characters, including rate, interval, order, and so on. So it may be necessary to provide explicit information regarding allowable segmentation value characters.

2.1.4. Proficiency composition

There are some of special cases which have 2 or more continuums. For example, "Judo", which is one of the fighting sports, has 2 continuums, "Kyu (級: class)", and "Dan (段: stage)". Kyu begins from 10 to 1, Dan begins from 1 to 9. A lower number of Kyu means more skilled, and a lower number of Dan means **less** skilled. The flow from 10 Kyu to 1 Kyu, and 1 Dan to 9 Dan follows two continuums that are ordered differently. In this case the measurement range is "19" grades. However, in such a case the attribute of "composition" is useful as it can indicate 2 different but related grading continuums.

The license of skiing in Japan is more complex. There are ranks from 5 to 1. A lower number means more skilled. Above rank 1, there are two additional ways to indicate skill level. One way is "Technical expert" and "Crown expert" from the viewpoint of competitive and practical technique, the other way is "Semi instructor" and "Instructor" from the viewpoint of variety and completeness of technique. In this case, there are two or three continuums, so the composition of two or three grades needs to be accommodated. The instance are "3" components, and the respective components have a measurement range of "5", "2", and "2" grades. This means that the competency proficiency concept needs to allow for multiple components, and to respect "cardinality".

2.2 Metric

Metric information is used to specify differentiation in the competency proficiency of learners, trainees, students, etc. A metric is used to help specify how a measurement category (e.g., for grade, degree, level, etc.) for a competency proficiency is being applied. ISO/IEC 19796-3 is useful to chose and define metric type [15]. Each metric corresponds with a measurement

category that is being used. If a certain competency proficiency uses two different measurement categories, then it may have at least two metrics.
It is easy to define and to specify attributions of a measurement category from an initial observation of information related to the competency proficiency in question. However, it may not be as easy to elicit and to define the metric being used, because more detailed information related to the metric that is being used may be hidden or implicit, and complex.
The concept of metric for competency proficiency may be composed of two elements at least, which are criterion and discrimination.

2.2.1. Criterion

Criterion specifies a condition statement used for measuring and judging a competency proficiency. When criteria are grouped together, they can provide an overview useful for assessment and benchmarking.
Criterion can be used to specify dimensions/factors and how they are combined. For example, a driving license may include several different components such as a paper test and an in-person practical exam of driving skill. Criteria may be combined under at least three different dimensions including knowledge regarding driving (knowledge of laws, regulations, etc.), practical knowledge regarding cars and how they work, and driving skill. For this type of situation criteria may be grouped with the condition that all criteria must be met in order for a driving license to be issued.

2.2.2. Discrimination

Discrimination is used to specify how the content of dimension outlined in the criterion will be measured and judged to arrive at a level, degree, grade, etc. of competency proficiency. Discrimination can be used to provide a specific view for scale and assessment.
Discrimination specifies all the dimensions that are used for making differentiations for the metric being used to measure competency proficiency. There may be more than one discrimination item for each criterion and one discrimination item may be used for more than one criterion.

2.2.3. Segmented level

There may be variations in the measurement categories, metrics, criterion, and discrimination information across the different levels that are used to define a competency proficiency. The concept of segmented level is intended to allow for the exchange of information to support these possible variations.
For example, if a competency proficiency has three levels, such as beginner level, intermediate level, and expert level, each level may be measured differently. However, information for all levels is required in order to exchange and share information regarding a competency proficiency.

3. Use case for EQF

The competency proficiency ontology outlined above was applied to the European Qualifications Framework (EQF) concept of levels. Two types of use cases were considered, one use case is for the whole concept of EQF level. In other words, EQF proficiency structure is expressed by the competency proficiency ontology. The other use case employs the competency proficiency ontology to express one level (the 3rd) within EQF.

3.1 Instance of proficiency structure

Category of measurement type is “EQF level”. Measurement range is “8”. Segmentation value is “from (lowest) {1} to {8}”. Segmentation value character is “order” and “integer”. Proficiency composition is “none”.
Metric is “EQF_Metric_01”. Criterion is “d01, d02, d03, d04, d05, d06, d07, d08, d09, d10”. Discrimination is “d01: width of general knowledge”, “d02: range of domain specific knowledge”, “d03: purpose of action in tasks”, “d04: theoretical knowledge for operation” etc. For this use case, 8 segmented levels would be linked to this information, because EQF has 8 levels.

3.2 Instance of a specific proficiency level

The following is an example of EQF “level 3”. Category of measurement type is “EQF 3rd level”. Measurement range is “3rd”. Segmentation value is “{3} by {8}”. Segmentation value character is “order” and “integer”. Proficiency composition is “non”.
Metric is “EQF_Metric_01_03”. Criterion is “and {d01, d02, d03, d04}”. Discrimination is “d01_3: broad knowledge”, “d02_2: industry field range of knowledge”, “d03_1: to undertake simple tasks”, and “d04_1: basic theory etc.

4. Future Works as a Consideration

A competency proficiency ontology that has been used within several skills standards and industry competency models in Japan has been applied to two use cases of the European Qualifications Framework. Next steps will be to apply what has been learned to a database environment and to experiment with further application of the ontology including exploration of a competency proficiency information architecture and data coding in the near future.

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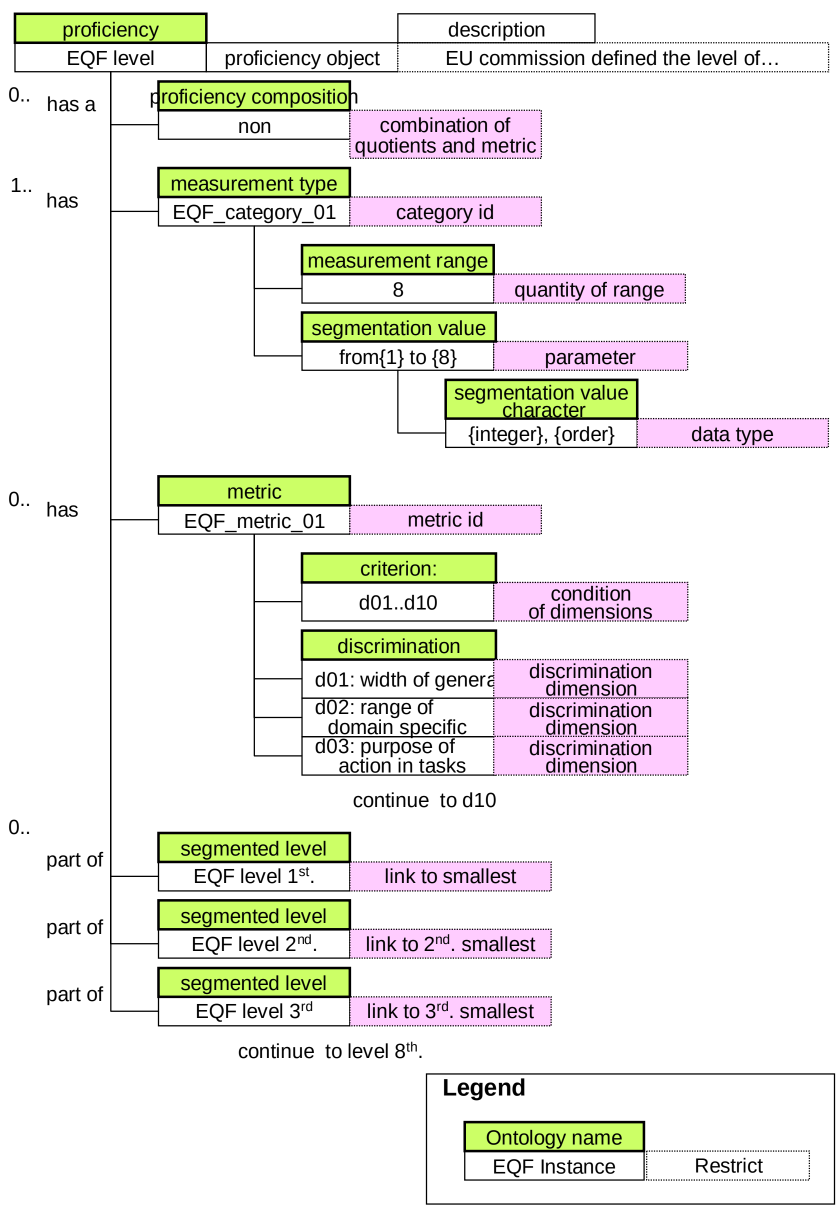

Figure 1 Use case of EQF (for whole level expression)

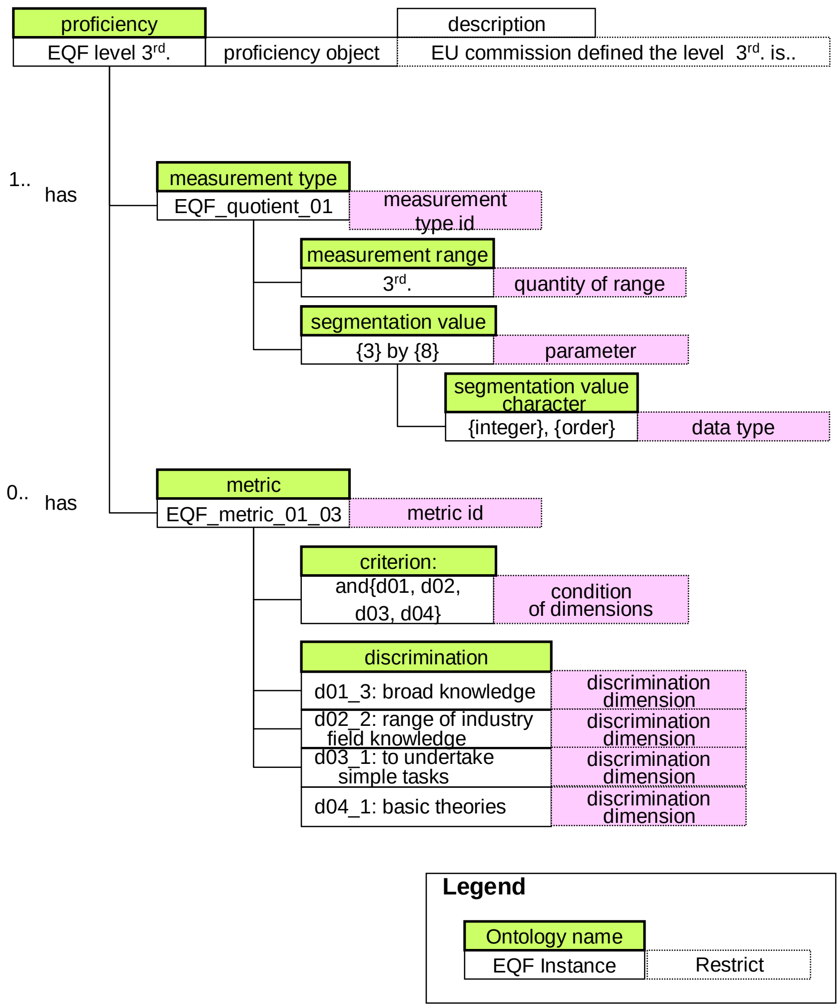

Figure 2 Use case of EQF (for the third level)

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Implementing Learning Design Specification using Extensible Learner-adaptive Environment

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Abstract: Application of an extensible learner-adaptive environment to implement the Learning Design specification is proposed. The design goal of the extensible learner-adaptive architecture is to provide a flexible learning environment that ensures both function extensibility as well as content reusability. The concept of a "courseware object," which is a program module used to incrementally implement various educational functionalities, has been introduced to achieve this goal. On the basis of this concept, implementation of an execution environment for the Learning Design specification has been investigated. The results of this investigation indicate that a self-learning environment based on the learner-adaptive capability, such as SCORM 2004, could be seamlessly integrated with a collaborative learning environment based on the Learning Design specification.

Keywords: e-learning technology standardization, learner adaptation, function extensibility, platform architecture, courseware object, SCORM 2004, Learning Design

Introduction

The interoperability and reusability of learning content is inevitable for high-quality e-learning services with rich learning experiences. Various efforts have been made to tackle this issue by developing and disseminating e-learning content specifications [5, 12]. Some of them have been successfully accepted by the e-learning industry to achieve interoperability between e-learning content and learning-management systems [1, 8]. Many learner-adaptive systems have also been considered as an effective means to provide an improved learning experience by presenting learning content and resources that match the learner's comprehension status [3, 6, 10, 11, 14]. However, there has been little consideration about the interoperability and reusability of content in the field of learner-adaptive systems. In most cases, learner-adaptive systems have been designed based on a certain single learner-adaptive strategy without any extensibility to support multiple learner-adaptive strategies or even to modify a single implemented strategy. This lack of flexibility makes it difficult to add new functions that could improve the effectiveness of learning because the newly added functions may conflict with those for executing existing learning content, resulting in damage to the reliable behavior of this existing content.

To overcome this problem, new learning-system architecture has been designed aiming for capability to both extend learner-adaptive functions and make learning content interoperable [13]. To achieve this goal, the proposed architecture introduces the concept of a "courseware object," which is a program module to implement various educational functionalities. It is possible to incrementally extend functions by adding new courseware objects. Several learner-adaptive functionalities for self-learning, including the SCORM 2004 standard specifications [1] and their extensions, could be successfully implemented on this architecture.

Educational Modeling Language (EML) has recently been attracting attention. EML was designed with the intention to share and reuse pedagogical strategies to achieve effective learning. For this goal, it has the capability to formally describe formations and sequences of various types of educational activities, including self-learning, lectures, and collaborations. In particular, the IMS Learning Design (LD) specification [9], which was derived from EML developed by the Open University of Netherland, has been widely used in several research projects. Such research projects include LD authoring tools, LD execution systems [4], and a system to generate pedagogy described in LD from higher level design requirements that take into account instructional design theories [7].

This paper discusses an investigation to implement an LD execution system based on Extensible Learning Environment with Courseware Object Architecture (ELECOA), which is an extensible learner-adaptive architecture developed by the authors. The results of this investigation indicate that self-learning learner-adaptive capability, such as that of SCORM 2004, could be seamlessly integrated with an LD-based collaborative learning environment based on ELECOA.

1. Extensible Learner-Adaptive System Architecture

1.1 Issues with Conventional Learner-Adaptive Systems

Conventional learner-adaptive systems commonly have the system architecture shown in Fig. 1 in which the content is separated from the platform [10]. In this type of architecture, the content consists of learning material specific to a particular learning subject, and the platform devises common learner-adaptive functionalities independent of the specific learning subject. By separating content from the platform, this configuration makes it possible to design learner-adaptive content with less effort because the designer can concentrate on creating content to fulfill the specific learning goals and not worry about the details of implementing learner-adaptive functionalities.

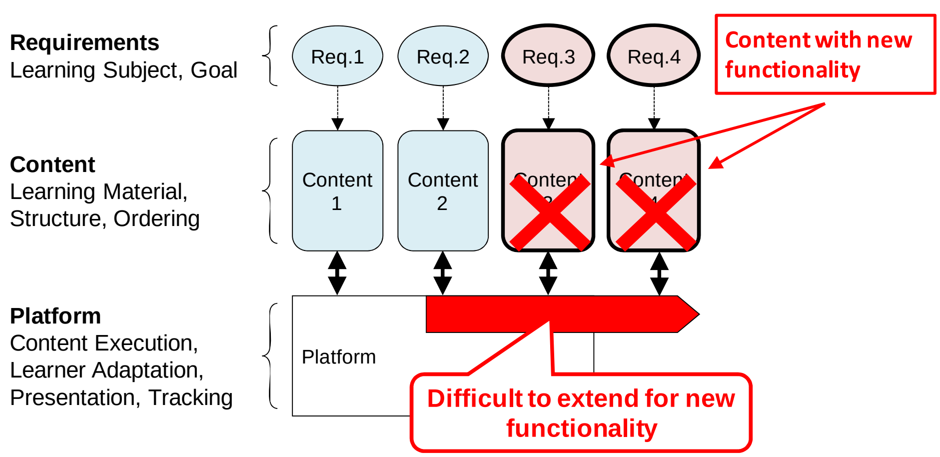

Fig. 1. Architecture of Conventional Learner-adaptive Systems.

The drawback to this architecture is the lack of function extensibility. After implementation, extending the platform to add new functionalities is difficult because it is not known if existing learning content designed for the original platform will work correctly on the extended platform. A representative standard with learner-adaptive capabilities, SCORM 2004, uses the same configuration, resulting in a lack of function extensibility.

1.2 Approach of Proposed Learner-Adaptive Architecture

To tackle the problems of conventional learner-adaptive systems, new learner-adaptive system architecture has been proposed aiming to achieve both function extensibility and system interoperability [12]. The key idea for accomplishing this goal is the concept of a "courseware object" to modularize [2] the learner-adaptive system architecture. The courseware object is a program module for implementing various educational functionalities that are embedded in the platform of the conventional architecture. The courseware objects implement functions, including learner adaptation to choose the most suitable learning material for the learner, material presentation to tailor the way the learning material is presented, and learner tracking to record the status of the learner's progress. For example, there can be multiple courseware objects, each of which respectively implements simple linear, conditional branching, complicated remedial, or much more sophisticated strategies such as scenario-based sequencing using a state-transition machine.

Figure 2 shows the proposed architecture in which the courseware object is clearly separated from the platform. With this configuration, incremental extension of functions is possible by adding new courseware objects. Since this extension does not affect functions previously implemented with existing courseware objects, existing content is certain to always work correctly. In addition, courseware objects can be distributed with content, thus enabling existing platforms to be immediately updated for newly developed functionalities.

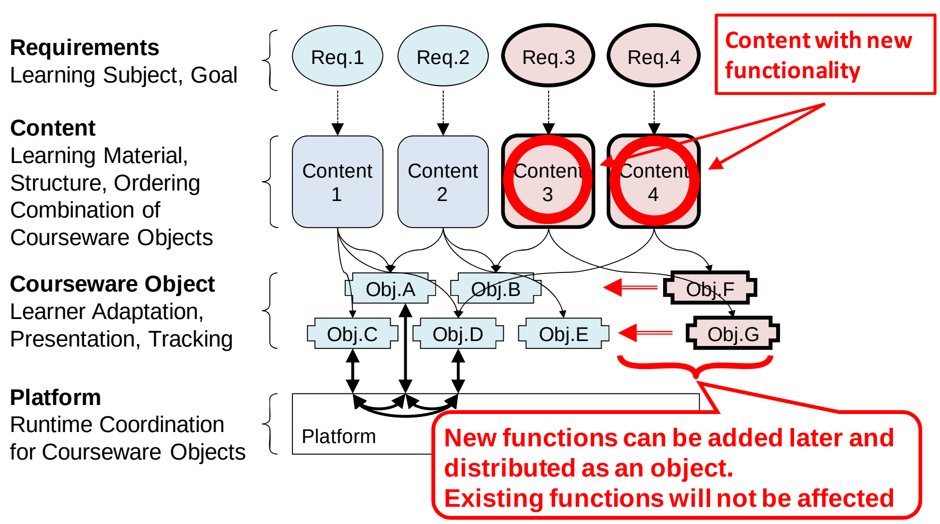

Fig. 2. Configuration for Proposed Learner-Adaptive System.

1.3 Implementation of Proposed Learner-Adaptive Architecture

To achieve the goal of the proposed architecture, it must be possible to combine any courseware objects developed by various designers at various times to work together. To make this feasible, it is necessary to design some criteria or standards to which every courseware object designer conforms. These criteria may include the communication scheme between courseware objects, the information maintained by courseware objects, and the responsibility of courseware objects.

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To investigate these issues, the system was designed based on the following principles and assumptions. First, it was assumed that the content is structured hierarchically or like a tree. This is because content with a hierarchical structure is widely adopted in learning materials by various standards, including AICC CMI, ADL SCORM, and IMS CC [5] as well as various proprietary LMSs.

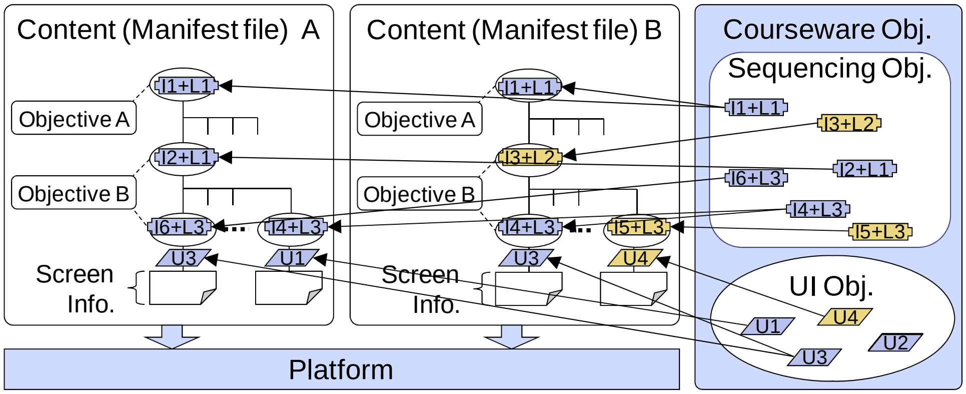

Fig. 3. Configuration of Proposed System for Hierarchical Content.

Second, it was assumed that the courseware objects are assigned for each hierarchical node of content as outlined in Fig. 3. It is a responsibility of the courseware object assigned to a content node to manage the learner-adaptation behavior of the sub-tree under the assigned node. The courseware object sequences its child nodes by taking into account their learner progress information according to the pedagogical strategy implemented in it. This makes it possible to implement different pedagogical strategies in different sub-trees. It is also assumed that the communication between courseware objects is only limited between parents and children. On the basis of this assumption, definitions are designed for the required communication patterns between courseware objects and the interface that courseware objects should provide for other courseware objects.

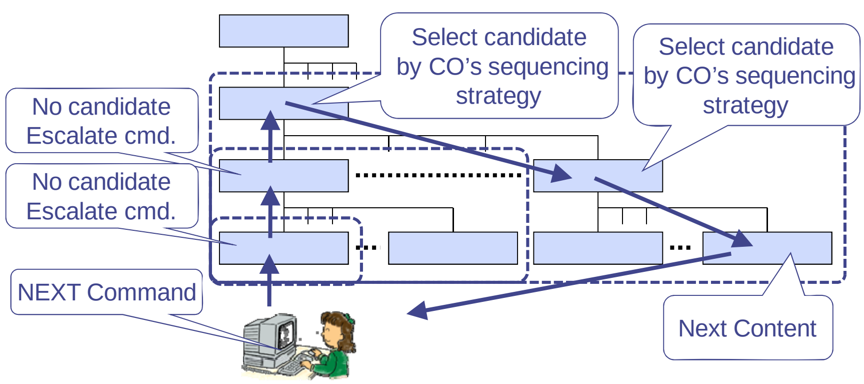

Fig. 4. Communication Schema for Command Execution.

Figure 4 illustrates the process to determine the next content or next page presented to the learner in the hierarchical structure. First, the current courseware object presented to the learner receives the command from the learner. It then escalates the command to its parent to select the candidate for the next page from its children. If the parent cannot find a suitable child, it escalates the command to the grandparent. The grandparent makes its children select a suitable node from their children. This recursive behavior is repeated until a suitable candidate for the next page is found. This results in a behavior that gradually expands the search space for the candidate in the content tree from the local (the smallest sub-tree containing the current object) to the global (the entire content tree). The identified node for the next page will be presented to the learner, and its associated courseware object will be the new current object. Note that the criteria or pedagogical strategy to select the next node from the children may differ between courseware objects. They might implement a completely different strategy despite they can be integrated in one hierarchical structure.

2. Learning Design Specification

The LD specification is designed to promote the share and reuse of pedagogical strategy to achieve effective learning results by formally describing formations and sequences of educational activities. It is a pedagogy-neutral technical specification capable of describing various types of educational activities, including self-learning, lectures, and group study. However, the LD specification's notable feature is its capability to describe collaborative learning activities, which meets the recent trend of e-learning toward a learner-centered approach. LAMS [4], which is the most commonly disseminated learning tool based on the LD specification and is distributed as an open source software, has two types of communities, one for a system developer to update the system itself and the other for instructional designers to share and reuse descriptions of designed educational activities.

The LD specification defines a data model to describe learning activities. In the LD specification, the primary elements to describe learning activities are "activity," "role," and "environments." An activity uses several environments, including "learning objects" and "services." It also involves people with several roles, such as "learner" or "staff." The activity has an "activity structure," which is a hierarchical one so that the aggregation of activities becomes an upper-level activity. The above-mentioned description of learning activity can be represented using level A of the LD specification. With level B, the properties of a person or group and conditions for the sequence of activities can be described. In addition, events resulting from certain activities, such as notification of a question from a learner, can also be described.

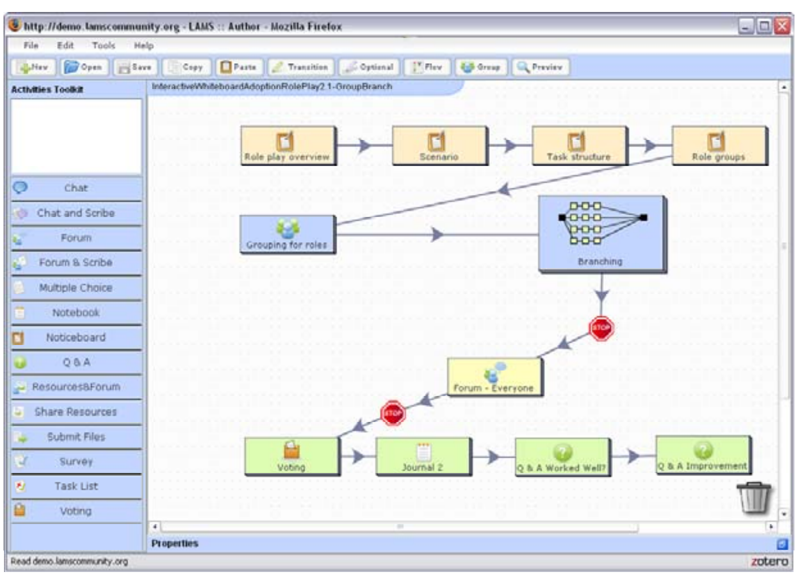

Fig. 5. Learning Activity Design by LAMS (© James Dalziel).

Figure 5 is an example of a learning activity description in LAMS. Each box represents an activity assigned with one of various environments, such as document, survey, chat, or forum. The large box to the right of the middle is a hierarchical activity that has an internal structure with conditional branches. Each "stop" symbol is a waiting point where all the learners have to stop until every other learner finishes the previous activities. For example, before entering a synchronous forum, all the participants must finish the activities before the forum.

3. Implementation of LD Specification using ELECOA

3.1 Basic Implementation

Implementation of the LD specification using ELECOA was investigated. ELECOA was originally designed for self-learning; it was not intended to support group learners. However, both ELECOA and the LD specification deal with hierarchical structures. In addition, ELECOA has the capability to control learning activity sequences by means of courseware objects.

The investigation took into account these characteristics. With the LD specification, learners follow a predefined learning path in which they communicate with other learners and instructors by using communication tools such as chat or forum. The learning path varies according to the learner's own learning status as well as other learners' learning statuses. Thus, the following issues should be considered for implementing the LD specification using ELECOA:

(1) implementation of a learning path for each individual learner,
(2) integration with communication tools, and
(3) control of the learning path based on multiple learners' learning statuses.

The implementation is outlined in Fig. 6. First, the learning path of each learner will be controlled by the courseware objects in a similar manner to the original ELECOA behavior for self-learning in a hierarchical structure. The courseware object selects the next node to be presented to the learner according to the learner's status. This makes it possible to implement learning path control that takes into account each individual learner's learning status.

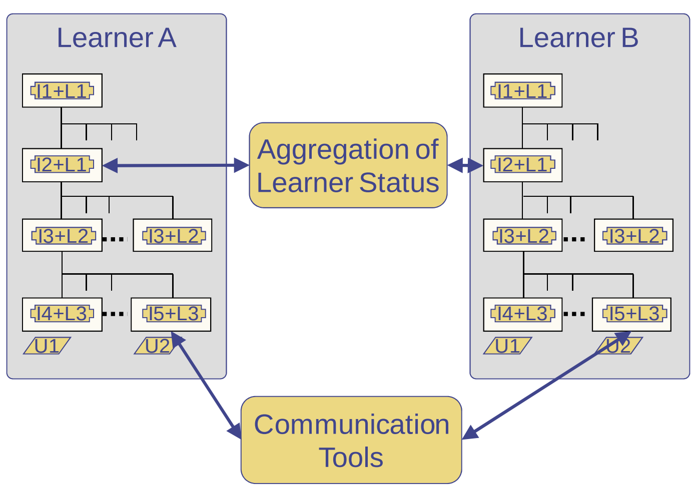

Fig. 6. Implementation of LD Specification.

Second, communication tools will be integrated as learning resources to be associated with the leaf node of hierarchical content. In the LD specification, communication tools and learning services are environments that also include learning resources such as static HTML documents or quizzes associated with the leaf node of hierarchical learning activity. Thus, in the ELECOA-based implementation, they are associated with the leaf nodes in the same way that the original ELECOA has learning resources assigned to leaf nodes.

Last, to reflect multiple learners' learning statuses in each individual learner's learning path, a courseware object will be equipped with the capability to exchange information with other courseware objects controlling the learning path of other learners. In this way, the courseware object can determine the learning resources to be presented by taking account of multiple learners' learning statuses. For example, Fig. 7 represents the situation in which the middle-level courseware object selects the next learning resource presented from candidate learning resources "1," "2," and "3." Note that learners A and B will be presented different learning resources depending on their own learning statuses. The learning resources may be replaced with the content sub-tree, which implements more complex learning control.

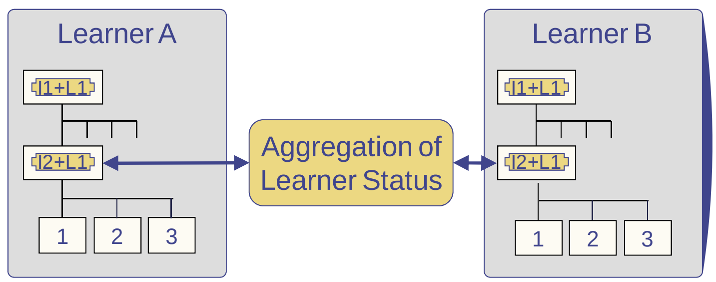

Fig. 7. Branch Structure Taking into Account Other Learners' Statuses.

It is important to point out that the basic framework of ELECOA is not modified to implement the LD specification. The framework defines the process of information exchange between courseware objects assigned to a hierarchical structure to determine the next learning resources presented to the learner. Since this framework is independent of the learning resources to be presented, it does not need to be modified if communication tools or learning services are assigned as learning resources. In addition, this framework simply defines the communication schema between courseware objects in the hierarchical structure, which is independent of the internal behavior of each courseware object, to control the learning path. Thus, the framework does not need to be modified if the courseware object, as its "internal behavior," exchanges information with other learners' courseware objects to control the learning path. Therefore, it is possible to implement the LD specification using ELECOA without modifying its basic framework but by simply adding learning resources and courseware objects for collaborative learning.

3.2 Extended Implementation

There are several possible function extensions in the LD specification implementation using ELECOA. First, group activity consisting of some subgroups can be implemented by associating communication tools with the leaf nodes in the branch structure shown in Fig. 7. In this way, subgroups of learners meeting certain criteria, such as learning status or personal characteristics, will be allocated to the same communication tool for a group learning activity.

Second, it is not necessary for all the learners to learn in the same learning structure. According to each learner's past learning status or competency, a different learning structure with a different learning path, such as for the role of leader or normal participant, could be prepared. Then the learners in different learning paths can interact with each other in the proposed framework.

Last, there is no limitation to the learning resources associated with the leaf node. It is possible to utilize various tools including Web2.0 tools. Since there are several standardized interfaces between LMS and e-learning tools, a learning environment could be constructed on the proposed framework with minimum effort by exploiting these e-learning tools with the standardized interfaces.

4. Conclusion

We investigated implementation of the LD specification using ELECOA, an extensible learner-adaptive environment enabling both functional extensibility and content interoperability. Although the original intention of ELECOA was to support self-learning, its extensibility may make it possible to implement the LD specification including group learning. With this capability to implement self-learning and group learning in the same framework, it would be possible to provide an integrated learning environment in which materials and learner history could be seamlessly exchanged between self-learning and group learning. We will further investigate and design in detail the actual implementation of courseware objects to execute the LD specification.

Acknowledgments

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Supporting the Reuse of Open Educational Resources through Open Standards

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Abstract: In this paper we analyse open standards for supporting the reuse of OER in different knowledge domains based on a generic architecture for content federation and higher-order services. Plenty OER are available at different institutions. We face the problem that the mere availability of these resources does not directly lead to their reuse. To increase the accessibility we integrated existing resource repositories to allow educational practitioners to discover appropriate resources. On top of this content federation we build higher order services to allow re-authoring and sharing of resources. Open standards play an important role in this process for developing high-level services for lowering the thresholds for the creation, distribution and reuse of OER in higher education.

Keywords: Open Educational Resources, Content Sharing, Educational Design, Open Standards

1. Introduction

Within the JISC E-Learning framework [1] different classes of E-Learning functionalities have been proposed. From the user perspective the core functionalities for the distributed management of open educational resources are search and browsing, viewing and publication of learning resources. The development of good resources for online teaching and learning easily becomes a time and resource-consuming task. Open educational resources (OER) are an approach for sharing and improving E-Learning material.

In the last years several initiatives have made OER available in many knowledge domains. While some examples of large OER repositories support the needs of communities from different knowledge domains, most OER repositories are focusing on learning objects from a discipline or a single institution. Although the availability of OER has been increased by several initiatives and projects, the accessibility for end-users remains low because useful OER are distributed across many different repositories. To identify these repositories and to search in each repository is one barrier for the large-scale uptake and reuse of OER. However, access to OER repositories and the ability to search them is not the only obstacle. Through our engagement in several international projects focussing on the improvement of accessibility of OER in different knowledge domains we developed a better understanding on the OER lifecycle. Open standards play an important role in this process for developing high-level services for lowering the thresholds for the creation, distribution and reuse of OER in higher education.

In this paper we share our experiences from these projects and report about how standards have been used for developing a generic basic infrastructure for search and browsing of OER as well as value-adding services. The projects related to this research share the assumption that a sufficient amount of educational resources is publicly available and that a better infrastructure and value-adding services are needed for increasing the resources' usage [2]. Two kinds of value adding services have been explored in the past and ongoing research. The first kind of services refers to applications that *use* OER to create additional value for learners. The second kind of services refers to applications for enriching information and composing new resources *on top of* OER. The result of the former kind of service is disconnected from the OER life cycle, while the latter kind of service feeds back into the life cycle and extends the pool of resources. Open standards support the development of both kinds of services by reducing development overheads through standardized concepts and interfaces.

In this paper we analyse the standards and specifications that have been used for value adding services. The paper is structured in three parts. In the first part we introduce the projects that provided the main input to this research. We discuss the OER life cycle in the second part. Finally, we relate the standards and specifications that have been used in our research to the different parts of the OER life cycle.

2. Project descriptions

This paper is based on the experiences from three main international OER projects over the past years. The principal structure of the projects is similar, but each project has a different focus on challenges related to the OER life cycle. The first project is the MACE project, the second project is the OpenScout project , and the third project is the Share.TEC project. This section briefly outlines the objectives and the scope of these projects.

2.1 MACE Project

MACE stands for 'Metadata for Architectural Contents in Europe'. The project developed an internet-based information system that links up major international architectural archives with data records about completed and presently planned construction projects. The knowledge domain of MACE is Architecture and Construction Engineering. This 3-year project (2006-2009) is co-funded by the *e*Content*plus* programme.

MACE offers a set of tools and services for accessing several resource repositories for architecture and construction education. These tools and services are made available through a central portal. The portal offers several ways of searching and accessing architectural content from several European architecture repositories: 'Filtered Search', 'Browse by Classification', 'Browse by Competence', 'Browse by Location', and 'Social Search'. These interfaces allocate various contents and real world objects from all over the world that are stored in the connected repositories. Through these functions both, educators and learners, can search and explore architectural content by using metadata for filtering, visualizing results, or defining search parameters.

By connecting several repositories, MACE assures a critical mass of educational resources and provides access to rich multi-lingual resources in the knowledge domain. Besides the metadata provided by the content repositories, the MACE services provide additional data such as competence descriptions and peer-rating. The enriched meta-data enables educators and learners to identify appropriate resources for specific learning tasks in formal education and self-directed learning in ongoing professional development.

2.2 OpenScout

OpenScout stands for "Skill based scouting of open user-generated and community-improved content for management education and training" [3]. OpenScout is a project co-funded by the European Commission within the *e*Content*plus* Programme as a Targeted Project in the area of Educational Content. OpenScout started in September 2009 and runs for three years. The knowledge domain of OpenScout is Business and Management Education.

OpenScout aims at providing an education service in the Internet that enables users to easily find, access, use and exchange open content for management education and training.

The management education market is highly diversified, training topics range from general management and leadership to very specific issues like risk management in the banking sector. Despite the increasing need for management education and content, the potential of already existing open learning materials is hardly exploited. The same holds for the business sector and SMEs, in which the need for lifelong competence development is even greater.

In order to reduce the barriers for accessing OER for management education, OpenScout offers easy-to-use skill-based federated search and retrieval web services, provides an openly accessible tool library for improvement and re-publishing of open content, and establishes an open community [4]. This community opens up its content to the public and adopts OpenScout web-services in real application contexts. OpenScout is available to learners as well as to education and training institutions that search for learning content to be integrated into their educational programmes.

OpenScout integrates metadata from several connected learning-content repositories in Europe. This assures that OER for business and management education is available in different languages and different target user groups.

2.3 ShareTEC Project

Share.TEC stands for 'sharing digital resources and practices in the Teacher Education Community' throughout Europe. This 3-year project (2008-2011) is co-funded by the *e*Content*plus* programme and is devoted to foster a stronger digital culture in the teacher education (TE) field.

Share.TEC has three main objectives. Firstly, it makes quality content for TE across Europe more accessible, reusable and exploitable. Secondly, it initiates a European network of communities in the area of TE. Finally, the project supports the sustainable and coordinated expansion of federated TE content aggregation. The project addresses critical aspects of using digital resources in TE. These aspects are: bridging cultural differences in TE, unlocking TE resources & expertise, connecting TE networks, and providing an effective brokerage system for TE.

The Share.TEC project team develops an on-line platform that helps practitioners to search, access, and exchange OER for TE. Grounded on the critical mass of OER in the partners' repositories, Share.TEC encompasses a wide range of types of resources, including material suitable for formal, structured TE. Furthermore, the system covers content suitable for individual and self-guided continuing professional development, for supporting collaborative learning, as well as schemata or plans that model reusable learning paths.

With the focus on making quality content for TE across Europe more accessible, reusable and exploitable, Share.TEC provides integrated access to different databases. This integration is supported by the development of new resources, which fosters constant enrichment and diversification of the available OER for TE.

3. The OER Life Cycle

All projects address several challenges related to the OER life cycle. The OER life cycle takes a holistic perspective on the creation, distribution, and reuse of OER. The OER life cycle adds collaborative authoring and knowledge extension to the value-adding process, while a typical value-chain perspective emphasizes content creation, distribution and usage of resources, in which the content users are the main beneficiaries. As this is a major concern for content developers and content owners, it is important to create solutions to support content users to re-inject their extensions, experiences, and solutions into the value-adding process.

The OER life cycle has four main phases: authoring and composing, publishing, finding and accessing, as well as content-federation and enrichment. Figure 1 illustrates the relation between the four phases.

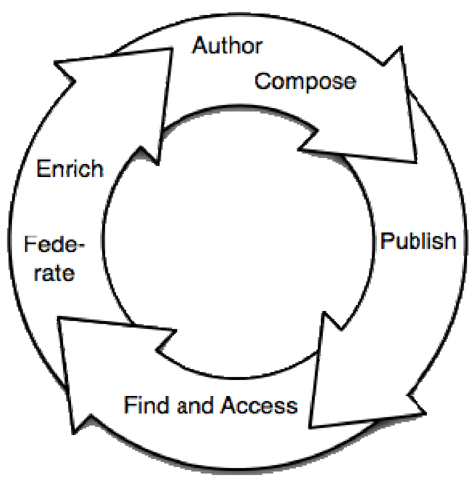

Fig. 1: OER Life Cycle

The cycle starts with the *authoring* of a resource. Resources can be pieces of text, images, multi-media documents, or videos, but also complex structures such as instructional designs, or course packages.

The second phase is *publishing* the resource to an OER repository. Typically, this phase includes not only the upload into a repository but also the licensing of the resource as well as the definition of meta-data for the resource.

The third phase include *finding and accessing* resources in a repository. In this phase an OER repository has to provide interfaces that allow to search and to retrieve the resources that are stored in the repository. These interfaces can be present for human-computer interaction, but also for automated agents to access the repository.

The fourth phase refers to *content-federation* and *enrichment* of the meta-data of a resource across repositories. *Content-federation* describes the integration of resources of different repositories into a single meta-repository. Meta-repositories do not store the resources themselves but only keep track of links to resources and resource meta-data. Therefore, they are also called "referetory" as a short form of "reference repository". In these repositories it is also possible to *enrich* the meta-data for resources through community-based information, such as additional keywords (tags) or competence related information.

The last phase leads to an extension of the first phase in which existing resources are *re-authored* according to specific needs or in which several resources are *composed* into more complex resources. The task of composing new resources from existing resources is slightly different from normal authoring, because the resources that are used in this process typically remain unaltered.

The MACE project focused mainly on the phases: publishing, resource access, content-federation, and enrichment. Share.TEC addresses problems of content-federation, enrichment, and composition. OpenScout mainly focuses on practices of supporting enrichment, re-authoring and composition.

4. Open Standards and Specifications for Value-adding OER Services

In the presented projects we were heavily relying on open standards for developing new or integrating existing OER services. Through defined concepts, data formats, or interfaces open standards support the development of high-level services for adding value to OER. This section discusses which open standards and specifications were used for supporting the different phases of the OER life cycle. Figure 2 summarizes the relation between the OER life cycle and the standards and specifications used by the projects.

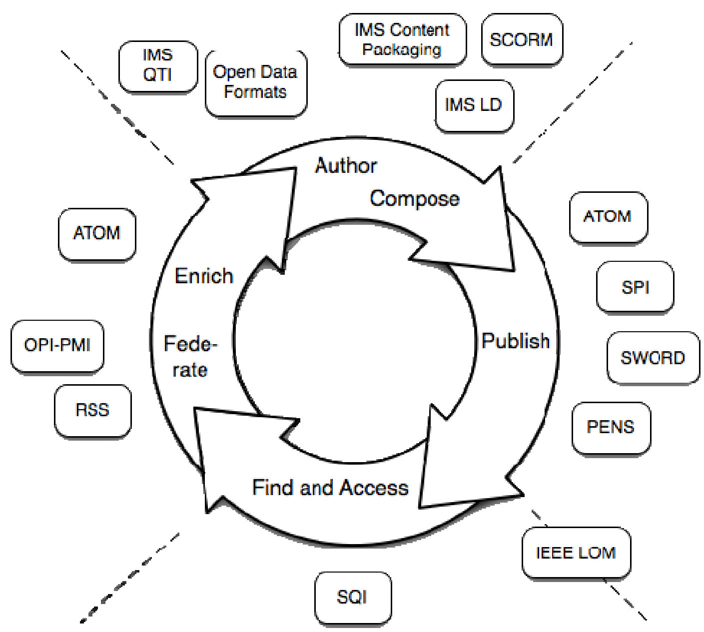

Fig. 2: OER life cycle and related open standards

Open document formats are an important foundation for authoring and re-authoring OER. Besides the prominent HTML format and its variants, the IMS QTI format [5] has been gained some attention for creating and exchanging test-based assessments. Although a range of open document formats exists, by far not all OER are available in these formats.

Another form of authoring educational resources is the composition of complex resource-packages from single resources. Composing of resources has been recently addressed on a large scale by the TENCompetence project [6]. The most prominent specification for composing resources is SCORM [7] and the related IMS Content Packaging specification [8]. These specifications mainly focus on the combination and sequencing of resources. For more complex educational arrangements the IMS Learning Design [9] specification is recommended. Within the GRAPPLE project Gruber and colleagues [10] have analyzed how MACE resources can get integrated into personalizing educational designs in IMS Learning design. While at large the integration is feasible, the interplay between interactive resources and the educational design rules required fundamental adaptation of existing resources.

Publishing resources to OER repositories is a key threshold for content authors. The process includes two aspects. Firstly, the authors need to be able to upload resources to a repository. Secondly, the authors need to specify appropriate meta-data for their resource.

For publishing exist several solutions. These include solutions include the Simple Publishing Interface (SPI) [11], the Simple Web-service Offering Repository Deposit (SWORD) or the Package Exchange Notification Services (PENS). Furthermore, the Atom Publishing Protocol [12] has gained increasing popularity for web-services. SPI allows publishing with bindings. This allows the development of publishing services and applications for repositories that support different publishing protocols. For example, an SPI binding for the Atom Publishing Protocol has been developed.

For exchanging meta-data the IEEE LOM specification [13] has been established for OER. This simplifies the publication and the exchange of resources. IEEE LOM provides a core vocabulary for educational meta-data.

At the level of finding and accessing resources in OER repositories, it is useful to provide interfaces that allow automated access to the repository. Particularly for integrating repositories for providing better access to OER in a domain this step is crucial. The ARIADNE foundation [9] developed an API to query learning objects within ARIADNE repositories from outside. Similarly, European Schoolnet developed a search API based on Java Messaging Service [15]. Edutella [16] and LOMster [17] wrap educational repositories in peer-2-peer networks. This work was brought to CEN ISSS for harmonisation resulting in the Simple Query Interface (SQI) [11]. Since then SQI has been widely implemented and supported by repository federations.

One of the first steps in the MACE project was to improve the accessibility of open educational resources from several repositories in a so-called *federated architecture*. The standards Atom [12], RSS [18] or OAI-PMH [19] are recommended for distributing metadata. Ternier and colleagues [14] compare two different main strategies to realize a distributed search in multiple learning object repositories. In the “federated search” strategy search requests are distributed to the original repositories. This has the disadvantage that the reliability and speed of the search process depends on the slowest repositories in the federation. The other alternative is the “metadata harvesting” strategy where the metadata are collected on a central server and search requests are only submitted to this local metadata repository. In the projects presented in this paper the second alternative has been proven to be the most reliable and the fastest solution.

On top of a federated architecture it is possible to build higher-level services to enrich the metadata in the federated repository, such as tagging, rating, or competence development services. Enrichment services can get built on top of the Atom Publication Protocol for injecting additional information into metadata system. These services often remain unused [20], although they hold the potential to improve the quality of search results and to connect users and resources [21].

5. Conclusions

In this paper we analysed the relation of open standards for developing value-adding services for the OER life cycle. From the experiences of three international projects we identified the role of different standards and specifications for supporting the uptake of OER in higher education. The applications of open standards for publishing, for searching and for content-federation lead to a well-established value chain that support the development of OER services. This value chain is partially extended by open-standards-based services for content sharing, for content enrichment, for re-authoring, for repurposing, and for composing complex resources. However, it appears that the related standards and specifications require more alignment and support in order to lower the thresholds and make it easier for educational practitioners to benefit from the OER principle.

Acknowledgements

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Workshop

Workshop on New Paradigms in Learning: Robotics, Playful Learning, and Digital Arts

Workshop Organizer

Maiga Chang (Athabasca University, Canada)
Eric Zhi-Feng Liu (National Central University, Taiwan)
Hao-Chiang Koong Lin (National University of Tainan, Taiwan)
Hung Cheng Chen (Chinmin Institute of Technology, Taiwan)
David Crookall (Université de Nice Sophia Antipolis, France)

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Preface

Robotics, playful learning, and digital arts are emerging research topics, which attract a lot of interdisciplinary researchers involved in it. The goal of this workshop is to discuss the future issues of new paradigms in learning: Robotics, playful learning, and digital arts. This workshop provides a forum, with paper presentations and demo sessions, for researchers and practitioners from various discipliners to exchange ideas. Moreover, this workshop is planned to be a place where people in arts can meet with people in IT, having strong ties to arts in their works.

The workshop plans to use one day and divides it into three academic paper presentation sessions, one panel discussion, and one further collaboration session. In the paper presentation sessions, the workshop will provide the audience opportunity to know the state-of-the-art research in robot supported education, learning by playing, and digital arts for learning. Moreover, most of researches and presentations offer audience hands-on opportunities. At the panel session, the workshop invites couple of panelists to discuss "Virtual or Reality? Whether Robots or Agents are Better for Learning?" At the end of this workshop, the further collaboration session offer attendees a platform and channel to discuss the problems they have encountered; to plan their long-term research direction in the context of building connections between researchers and/or educators; and, to propose practical and/or research-oriented projects across geographical borders.

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Implementing an Interactive Digital Artwork Based on Concepts of Concrete Poetry

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Abstract: In this paper, we create a digital artwork based on the concept of concrete poetry. This work is to present interactive poems which are established by combining sounds and text-based poems. The artwork was exhibited from March 6th, 2010 to April 11th, 2010 in TaipeiDAC. Most audiences felt emotionally fulfilled while interplaying with this artwork.

Keywords: Interactive artwork, concrete poetry, digital poem, human computer interaction

Introduction

In the past, artists presented their artworks of domain or private space based on non-interactive visual creation. With the progress of information technology development, people can create art by using the digital multimedia rather than just doing in a traditional manner. That is, the way of art-creating has changed dramatically. Thus, the digital art creation becomes more lively and interesting. Furthermore, these materials/technologies enhance the artists' creativity. Artists are able to create artworks via technologies and multimedia; that is to say, they can create artworks with the multimedia besides the traditional way of creating arts, so they can create in more fashions to express their thoughts. Today, as the computing technology is more and more advanced, artists can create artworks with the help of the powerful computing which calculate the input information in real time. The process of artwork creation is charming because it is no longer a presentation of a phenomenon but a manifestation of an experience.

Interaction has been considered as an important characteristic of digital artworks. Nevertheless, the evolution of the aesthetic viewpoint is seldom mentioned. Above all, the experience of participating plays the essential role of creating artworks, which forms the "interactive aesthetics" gradually. What is stated above are crucial concepts in new media art [1][2].

Along the lines of "The End of Art", Arthur C. Danto states that the function of art imitation and reappearance has already disappeared. From now on, emphasizing the verisimilitude imitation is also redefined in the art history [3]. The text should be open to and created by readers. Moreover, the meaning of text is interpreted by readers instead of authors. This is the well-known "writable text" concept [4]0.

Stephen Wilson [5] supposes that interaction means the manipulator, browser interface and audience are able to have an effect on one another. Because of the changeable computer art Interactivity, Christine Tamblyn [6] and Binkley [7] consider computer art interactivity to be a form of conceptual art. In our work, based on concept of concrete poetry and the interaction between the audience and Chinese characters, we create digital poem.

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Concept of Work

Oftentimes, we need some stimulus to refresh our memories and lake water is like memory. It needs outside force to cause rippling. That is, stimulus is to memory what outside force is to lake water. Similarly, in this work, pixels in frames are necessary because only changes of them can provoke reaction.

The image of a person is formed by the sense of sight and mostly the sense of hearing. We see the person and receive some information about the person from others. Then, our brains arrange these messages in a specific fashion. Therefore, the image of a person is depicted through words and partly via what we see. Likewise, this work plays a role of presenting the shape of someone or something through the arrangements of Chinese characters and thus the image of the work is shown.

Concrete poetry is the combination of poetry and painting. Therefore, we have to not only read the poetry with brain but also appreciate it with eyes and heart. Based on what Wang, Wei (8^{th} century Chinese poet) said "Painting lies in the poetry and poetry also exists in the painting", the highest level of reading poetry is reading it as admiring the painting. If we can experience what Wang, Wei said, we can enjoy poetry as well as paintings.

Implementation of Work

This work presents interactive digital poem by the movement of objects' contour. In recent years, researchers and artists use the Processing programming language to create digital artwork [8]. A system (written in Processing [9][10]) is established where the digital poem is generated by combining sounds and text-based poems. In other words, the system acquires two kinds of inputs: (1) a sound file which was produced by the artist before, and (2) a modem poem which was written by the artist.

1. System Architecture

As for the development of the system and demo environment, we use a PC with Pentium (R) Dual-Core 2.6GHz CPU, Logitech Pro 9000 as the webcam, which captures 30 frames per second. The frame size is 640×480. In system flowchart (as depicted in figure 1), the webcam captures video frame and sends it to the system. The system extracts pixel in stream frame and detects contour (Contour Detection [9-12]) of stream frame in real time. If the system detects contour, it will extracts RGB component of pixel and label the contour. Then, each pixel is labeled and turn into colorful Chinese characters which make up the poem. The system will generate a sound when the pixels of each frame reach a certain number. The image on the monitor presents a concrete poetry while people are interacting with the system.

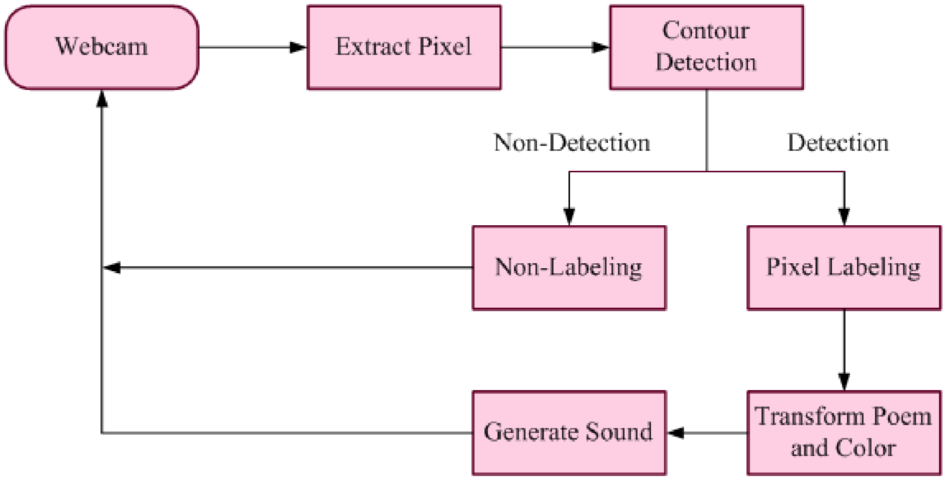


Figure 1: System flowchart.

2. System Implementation

Speaking of the installation of artwork, the PC is placed inside a white box. On the white box lie two lightweight fans in order to avoid overheating which may cause computer to crash, as Figure 2 shows. Besides, the HD LCD monitor is hung on the white wall and a black cuboid box is upon the monitor. The webcam is situated in the center of the black cuboid box, as Figure 3 shows. Figure 4 is an image of audience interacting with the system. A child and his father interacted with system and the child seemed very interested in interacting, shown as Figure 5. Figure 6 also shows how audiences interact with system. In Figure 6(a) there are three people in front of the webcam. As we can see in Figure 6(b), someone is taking a picture in front of the webcam. Seeing these interactions, we know that the image on the monitor generates a concrete poetry that combine with digital poem.

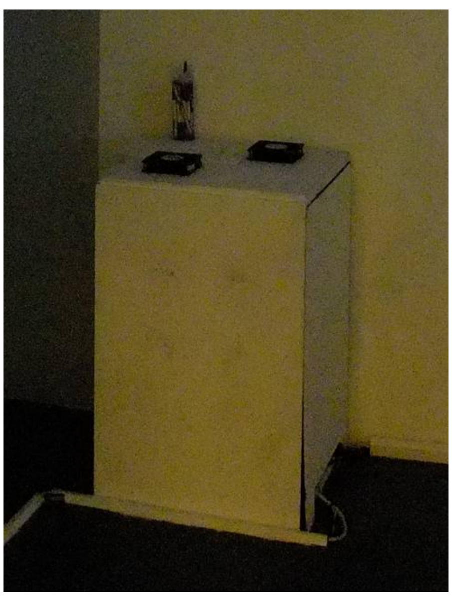


Figure 2: Installation of the white box

Figure 3: Installation of the monitor

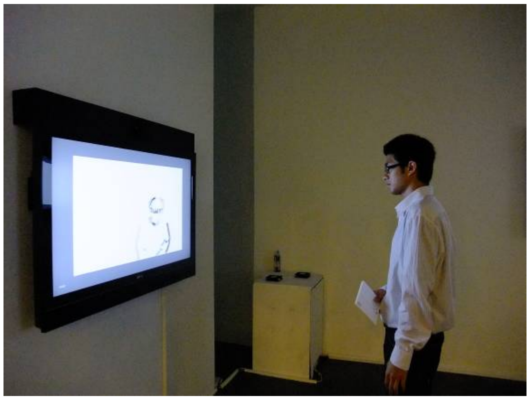
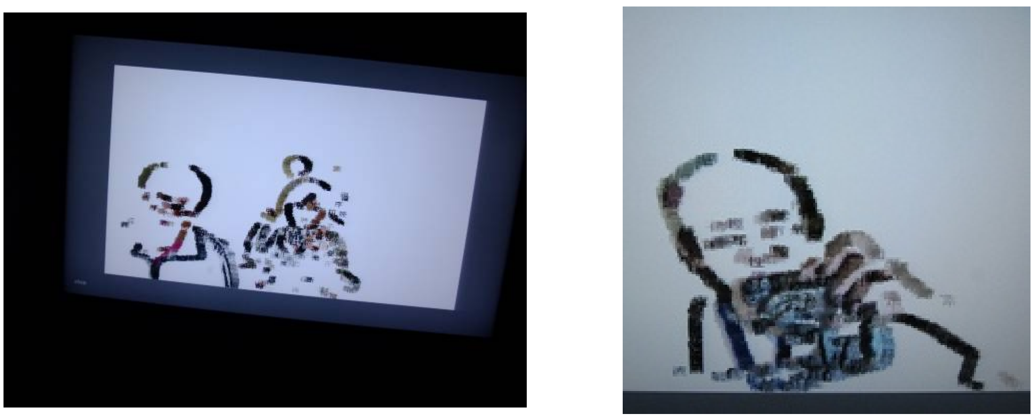


Figure 4:
The audience interacts with the artwork.

Figure 5:
The audience interacts with the artwork.



(a) (b)

Figure 6: The concrete poetry

Conclusion and Future Work

We implement interactive digital poetry by contour motion of people or objects. The interactive digital poetry is an interesting and novel device for artworks which combine concept of concrete poetry. The artwork was exhibited from March 6th, 2010 to April 11th, 2010 in DAC. Most audiences felt emotionally fulfilled while interplaying with this artwork. The system was so robust that it never crashed during the exhibition. In the future, we will assess the interactive usability evaluation of this work and put this work on the Internet and apply it to more aspects, so that the audience can interact with digital poem on the webpage.

Acknowledgements

We would like to thank TaipeiDAC (Digital Art Center, Taipei) in Taiwan for inviting us to take part in the artworks exhibition which is from March 6th, 2010 to April 11th, 2010 in DAC (http://www.dac.tw/). We also thank the National Science Council of the Republic of China for financially supporting this research under Contract No. NSC 99-2511-S-024-005 and the anonymous reviewers for valuable comments.

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Geometric Arts Through Botanical Patterns

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Abstract: In this paper, we describe a creative work on how digital documentation of plant and flowers in daily life can be used for exploration of geometric arts and pattern generations. Garden with plants and other inhabitants is a place of thousand secrets, which we explored and discovered through a documentation of an interactive art work entitled, Garden of Pattern (Koo, Lim, & Chin, 2009). It is a flash-based pedagogic and instructive interactive program. This paper/workshop intends to explain the processes and the tools used for creating the artwork, from the conception of idea to the completion stage. The workshop will provide a communication platform with the audience on how this digital documentation of botanical patterns can be made easier through camera, and how Adobe Flash can be used as a tool for drawing and generating patterns from plants. Future direction of the research on this project will also be shared with the audience.

Keywords: Patterns, mathematics art, geometry, interactive art, Adobe Flash

Introduction

Pattern can be defined as arrangement of shape(s), outlook(s) or behavior(s) with regularity, order, repetition, and scale. Pickover(1995) defined pattern by including visually interesting shapes and themes as patterns, where the visual can be extracted from human, nature, and mathematics. László Orlóci (2001) explained about natural pattern needs to be observed and discovered before an understanding of natural phenomena can begin. Pattern is a main concern to all fields of natural science. Natural patterns are dynamic and able to manifest the complex dynamic processes in nature. Many natural patterns share a similar process of formation called "self-organization" (Camazine, 2003). It happens in a wide range of processes in both living and nonliving systems. Those processes are characterized by simple "rules" that depend solely on local interactions among the subunits of the system (Camazine, 2003, p. 36).

2. Patterns and Geometric Arts

Botanical patterns have a strong linkage with geometry and mathematics. Although the patterns are extracted from nature, they can be interpreted mathematically. The following show an examples of our findings, which was described in a prototype of our Interactive works, namely Garden of Pattern (Koo, Lim & Chin, 2009). In the workshop, we will demonstrate the work, and present more findings:

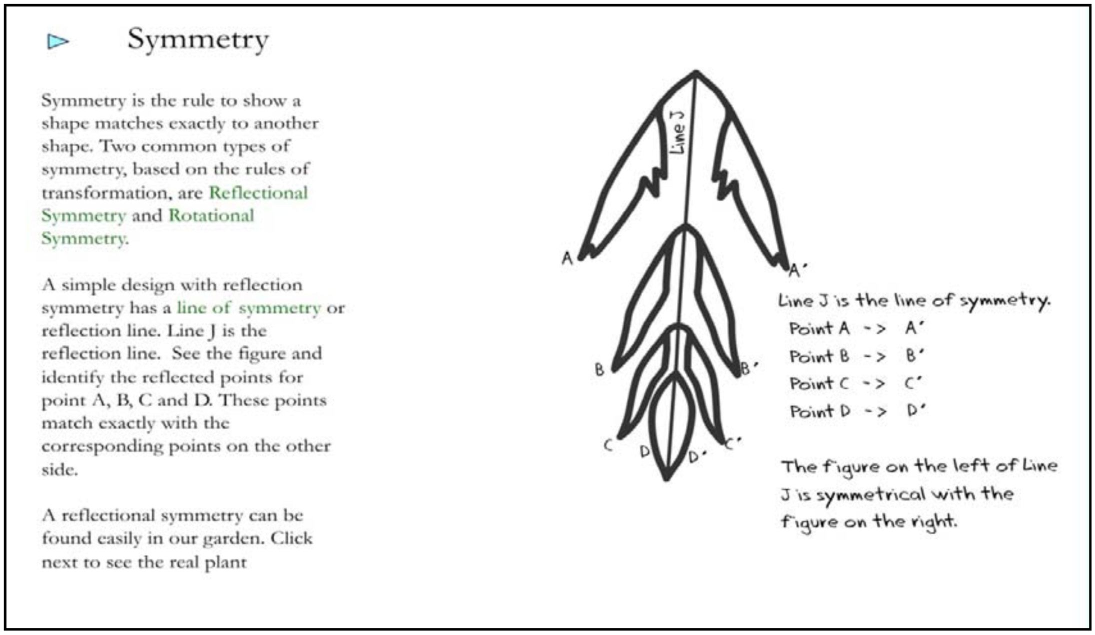

Figure 1: An example of findings of the relationship of geometry and botany nature.

3. The Processes (To be described in the workshop)

The core part of this workshop will be the description and explanation of the design and development processes of this artwork. The processes are quite straight forward, which consist of the following key steps:

Step1) Conception of Idea
Step2) Data gathering, analysis, and writing of findings/scripts
Step3) Design, and alternative design process
Step4) Development and refinement cycles
Step5) Final testing and checking
Step6) Completion and Exhibit (of Prototype).

The following are some of the snapshots (captured documents) showing the steps of the above processes.

Step1) Conception of idea, by writing a brief description of the project, and plans.

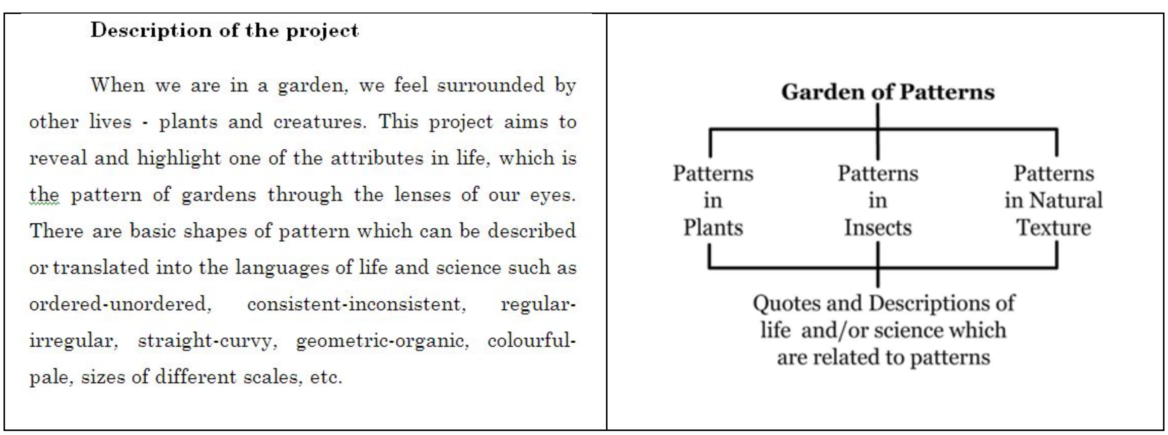

Figure 2: A brief description of the project and plan for contents.

Step2) Data gathering, exploration and classification/categorization.

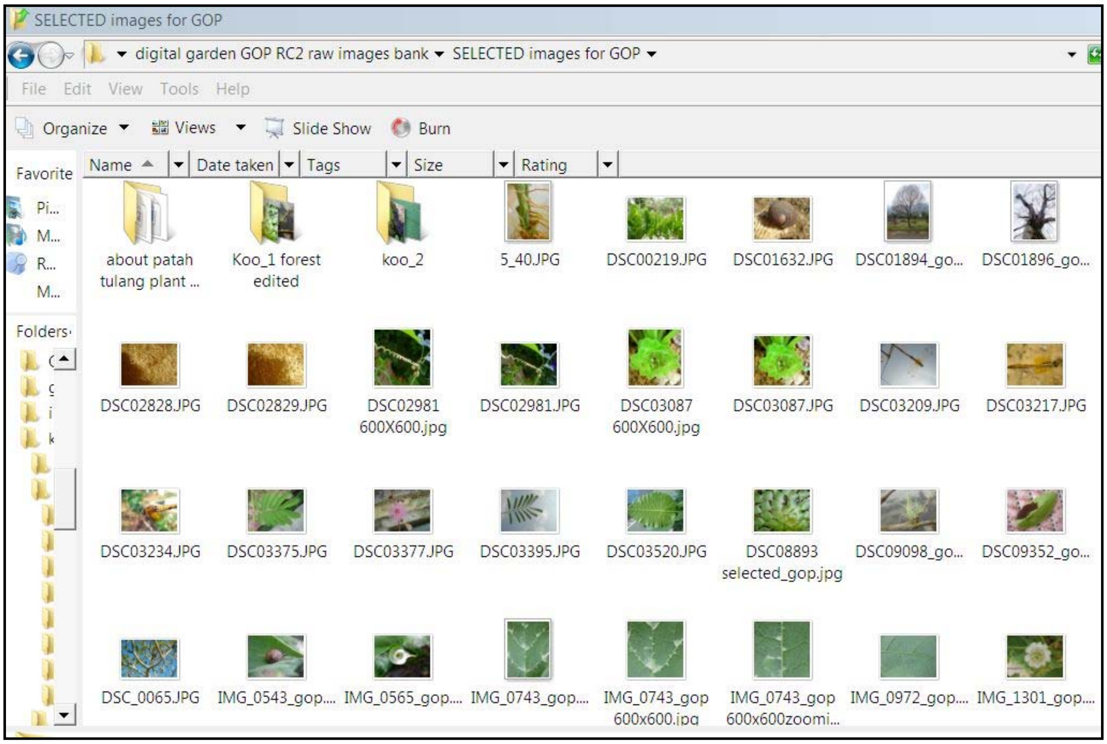

Figure 3: Collection and categorization of visual data of nature.

Step2) Writing of findings and scripts

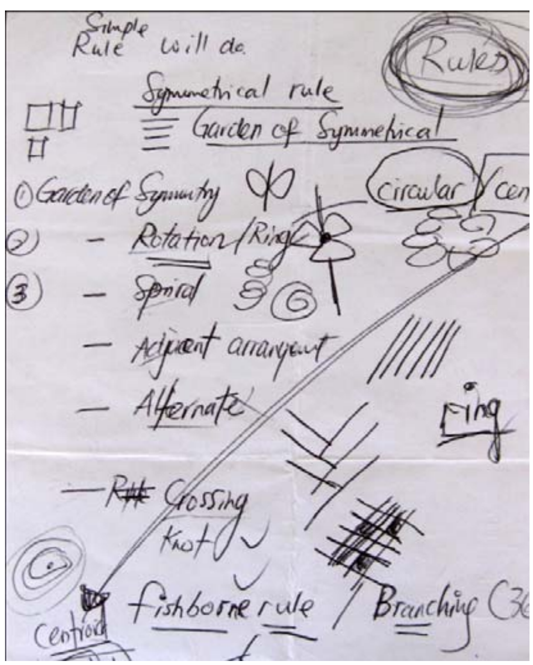

Figure 4: A sketch of how the findings should be outlined and written.
Library research was also conducted.

Step3) Design and alternative design, from initial to final stage.

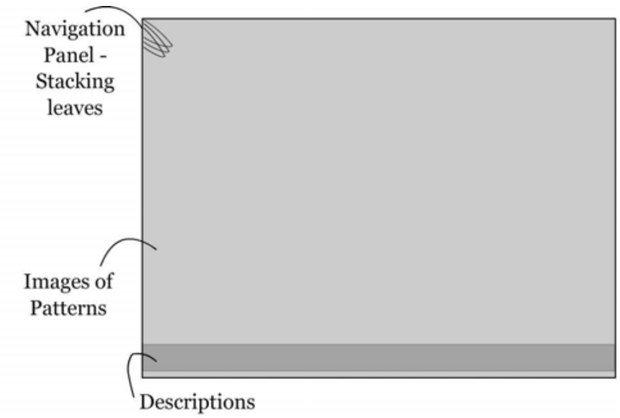

Figure 5(a): An initial layout design

Figure 5(b): A stack of design documents which consist of storyboard, thumbnail view of storyboards, and sketches of graphics elements.

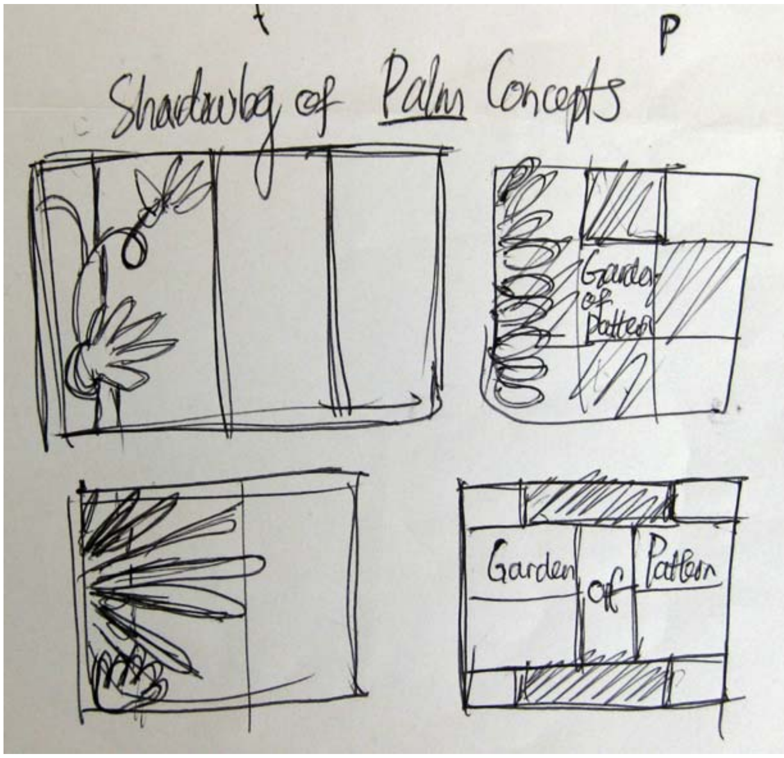

Figure 5(c): Almost finalization of design idea which was based on Palm tree.

Step4) Final Design, development and refinement on screen/computer (authoring environment)

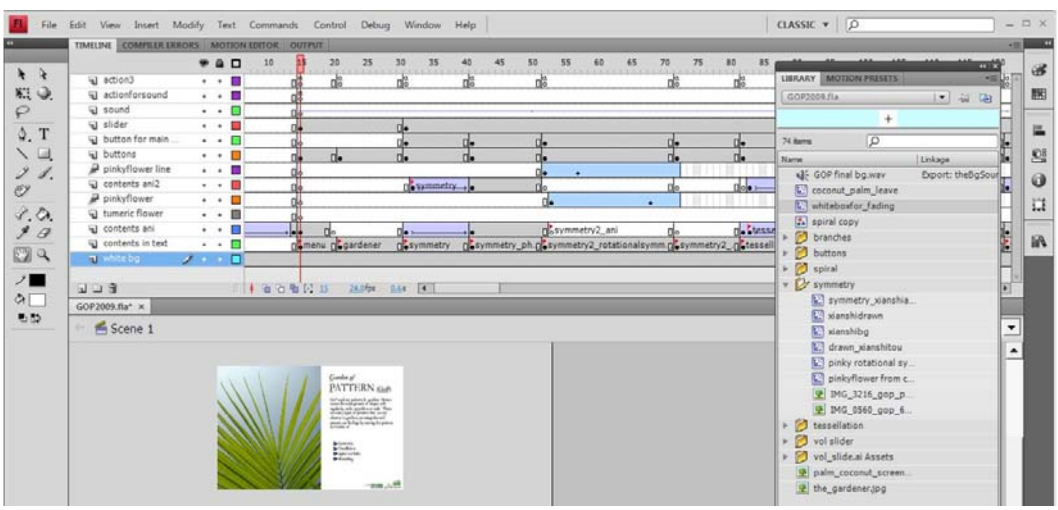

Figure 6: A screen capture of timeline structure, library assets and stage in Adobe Flash authoring environment.

As for the Development process, Adobe Flash was used for creating the interactive program. This workshop will also describe an overview of Flash, especially its Drawing tools, and how Flash can be used to create an Interactive Program with the contents on patterns and geometric arts.

Step5 & 6) Testing and Exhibit

Figure 7: The final prototype of Garden of Pattern (GoP), an interactive and instructive artwork based on botanical pattern.

4. Garden of Pattern (Final description)

This work is a simple Flash-based interactive program, with some photographs captured from gardens, classified into various categories of patterns. We do not need a big garden for doing this; our small tropical gardens at the backyard are adequate. Through observation and library research, we begin our creation journey by finding certain rules which govern the patterns. In this prototype, we classify them into a few categories, such as Garden of Symmetry, Garden of Tessellation, Garden of Spiral and Helix, and Garden of Branching. We dissect and build our understanding based on these rules. For each category, there is an overview and descriptions on the rule(s) itself and followed by the example of patterns. The future work of this project is to expand the findings to other geometrical categories and also to add more visual data for each category.

5. Conclusion

Through this workshop, audiences who are interested in content based interactive works will be able to learn how an interactive project was created, from initial to final stage. Through this project, we realize the various rules which govern the pattern in our gardens. We can then see the patterns and understand them from the science and art point of views. We also realize that environmental factors will cause some changes on patterns, and gradually emerge into another set of nice looking pattern.

Acknowledgements

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Developing a Mobile Learning Environment Based on Augmented Reality Technology

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Abstract: In this study, we establish a mobile learning system with the technology of augmented reality. A theoretical framework of learning by experience is applied to interpret findings. We conclude that three themes of interaction and conversation, double-loop learning, and technology supports have a major impact on students learning performance.

Keywords: Mobile learning, augmented reality, learning by experience

Introduction

An up-to-date report mentions that mobile devices have been widely used for more than 4 billion subscribers [1]. More and more individuals use software application, with augmented reality technologies, in mobile camera-screen devices to explore interesting subjects under study. This advantage provides an opportunity for learners to identify the subject and its relationship with context. Moreover, by participating in a real world, students are able to experience in authenticity and relate those findings with the surroundings that enriches their understandings.

There is a lack of mobile learning environment with augmented reality to help students learn from an authentic world. Furthermore, researchers lack of knowledge about students' learning effects based on the idea of learning by experience.

This study has established a mobile learning environment supported by augmented reality technology. Additionally, we used this developed system to investigate students' learning effects supported by a theoretical framework of Kolb [2].

Literature Review

We believe that mobile learning provides learners with great opportunities to learn with experience. While participating at authentic context, learners use the technology of augmented reality to help them to discover the unknown. To better understand related articles researched, the following sections of (1) learning by experience, (2) mobile learning, and (3) augmented reality is discussed.

1. Learning by experience

Learning by experience refers to learn through experiencing the reality and transforming experience. The goal of learning by experience focuses on help learners more deepen understanding the learning topics related to context than merely understand preexisting facts [3]. A key element of learning by experience emphasizes the needs of reflecting on their findings from learner experience [4]. To obtain own knowledge, Awad and Ghaziri [5] argue that learners need to share their understandings and make own meaning while experiencing the learning topics.

Nonaka and Takeuchi [6] argue that learners adapt learning strategy to learning by experience help them enrich an individual experience and obtain own knowledge. Furthermore, learners need to learn from concrete experience, reflective observation, abstract conceptualization, and active experimentation to implement the transformation of experience [2] and creation of knowledge [7].

Furthermore, Kolb [2] provides a conceptual underpinning of learning by experience from four different dimensions that help researchers evaluate its effectiveness. We focus on the “learning styles” component, which is an actual learning activity, as a theoretical framework to support this study (see Figure 1).

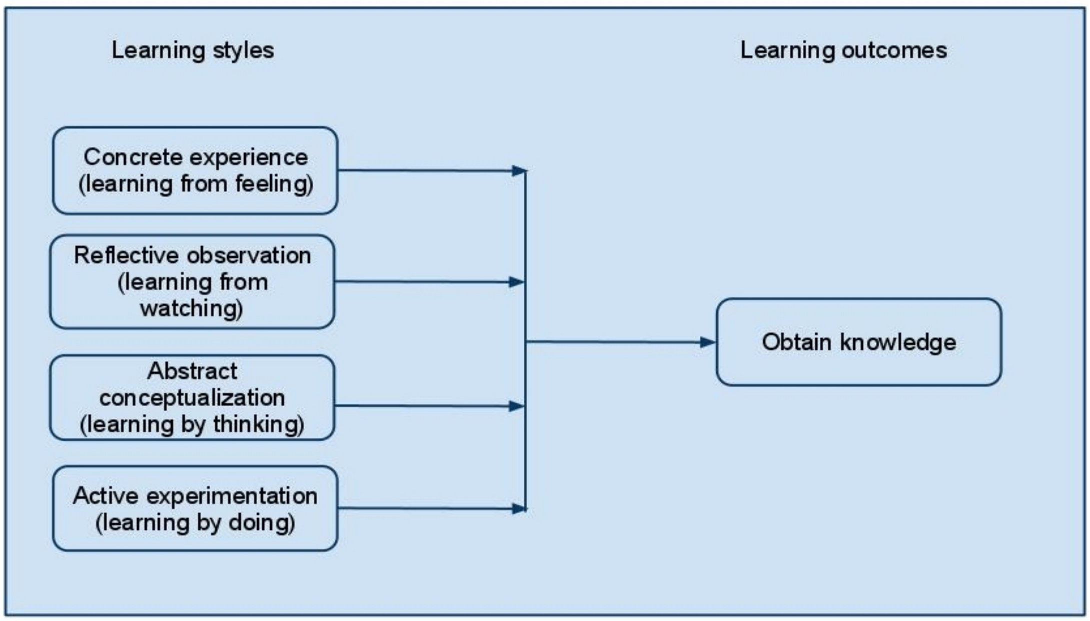

Figure 1: A description of four learning styles of learning by experience as related to students’ achievement and this study inspired by Kolb [2]

The idea of experiential learning suggests students to obtain knowledge beyond the limits of indoor classroom activities [8]. Nowadays, mobile phone has been widely used for information collection and for sharing ideas anywhere and anytime.With the help of innovative technology, mobile learning provides learner opportunities to obtain knowledge in an authentic context.

2. Mobile learning

Mobile learning is learning that occurred when the learner applies mobile technologies in learning activities. Mobile learning, through the use of camera-screen and Internet connection, facilitates students to construct their learning experience by instant interaction with learning subject and other learners [9]. On the benefits of mobile technology innovation, learners are able to interacting with learners and soundings at anywhere and anytime to construct own knowledge [10].

The GPS function, a location-aware function embedded in a mobile device, provides learner opportunities to identify the subject under study. With the application of GPS technology, students are able to grasp information from the database based on the students’ locations to explore findings and then apply understandings for future research. Additionally, the integration of camera-screen and GPS provides a bridge between the physical and digital worlds that help learners identify the learning subject and understand a broad context.

The application of the mobile device, integrated with wireless and software resources, becomes a tool for study and survey. An annual report suggests a mobile phone with an application of augmented reality has growing tendencies that help students to learn in authentic worlds [1].

3. Augmented reality

Augmented reality (AR) is a system that applies virtual computer-generated information in live view of the surrounding real world of the user as a way to supplement the physical real-world environment [11][12][13]. The theoretical sources of AR come from Milgram and Kishino's Reality-Virtuality Continuum [14] and Mann's Mediated Reality Continuum [15]. This framework considers that reality may be modified by devices in various ways, deliberately or accidentally. As a result, the technology potentially enhances one's current perception of reality.

Augmented reality combines reality and virtuality to demonstrate an information layer on top of the user's real world view. To accomplish this combination, AR system needs the hardware devices to identify the users and the objects in the physical context. Modern AR systems use one or more of the following technologies to recognize the user and the object, such as magnetic, ultrasound, inertial, accelerometer, UWB, optical, GPS, Wi-Fi, and hybrid [16]. The user's pose and position can be tracked to provide a three-dimensional interaction with the objects for the augmentation of the user's view. With the help of the head mounted or spatial displays, users can have immersive experience and collaborative work from the AR systems. However, the cumbersome hardware components are not satisfied with the requirements of portability and ubiquitousness for current AR applications.

Recent advances in mobile computing have enabled a new type of augmented reality systems and applications. Mobile AR systems employ a small computing device with digital cameras, GPS, gyroscopes, and solid state compasses that often fits in a user's hand. Most mobile AR machines adopt video see-through techniques to overlay the graphical information to the physical world. Machines that fit the user's environment, instead of forcing users to enter theirs, help overcome the problem of information overload [17]. Current mobile AR applications have virtual character-based applications, cultural heritage, edutainment and games, navigation and path-finding, collaborative assembly and design, and industrial maintenance and inspection [18]. There are still important challenges confronted by mobile AR applications, which are limited computational resources, size and weight, battery life, ruggedness, tracking and registration, 3-D graphic and real-time performance, social acceptance and mobility, and networked media [18].

AR has been used in the field of business and education to create state of the art in knowledge transfer for learning. The marker-based augmented reality applications help students better understand learning concepts and make more effective and interaction [19]. However, wireless mobile AR systems expand students' experiences and interactions by infusing digital resources throughout the real world. This type of mediated immersion aids students' engagement and understanding through embodied participation [20].

Research methods

The goal of this study is to establish a reliable mobile learning environment for students to obtain knowledge. We conduct two methods to help us understand the usability of mobile devices and the perceptions of students about their experience in learning activities. Two methods of: (1) implementing a mobile learning environment and (2) evaluating the effect of mobile learning based on a theoretical framework are described as followings.

1. Implementing a mobile learning environment

Mobile AR systems require many enabling technologies, including computing hardware, software, wireless network, tracking and registration, input and interaction devices, and displays. This study chooses the smartphone to demonstrate a mobile learning platform, because this handheld device combines powerful CPU, multi-touch and high resolution displays, digital camera, 3G networking, accelerometers, GPS, and solid state compass to a parsimony mobile AR equipment and frequently found in navigation and educational settings.

Mangrove ecology systems in Hsinfon area are the source materials that provide the content to be viewed in the AR browser (see Figure 2). Layar libraries are used to create the AR application. The Layar App combined with a mobile device allows the user to see the virtual objects augmented onto the screen of the real mangrove world. The Layar Developer API is used to create mangrove content layers and submit them via the Layar Provision Website to be added to the Layar service. A smartphone is required to test and demonstrate the application. The demonstration shows how location and objects recognition permits the real-time context to be augmented directly onto the screen. Observers are able to see for themselves how augmented reality visualization assists in their understanding of the mangrove ecology systems. Data collected from five learners have identified this as a highly portable, ubiquitous, and effective system, expected to be of great benefit for learning.

2. Evaluating the effect of mobile learning based on theoretical framework

This study use the framework of learning by experience provided by Kolb [2] to measure student achievement by using mobile phone embedded with augmented reality technology. A focused group study has conducted to investigate the feedback of students. Five college students are chosen to a selected location, where they have never been there before, to experience the learning topics. Open-ended questions have been asked and students are allowed to interact with others to answer the questions with paper-pencil. Data has transformed into text and typed into computer for analysis.

Figure 2: A picture of Mangrove environment through camera-screen of a mobile device with augmented reality.

Discussion

After data analysis from feedback of the focused group, three themes of (1) interaction and conversation, (2) double-loop learning, and (3) technology supports were found. Each theme is described at the following section.

(1) Interaction and conversation: Students find it is an interacting experience to interact with mobile device to retrieve information from a database for identifying learning subjects. Through conversation with each other, students are able to share their understandings and help them clarify findings.

(2) Double-loop learning: after the content investigation, one student has researched further on the Internet to discover deepen understandings related to learning topics. This effort also triggers other students to identify their previous beliefs and then transform their experience.

(3) Technology supports: Students use mobile devices to connect their thoughts with contents and experience of individuals that motivate them toward a desired outcome. When learners participate in an outdoor learning activity, mobile devices provide a better learning opportunity beyond limitations of traditional face-to-face classroom. With the help of mobile devices embedded with augmented reality technology, students are familiar with subjects under study as well as an extent their views on a related study to the surroundings.

Conclusion

We found the dynamic nature of knowledge creation in a mobile learning environment with augmented reality. The learning topics, supported by mobile learning environment, provide historical facts and guide students to identify contents and context. Moreover, students apply three learning strategies of interaction and conversation, double-loop learning, and technology that enrich their experience and transform knowledge for new understandings. With research further on new understandings, learners begin to plan on solving an incoming issue and justify their assumptions, this action led to a new loop of knowledge creation.

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The Implementation of a Game Based Character Model E-Learning System

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Abstract: This study focuses on animal image through visual converted into digital role in the real digital games learning, for a characteristic animal in Taiwan as a blueprint, through literature analysis, game-based learning theory and the role of design, actual design and develops a game named "Wind Wings". The game used 2D and 3D technology, combined with cute animal shapes features and eco-park design; also eco-environment and animal knowledge-oriented are focusing on the correct values, at the same time, learners benefit knowledge about environmental conservation during the game.

Keywords: Digital games learning, Character design, Visual design

Introduction

Background and Motivation

In this day and age, "computer games" is the favorite of modern young students, and playing online games is the most popular entertainment. After school, the topic of regular students is to discuss experiences of playing online games; as a result, we can see the charm of online games. However, in recent years, seldom games combine with knowledge of animal ecology in children's computer games. It is a challenge and meaningful work for students to shift the attention on conservation through online games. In addition, if combined with knowledge of the ecological environment and animal-oriented, transfer student's attention to conservation knowledge, perhaps it could help children benefited knowledge on environmental conservation during playing games.

Research Purposes

In recent years, due to computers and internet are among in general household, digital games, whether stand-alone or online games are very popular. The company – Adobe, introduced flash multimedia development software, which has developed easy and high interactive features, if we can use the software as a learning tool to children's favorite games and provision different learning fun during playing games. Therefore, this study focuses on third grade children, developed a real game "wind wings", which including ecological knowledge of animals. It used a digital learning game to explore the meaning of development the endemic animal to the role of visual design, interaction mechanism in a modular way of the game.

1 Literature

In this study, the company, Adobe, introduced Flash multimedia development software designed as a platform of games, contains of learning animal ecology elements, the following research conducted for literature.

Game-based Learning

Loves games are children's natural, games are the important part of their lives. Eisner (1982) Games let children explore possible experience to understand the way the world is a natural childhood activities. Prensky (2001) against that there are few characteristics for games on digital learning: 1, Entertainment 2, Games 3,Regularity 4, Targeted 5, Human-computer interaction 6, Results and feedback 7, Adaptive 8, Victory sense 9, Competitive nature of conflict and challenge 10, Problem solving 11, Social interaction 12, Plot of the image. Hogle (1996) Computer games can lead to intrinsic motivation and increase interest in strengthening the memory and to provide high-level thinking in practice and feedback.According to Ebner and Holzinger (2007), the study also shows that learning materials can show the real situation and experience more than the traditional teaching media. Malone (1981) factors that there are three elements of making a fun game: 'challenge', 'sexual fantasy' and 'curiosity'. Therefore, we can design digital games to let children in games through interactive operations and exploration in order to enhance intrinsic motivation and interest, and to focus on children interactive content on games, access to animal ecology of the relevant knowledge.

Character Design

Successful role in the design, the effect of expanding out from the core values, Yesi Yi, Song Yun Lu (2004) mentioned, good character design will cause the player's interest in the conduct of the process through the game, so players like the roles and produce on the role of emotional Contact (Hook), or the so-called recognition. Shi Hengda (2004) says if the situation similar to the story, but the role of treatment between the different results caused by the difference, it leads to more attracted attention of learners, and enhancing learning efficiently. Huang-Huai Lin (2001) targeting children in Taiwan, and the sample was 540 questionnaires, which in order to understand children's modeling style preferences of the image, the results show that both boys and girls are clearly the theme of any story like cartoon style. In addition, Wang Menghui (2005) in who studies of children's illustration style preferences, the characteristics of the image modeling, which shows different classification of styles. One of the feature of cartoon-style, focused on the lovely appearance and childish of the values and behavior, they are important conditions, such as pattern cartoon character form proportion, color flat painted surface, simplified or disappearance of the shadow of a clear outline of closed contour lines or thick and so on. From the literature, understand about the importance of character design, not only allow learners to the role of the affective, but also more recognition to help familiar with the learning content. Therefore, this study will focus on the actual development of Taiwan's endemic species of animals, design role, Relate to the game unit needs, individual design of six different animal characters.

2 Study and design

The main purpose of this study was designed to learn a game with using a computer technology with characteristics of entities animal visual images, design and develop of animal ecology in Taiwan. Due to a system design process by studying animal ecology expert feedback to amend the content and the final integration work, the study completed a six-unit learning games.

2.1 Study

After research design is completed, we invited 60 third grade children to operate the actual software testing.

2.2 METHOD Conceptual Design

Taiwan's endemic animal ecology as the theme of learning games, the development of flow include visual design, expert feedback, multimedia integration and system design stage, the stage of the process design shows in Figure 1.

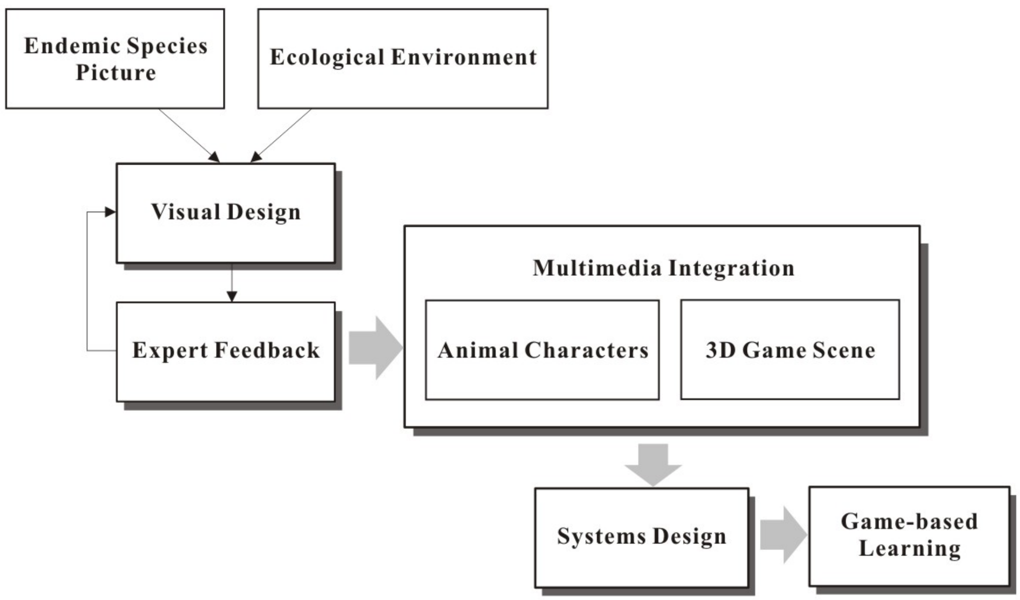

Figure 1: Conceptual Model and System Architecture

2.3 Animal Character Design

The role of animals for games unit design, the design characteristics of animals, such as the role of style, with lovely shape, color coated flat surface simplification, closed contours to the design. The conversion process shows in Figure 2.

step1.animal images step2. Transformation step3.Computer Drafting

Figure 2: the role of the visual design of the conversion process animal

2.4 Operation process

Children into learning the game screen after the procedure, the order of animation context, ecological scenes, the role of animals unit games, shows in Figure 3.

Figure 4: Control screen flow

3 Conclusion and Discussion

The purpose of this study is to develop learning style games combining the contents of animal character design and integration into ecological relevant elements of knowledge for children. From the results, the game really can attract third-grade children's interest in learning, and lead to active learning about the content of ecological knowledge with cute character design style. Due to the time, resources and other factors, only completion of building the current 3D Animal Ecology Park, and six roles of the theme on the game, yet other animals eco-related design and development. In the ecosystem, animals have their unique living environment, and also are the most valuable property resources. In addition, researchers can continue to enrich the related teaching materials in the future.

In this study, researchers can development of animal ecology learning games assist children a valuable reference through the visual experience of the process of transforming the image of animals in the future. Finally, the expectations and results of this study can promote ecological conservation and environmental protection and make a contribution in our society. Also hope this study can makes a discussion to be able to draw all the attention of animal conservation.

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CAMEG – A Multi-Agent Based Context-Aware Mobile Educational Game for On-the-Job Training

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Abstract: In this paper, we present a multi-agent based context-aware mobile educational game that can generate a series of learning activities for users doing on-the-job training in their working environment. We apply multi-agent architecture (MAA) into the mobile educational game design to achieve the goals of developing a lightweight, flexible, and scalable game on the platform with limited resources such as mobile phones. Multi-agent architecture not only makes different agents have its own tasks, but also provides developers an expandable way to add further functions into the game and to polish agents in order to make improvement on the game. This research focuses on designing the tasks that each agent needs to do and the communications may happen among agents. The benefits of the proposed multi-agent architecture game design makes the game itself easy to maintain and to expand, at meanwhile, reduces computing power consumed by the systems due to not all agents will be needed at same time.

Keywords: Context-aware, knowledge structure; game-based learning; on-the-job training, multi-agent system, situated learning; mobile phone

1. Multi-Agent System and Mobile Educational Game

Mobile phones have limited computing power and resources than desktop and laptop computers, the mobile applications hence are small and simplified (Tan & Kinshuk, 2009). In this research, we propose a mobile educational game under multi-agent architecture to reducing computing power consumed by the mobile learning systems as much as possible.

Intelligent agent is independent computer programs, is capable of acting autonomous and learning continuously to meet its design objectives (Baylor, 1999). Multi-agent system is a system where many agents are living in it. These agents are responsible for their own tasks and collaborate with other agents whose responsibilities belong to the pre- and post-requisite tasks. Researchers have applied multi-agent concept into either learning management system design or mobile educational system design, and report good results in system scalability (Dutchuk, Muhammadi, & Lin, 2009; Zhang & Lin, 2007).

Multi-agent-based system is one of our research's objectives, designing a system with agent-based perspective makes our ubiquitous educational game more flexible and expandable. For instance, the system can find an agent to hold user's playing data temporary if the network is disconnected and the agent asks DB Access agent doing batch update as usual after it detected the network is available again.

The rest of this paper is organized as follows. We first describe the multi-agent based mobile educational game design including system architecture, database design, and the agent collaborations. This paper concludes with the summary and the discussions about possible future directions.

2. Multi-Agent Based Mobile Educational Game

In this research, we use positioning technology and two-dimensional barcode (e.g. QR code) to develop an educational game on mobile phones. To develop a lightweight, flexible, and scalable game, we take multi-agent architecture (MAA) into considerations while designing the educational game. Multi-agent architecture not only makes different agents have different tasks, but also provides us an expandable way to develop further functions, for instances, we can put new agents into the game for special purpose or can replace an old agent with a new and more powerful one. Figure 1 shows our MAA-based system model.

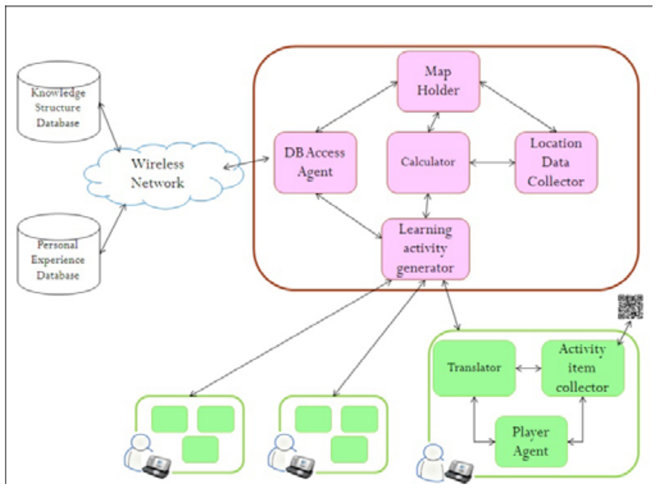

Figure 1. MAA-based system model

The agents in Figure 1 are responsible for specific tasks:

Player - Player agent is a bridge between the user and other agents. It acquires data from other agents such as translator and learning activity generator.

Activity item collector - The main task that activity item collector does is to scan the QR code with the camera and interpret the scanned data.

Translator - Translator can identify different language inputs and store it into database with suitable text encoding method. Translator is very useful in non-English speaking country (e.g. China, India, and Japan) and bilingual environment (e.g. English-French and Dutch-English). Calculator and learning activity generator - The two agents accomplish the tasks for learning activity generation.

Location data collector - Location data collector is responsible for detecting and processing positioning data. If the location data collector is a GPS-based collector, then it gathers the GPS data and interprets the longitudes and latitudes from the data. On the other hand, if the collector is a QR-Code-based collector, it can scan the QR code and interprets the embedded information from the scanned data.

Map holder - Map holder always keeps a copy of the map where the player is playing the game in case any other agents may acquire or the network connection is no longer available. The map here in the game is the context-awareness knowledge structure.

DB access agent - DB access agent makes up the appropriate data manipulation language of SQL commands and receives the results from the database. If the network connection is not available, the agent will keep the manipulation jobs and do batch update when the network connection is recovered.

To establish such expandable game, we need to design the database with a comprehensive perspective, which means, we need to take knowledge structure, game and role management, authentication, and game-play into consideration. The database design can be explained in four parts, authentication, game, location, and knowledge structure as Figure 2 shows. In order to improve the system flexibility, we use Boyce-Codd normal form (BCNF) database design strategy.

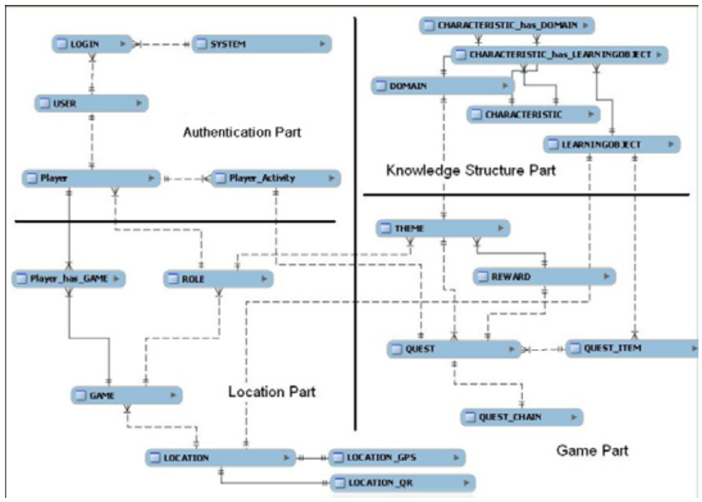

Figure 2. Database view diagram of CAMEG

In authentication part, this game can combine within other learning systems because the authentication relevant tables have user accounts independently from the learning systems and bind the user's ID in the learning system with the user account in the game, for instance, a user can use his/her employee id and password to sign in the game, the game then generates a user account and binds on the employee id when s/he first sign in.

In the game part, we design quest chain, quest, theme, and reward tables. The quest and quest chain tables are built for the learning activity generator in storing the learning activities. We also design rewards for learning activities to motivate users playing the game.

In the location part, we use location table to store learning objects' locations and to provide users right learning activities according to user's location. So the game world can be expanded to cover other areas in the real world easily, such as another building in school campus. In addition, with BCNF, the design of location part allows the game using hybrid positioning technologies freely.

At last, in the knowledge structure part, the main focus is context-awareness. The object table is associated with location, which means every learning object has a location id and can be located in the environment. Moreover, as Figure 2 shows, the knowledge structure has hierarchical characteristics and every learning object has its own characteristics.

Figure 3 illustrates the relations among the agents and database. We have not considered map holder here yet because the game world is only set to the 11th floor of Edmonton Learning Centre, Athabasca University, Canada. Nevertheless, multi-agent-based design lightens the programs, which means we could put a new agent into or replace existing agents anytime later very easily without changing the main program.

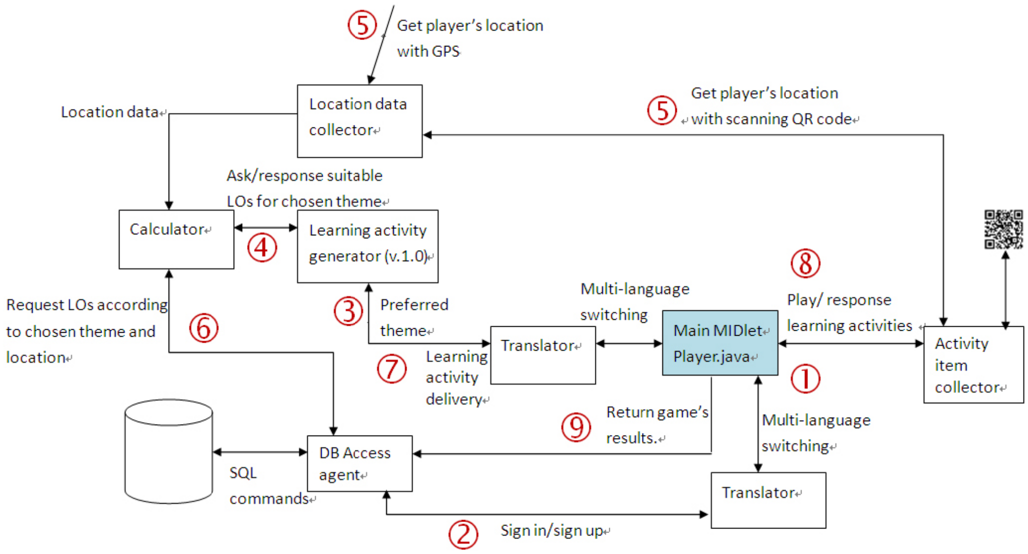

Figure 3. Relations among agents and database

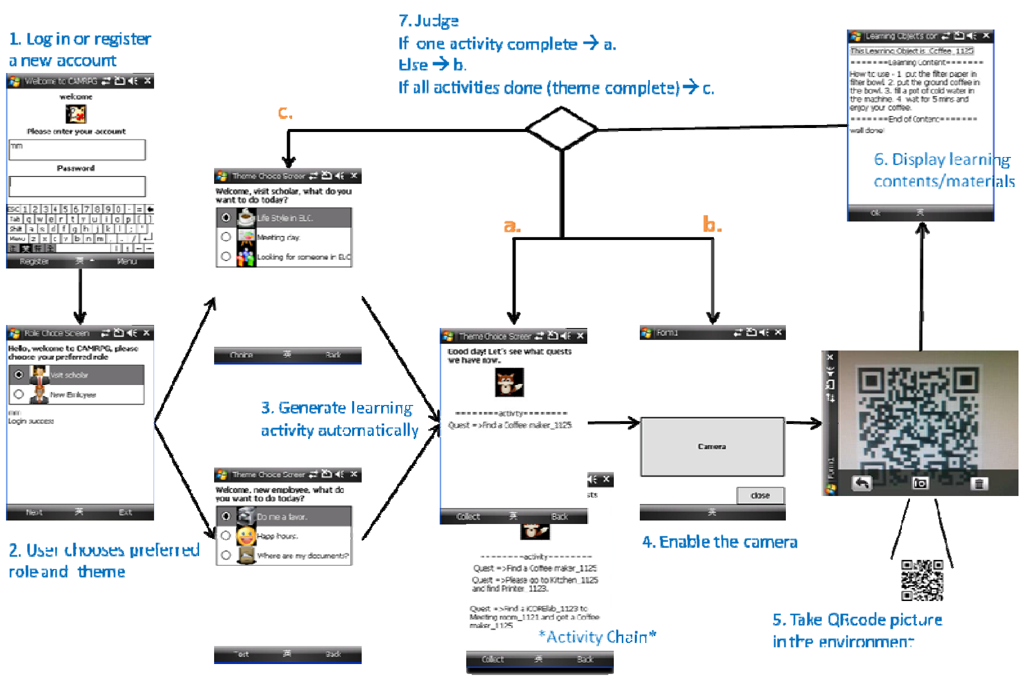

Figure 4. Screen shots of game-playing

We demonstrate the game-play and explain its process from agents' viewpoint. During the game-play, the Player agent will be the only one agent who interacts with the user and helps data exchanges between the user and other agents. At the beginning, the Player agent first gets username and password from the user (as step 1 on Figure 4 shows) and then sends these data to the Translator for checking the language these data uses (as step 1 on Figure 3 shows). The Player agent then sends user's username/password to DB access agent (step 2 on Figure 3). DB access agent judges if the account is existed in either the game database or other system's database (e.g. Moodle database). If the username/password doesn't exist, the Player agent will ask the user to create an account for playing the game.

After the user signed in or registered a new account successfully, the Player agent offers the user two role options, i.e. new employee and visiting scholar, which the user can choose to be (as Step 2 on Figure 4 shows). Each role has some pre-defined themes for user to pick-up. Once the user chose his/her preferred role and theme, the Learning Activity Generator and the Calculator will collaborate with each other to generate corresponding learning activity chain (as Step 4 to 7 on Figure 3 and Step 3 on Figure 4 show).

The user then receives the learning activity one by one offered by the Player agent. These learning activities ask the user to find specific learning objects and collect the learning objects by taking photos on its QR codes. Therefore, the Player agent will help the user to wake the Activity Item Collector up (as Step 8 on Figure 3 shows). The Activity Item Collector enables the built-in camera for the user and decodes the QR code photo that the user took (as Step 4 and 5 on Figure 4 show) Step 6 on Figure 4 shows text-based content as learning material. Beside text-based learning contents, the learning contents can also be designed as HTML-based, binary-based image data, an URL of webpage, media stream and Flash animation to deliver different types of information/knowledge to the user.

At last, the Player agent judges if the collected item is what the learning activity asks for (as Step 7 on Figure 4 shows). In the whole process, these agents are collaborative working to provide the user context-awareness learning activities and mobile game-based learning experiences. The multi-agent based system makes the game easier to design, develop, and alter/replace functions.

3. Summary

In this paper, we present a multi-agent-based mobile educational game. This game can help users doing on-the-job training to get familiar with the new environment; to adapt new working procedures and policies; and, to learn facilities related to their jobs. The proposed game's multi-agent architecture makes itself easy to maintain and to expand, also, reduces computing power consuming due to not all agents will be needed at same time.

The learning activity in this game is boring in some senses, the activity currently only asks the user to find specific learning object. In our next stage, we are going to put narrative elements and storytelling strategies into the learning activity generation process. The story-based learning activity may make users feel they are playing game rather than following orders made by the player agents.

Acknowledgements

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Learning English Playfully with GPS-E

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Abstract: In this paper, a game-based English learning system (GPS-E) was introduced and evaluated. The effectiveness of the first year experiment was concluded based on the results of a within-subject t-test study. The study was conducted in a university setting in Taiwan. Ten classes of university freshmen (first-year students) were invited for this study. Results indicated that most learners who tried the system have improved more in English than the ones who did not.

Keywords: playful learning, GPS-E (**G**ame-based **P**ilot **S**ystem for **E**nglish learning), game-based learning, CALL (Computer Assisted Language Learning)

Introduction

In Taiwan, English is core requirement at all schools, from primary schools to college-level schools and universities. Hence, Taiwanese students have been “forced” to learn English and “strongly demanded” for “expected academic achievement”—the higher grades, the better, not considering whether or not they could use English in real life. Research results revealed that most of the Taiwanese college students had either fear or unpleasant feelings about their English learning experiences. Plus, the less pleasant they felt about learning English, the worse grades they obtained. (Lin & Warden, 1998) In order to avoid the vicious circle, integrating play into learning seems to be a possible solution.

Ancient philosopher Plato advocated the role of “play” in education by saying that: “Do not… keep children to their studies by compulsion but by play” (Field, 1956) He even suggested: “The most effective kind of education is that a child should play amongst lovely things.” According to a play theorist, Sutton-Smith (1997), any useful definition of play must apply to both adults and children. In spite of different perceptions and learning behaviors influenced by ages, cultures, education process, etc., there are still many key themes of applying playful learning for children relevant to adult learning. Therefore, if the word “child” in the abovementioned Plato’s quotes were substituted by other words, such as “student,” “learner,” “person” and the like, the concept should keep unchanged.

Many educators and researchers confirmed that playful learning methods with its CALL-related approaches did reinforce learning process and even improved learning achievement regardless the age differences. (Warschauer, 1996; Sutton-Smith, 1997; Healey, 1999; Resnick, 2004 & Rice, 2009) According to Rice (2009): “Play can be a powerful learning process for adults in higher education, and is embedded in a constructivist theory of learning, and requires experience and reflection as part of that process.”

Therefore, grounded in the belief that playful learning can elicit students’ intrinsic motivation, and subsequently improve students’ achievement, the GPS-E (**G**ame-based **P**ilot **S**ystem for **E**nglish learning) was created in order to lead low-motivation English learners into a playful learning world. They will be encouraged to envision how play contributes to learning by physically applying the system. To better present the system, this paper aims to examine the effectiveness of incorporating playful CALL (in this case: GPS-E) into low-achievement English learning classes.

The GPS-E System

The name of this system GPS (Game-based Pilot System for English learning) is the equivoque on the name of the electronic device--Globe Positioning System. The idea was initially generated based on the target users. They were randomly distributed in ten classes which were labeled “Pilot English Classes.” The label indicates that the students got lower than acceptable scores in English, so that they are deeply in need of pilots to guide their directions toward more successful English learning. As to the name of the system, the general objective aims to provide a practical guide (as an experienced and humorous “pilot”) to invite students into a joyful journey of learning English. Moreover, the system does provide a GPS-like function for players to locate their current position and to look for desired destinations. Figure 1 presents the model of the system.

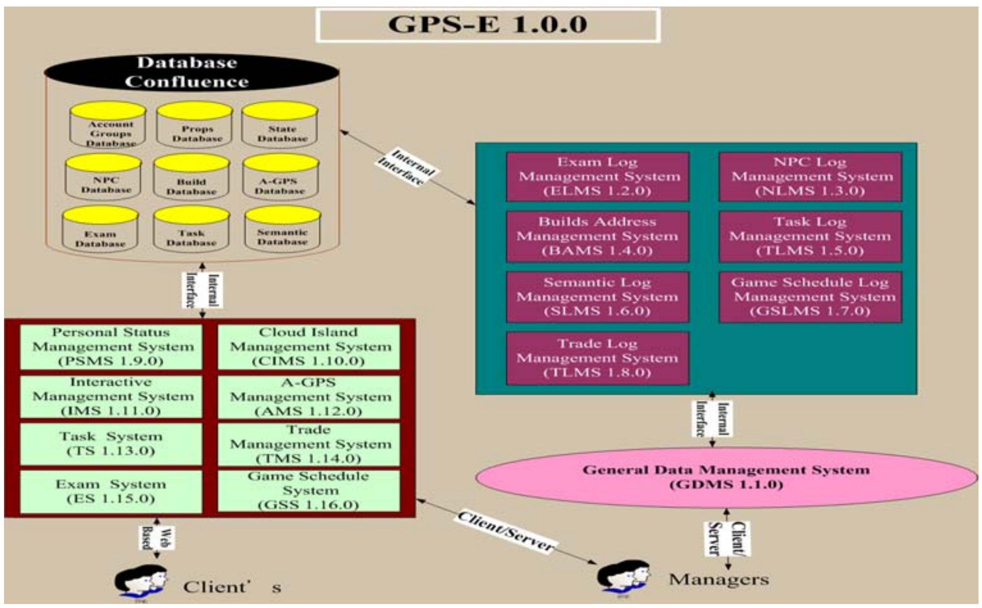

Figure 1: GPS-E Model

The system uses relational database to store learners’ status, learning corpus, and gaming information. Through the game-based interfaces, GPS-E creates an on-line virtual world for multiple users to play, interact, and learn virtually in the game. In the mean time, teachers can track the status of learners, set up learning objects and interact with student in the virtual world through management modules.

In order to improve target learners’ basic skills in English reading proficiency, the GPS-E system provides an English-rich environment that invites students to play around and learn English simultaneously. In addition, for decreasing some students’ anxiety about facing foreign language, necessary instructions, hints, clues, and assisting descriptions in learners’ mother language (Chinese Mandarin) are also provided. Figure 2 shows the portal island for the game.

Figure 2: GPS-E interface

First-time users will start with this island after logging in. Players can earn "cloud dollars" by viewing online English classes playing games, and competing with other players. The "cloud dollars" can be used to purchase items in the system, including tickets to visit other islands. Four different types of room are spread amongst islands: system rooms (including registration, student, teacher, and ranking rooms), learning classrooms, gaming rooms, and social rooms (dormitory, church, shop, airport, etc.)

Methodology

At the beginning, a survey was distributed for understanding the students' knowledge about English learning and computer usages to tailor a fitting system for the target users. Thereafter, a within subject t-test method was conducted for investigating the effectiveness of applying this system.

Sample and Setting

Students from ten freshman English classes in a northern university in Taiwan were recruited for this study during the school year of 2009. The ten classes were chosen based on their English proficiency (low in English subject of The General Scholastic Ability Test). As mentioned in the previous section, these students are fall-behind English learners who need "pilot" guidance.

There were six instructors who taught these ten classes during that time. Two teachers taught two classes and one teacher taught three classes while the rest three teachers taught one class respectfully. Even though all six instructors were invited to attend the GPS-E workshop, two instructors opted out of the opportunity for using the GPS-E system in their classes (three classes) based on their personal decision . Therefore, seven classes turned into the experiment group while the three classes became the control group.

Procedure

A 39-item questionnaire was applied for this study with the intention of exploring students' background, attitude toward English learning and learning English through playing digital games. The result reveals that 96.8 % participants are willingly to learn English through digital games. The finding supports the idea of implementing the GPS-E system in English learning. More detailed results from the questionnaire can be found in previous research paper (Li, Chen, Heh, Wang, Yeh & Huang, 2009). Furthermore, each student was asked to take the pre/post tests regarding English reading proficiency at the beginning and the end of the school year respectively.

Findings and Discussions

The results presented here are mainly about the pre-post tests outcome, as Figure 3 shows the noticeable growth on students' English proficiency between the pretest and the posttest. One class even raised 40 marks in average while the smallest growth is 13 marks.

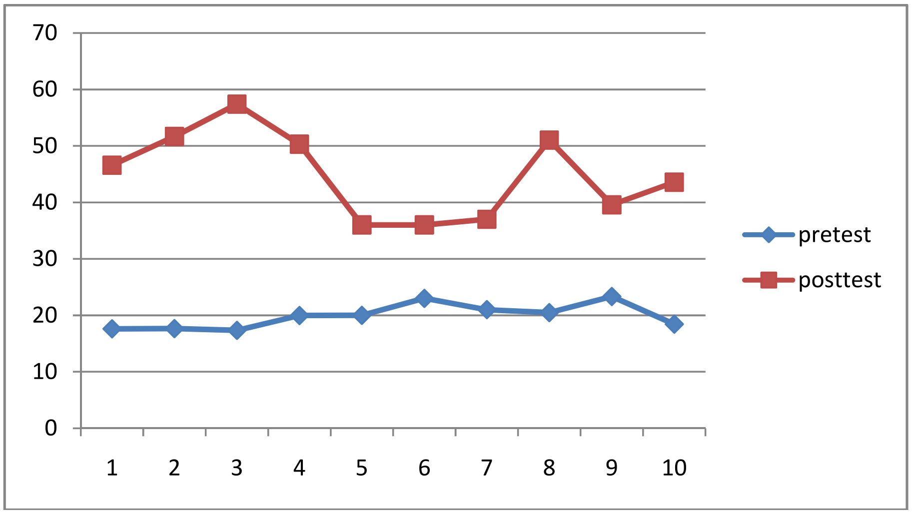

Figure 3: The line chart showing the differences between pre- and post- tests

Students from both control and experiment groups showed improvement in their English skills after one-year English instruction. Based on the scored shown in Table 1, the difference is significant, because the absolute value of the calculated value 2.94 exceeds the critical value of 2.262 (with df= N-1= 9; critical value of t at α= .05 is 2.262). However, students from control group did not improve significantly whereas students from experiment group performed significantly better than the control group (at α= .01, with df = 6 and 2 respectfully).

Vygotsky (1978) stated that "In play a child always behaves beyond his average age, above his daily behavior. In play it is as though he were a head taller than himself." As shown in Table 1, the results of this study indicated that players of GPS-E performed better than non-players.

Class	1	2	3	4	5	6	7	8	7	10	Ave.
Pretest	17.61	20	17.66	20.48	23	23.33	19.97	21	18.43	17.35	19.883
Posttest	46.57	36	51.66	51.03	36	39.56	50.31	37	43.57	57.39	44.909
Gain	28.96	16	34	30.55	13	16.23	30.34	16	25.14	40.04	25.026
GPS-E	21089	250	7214	0	136	0	509	61	0	588	

Table 1: The results

Conclusion

The GPS-E system provides a colorful, interesting virtual environment to invite students to explore the islands as well as learning English at the same time. It aims to encourage students to have playful spirit instead of dreary study attitude. The quantitative results not only confirm the value of play, but also provide the basis for further investigation.

In addition, informal interviews with the instructors during the process indicate that students learned a great deal through playing online games on GPS-E. Because play and learning are fully integrated, students were driven by intrinsic motivation instead of external rewards. To sum up, the system provides great opportunities for students to learn important English language concepts—and learn them in a much more meaningful and motivating context than in traditional classroom.

Unfortunately, regardless the proven benefits of playful learning, many schools still possess resistant attitude toward incorporating playful learning into school curriculum. As Buscaglia (1984) argued: "It is paradoxical that many educators and parents still differentiate between a time for learning a time for play without seeing the vital connection between them. Teachers and administrators are often skeptical of playful-learning activities, seeing them as "just play." Hence, the role of the instructor is extremely important for guiding student to learn through play.

In addition to the advantages of employing games and toys-like instructional instruments, Resnick (2004) reminded all educators that do not put a sugar coating for academic purposes in students' playful experiences. This is also another goal for the GPS-E project. This project not only aims to help a small group of college students, but also provide a framework for educators to apply and modify. Ultimately, English language learners around the world could all be able to experience the joys and benefits of playful learning, and consequently cultivate life-long learning habits.

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Applying Multiplayer Online Game in Actionscript Programming Courses for Students Doing Self-Assessment

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Abstract: This research applies a web-based multiplayer online game to motivate students doing self-assessment when they are studying. The experiment is conducted in the first and second year undergraduate programming language courses in Taiwan. Within the multiplayer online game, students can explore the game world, chat with classmates, and solve quests. The quests in the game are self-assessment items, however when the quest items are presented in game form, students feel they are not taking quiz but playing. We collect students' demographic information and their game-play log to evaluate the effectiveness of such multiplayer assessment game. The results show that gender and having internet at rental place do influence student's intention to play the game. Students who have better academic achievement (i.e. higher scores) also have much more willing to play the game during the semester.

Keywords: Educational game, online game, multiplayer, self-assessment, actionscript, programming language

1. Introduction

Many researchers focus the educational potential of multiplayer games in recent years (Herz, 2002; Foreman, 2003). A number of research put efforts in designing games for educational purpose and applying game elements to learning activity design (Bueno, Chacon, & Carmona, 2008; Chang, Wu, & Heh, 2008; Olazar, 2007), at meanwhile, very few attempts of using multiplayer online games to assess student's programming skills.

This research uses a web-based multiplayer online game to assess its efficiency. Section 2 illustrates the features of the assessment game. The experiment design is described in Section 3 and Section 4 shows the experiment results. At the end, Section 5 makes a brief summary and talks about possible future works.

2. The Assessment Game

Chang & Kinshuk (2010) have developed a web-based multiplayer online game to assess student's Java programming knowledge and skills. After players signed in the game, they can see the game world and user interface as Figure 1 shows. The game world is constructed as a set of tiles, each tile has different attributes representing different geographical features (in the world map) and buildings (in the village map). In order to enhance the sense of exploration in the game, the game world is initially hidden from the players (Graven & MacKinnon, 2006). As the players move around the game world, the terrain features of nearby tiles are revealed.

Players can choose various services and pick-up quests from vendors and NPCs (Non-Player controlled Characters) in the game. After players completed the quest by returning the correct quest item (i.e., the program's output and code pieces) back to the NPC, the NPC offers them gold pieces and experience points as reward. The quest types in this game are greeting quest, delivery quest, true/false quest, multiple-choice quest, fill-in-the blank quest, and coding quest.

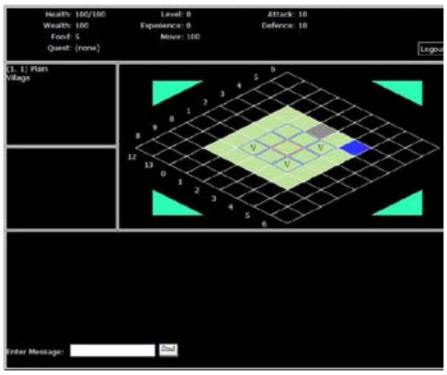

Figure 1. The assessment game

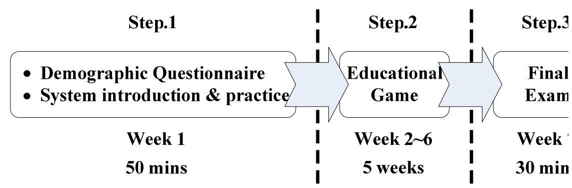

Figure 2. Experiment Flow

3. Experiment

Experiment Design

The experiment courses are the basic programming language learning courses in Department of Digital Design, which implies that all students in these two courses are non-computing relevant school students. These two courses teach Flash Actionscript for freshman and sophomore. Figure 2 shows the flow we designed for this experiment. The experiment starts at one week after the mid-term exam and we take the exam as pre-test. At Stage 1, we ask students to complete the demographic questionnaire and introduce the game to them by demonstrating how to play the game. Students then have 10 minutes to play the game for trial purpose. At Stage 2 (i.e., 2nd to 6th week), the students can play the game anytime they want freely for five weeks. Stage 3 is the post-test, again, we use the final exam directly.

Participants

There are 64 students in the freshman programming language course and 56 students in the sophomore programming language course. After removed those students who didn't complete the questionnaire at Stage 1, 74 students remained (including 28 males and 46 females). Beside gender, the demographic questionnaire also collects: (1) age, (2) living place (i.e., live at home and rental place), (3) have internet at rental place, and (4) have internet at home.

Hypotheses

Most of non-computing relevant school students have less interest in learning programming language and have worse learning outcome. This research uses the multiplayer online game and quests for students self-assessing their programming concepts and skills, including program structure, operators, and Actionscript function usage. If students have interests in playing the game, they can review and practice the programming concepts they have learned in the classroom by solving the quests. With these thoughts, we have two hypotheses before doing the experiment:

- H1: The demographics will affect students playing the game
- H2: The game-play will affect students' academic achievement of this course

Data Collected

The game-play data we collected in this experiment are:

- Number of Map Opened: The number of map tiles opened by players. The player who has opened more tiles may indicate that s/he likes to explore the game world, who probably is an explorer in Bartle's player style (Bartle, 1996).
- Number of Quest Taken: The number of quests the NPCs gave to the players during Stage 2 in Figure 2. More quests the students taken, more practices they possibly done.
- Number of Quest Solved Correctly: The number of quests solved correctly by the players. The data can help us know how many quests the students have tried and solved correctly in the game, i.e., sort of their academic achievement but only in the game.
- Experience Points: The final experience points which the players got from solving quests. The player who got more experience points usually means s/he has solved more quests. In some circumstances, the player may get more experience points by solving more difficult quests. In this experiment, coding quests give the students more experience points than the multiple-choice and the fill-in-the-blank quests. .

The learning performance data are:

- Mid-term Exam Marks: Student's mid-term exam marks, the maximal marks they can get are 31.
- Final Exam Marks: Student's final exam marks, the maximal marks they can get are 31.
- Semester Score: Student's final score for this course. The maximal score is 100.
- Improvement: Student's learning improvement from mid-term exam to final exam.

4. Results and Data Analysis

H1: The demographics will affect students playing the game

There are 60 students (81.1%) who didn't live at home but rent a room near the school, 59 of them (98.3%) have computer at the rental place and 54 of them have Internet there. All the students who live at home have computer and 13 of them have Internet.

Table 1. The statistics of having computer and Internet at home and rental place

Living Place	# of Students	Has Computer	Has Internet	No Response (for Internet)
Home	14	14 (100%)	13 (92.8%)	0 (0%)
Rental Place	60	59 (98.3%)	54 (90%)	3 (5%)

To test the first hypothesis, we use ANOVA to see if there is significant difference between the factors in demographics and the factors in the game-play. At the beginning, we check if there is gender difference in students playing the game. The analysis shows that gender has significantly influence to the game-play ($F(1, 72) = 5.435$, $p < 0.05$). We also check if living places affect the students playing the game. The analysis tells that living place has no significant influence to the game-play ($F(1, 72) = 0.609$, $p > 0.05$).

Having internet for students who live at home doesn't have significant influence to the game-play ($F(1, 12) = 0.151$, $p > 0.05$), however, the analysis shows that having internet at rental place has significantly influence to students playing the game ($F(1, 55) = 8.422$, $p < 0.05$).

According to the analysis results, the demographics do affect students playing the game and hypothesis H_1 is confirmed.

H2: The game-play will affect students' academic achievement of this course

The hypothesis H_2 is discussing the relation between the game-play and the learning performance. We use Pearson product-moment correlation coefficient to test the correlation between the factors in the game-play and the learning performance. All the factors in the game-play are correlated to the mid-term marks ($p < 0.05$), final exam marks ($p < 0.05$) and semester score ($p < 0.01$). However, none of them has correlation to the improvement from the mid-term exam marks to the final exam marks. Table 2 shows the Pearson product-moment correlation between the two categories.

Though the game-play is correlated to the mid-term marks, the final exam marks and semester score, we can't say that the hypothesis H_2 is confirmed because the game-play doesn't correlate with the improvement.

Table 2. The correlation between the game-play and the learning performance.

	Mid-term Marks		Final Exam Marks		Semester Score		Improvement	
	Pearson Corr	Sig	Pearson Corr	Sig	Pearson Corr	Sig	Pearson Corr	Sig
Number of Map Opened	.488**	.000	.378**	.001	.536**	.000	-.228	.051
Number of Problem Taken	.335**	.003	.242*	.038	.342**	.003	-.169	.150
Number of Problem Solved Correctly	.348**	.002	.242*	.038	.354**	.002	-.181	.122
Experience Points	.346**	.003	.245*	.035	.352**	.002	-.177	.131

**. Correlation is significant at 0.01 level (2-tailed)
*. Correlation is significant at 0.05 level (2-tailed)

Discussions

According to the abovementioned experiment analysis, we can find out that:

1. Genders do affect students playing the game. The educational game designers should consider designing gender dependent contents and user interfaces to attract both male and female students (Kafai, 1996).
2. Students have or have no internet access at rental place does affect their game-play behaviours. The possible reason is that they feel free to play the game at their own private place if compared to at home. Having or having no internet at home does not affect students playing the game. One possible reason is that their parents might not like them to play computer games at home. However, only one student has no internet at home in this experiment. We need to test this finding further in our future experiment.
3. There is significant relation between the game-play and the marks/scores. The data shows that the students who solved quests more usually have higher marks/scores. This finding indicates that high academic achievement students have more interests to play the self-assessment game. The finding also tells us that low academic achievement students might be afraid to play the game due to their fear of failure. So when we

develop the quests, we should consider having quests in different difficulty to increase low academic achievement students' confidence of playing the game.

4. There is no significant relation between the game-play and the improvement from mid-term exam to the final exam. One possible reason is also related to academic achievement, i.e., most students who play the game are high academic achievement students, hence, their improvement from the mid-term exam to the final exam is slightly.

5. Conclusion

This research finds out that the factors which influence students playing the self-assessment game. Two hypotheses are examined by using ANOVA and Pearson product-moment correlation coefficient. The first hypothesis shows that different genders affect students playing the game as well as the internet access way they have at home. The second hypothesis points out those students who have better academic achievement (i.e., having higher marks and scores) are willing to use the self-assessment game to practice the knowledge and skills learned from the classroom.

Students who use the self-assessment game are still less relatively. According to the feedback, the game needs to have a more attractive user interface in order to motivate students playing the game. Also, put PvP (Player vs. Player) and PvE (Player vs. Environment) elements can also raising students' interests effectively.

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Using an Edutainment Virtual Theatre for a Constructivist Learning

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Abstract: In this paper we present the first results of a research carried out using a Virtual Theatre by which users can learn different subjects in an enjoying and engaging fashion**.** In particular, thanks to the software Face3D users can model virtual actors as well as create/elaborate and attend educational performances, "constructing" their own knowledge. The stage is one of the Graphical User Interface of the software and virtual actors are three-dimensional heads ("Talking Heads") endowed with facial expressions and voice. The scripts are created by students, too. Results on learners' satisfaction in using this kind of Virtual Theatre as educational tool in classroom situations have been very positive.

Keywords: Learning, Constructivism, Virtual Theatre, FACS, Talking Heads, Edutainment

Introduction

In recent years, a number of storytelling systems in which the user can be a scriptwriter, actor, director or spectator, have been realized (Bohlin, Nilsson, & Siverbo, 1998; Popovici, Serbanati, & Gerval, 2002; Cavazza & Donikian, 2008). In many cases, these systems have been called "Virtual Theatres" (Adamo, Bertacchini, Bilotta, Pantano, & Tavernise, 2010), and their main characteristic has been the employment of pedagogical agents able to promote learning. In particular, in literature, an increased motivation, a stimulation of particular didactic activities, and an enhanced flow of communication have been identified as agents' primary educational benefits (Bourgonjon, Valcke, Soetaert, & Schellens, 2010). In this view, in virtual environments users can enjoy themselves having an active role, exploring/creating/ elaborating the content and learning by doing and/or playing. Therefore virtual space has become not only a tool for representation but also for action and interaction, thus integrating constructivist theories as well (Bednar, Cunningham, Duffy, & Perry, 1995; Bilotta, Gabriele, Servidio, & Tavernise, 2009). This divulgation of educational contents in an entertaining way has often been indicated using the term "Edutainment", that is the result of the mixture of the words "education" and "entertainment" (Pantano & Tavernise, 2009). Moreover, regarding the learning of different subjects, the Talking Heads of Leonardo da Vinci and Albert Einstein have been modeled and animated for the realization of an enjoyable science lecture, as well as Confucius, Buddha and Pythagoras for the explanation of a philosophical topic (Adamo et al., 2010).

Regarding synthetic actors in Virtual Theatres, since the pioneering work of Parke (1974), the Computer Graphics community has tried to reproduce realistic facial movements for synthetic actors in a 3D environment. Research in this area has implied the development of many techniques for the improving of the physical features (shapes, colours, textures) of the actors, as the deformation of limbs during motion or facial expressions to be performed simulating emotions. Extensive studies on basic facial animation have been carried out, and several models have been proposed, mainly falling into two major categories: those based on geometric manipulation (i.e. parameterization, muscle-based models, and so on) and those based on image manipulation; each realm comprises several subcategories (Noh & Neumann, 1998). Regarding parameterized manipulation, "Talking Heads" consist of polygonal surfaces which connect vertices moved by control parameters, and most facial expression models are based on Ekman and Friesen's Facial Action Coding System (FACS) (Ekman & Friesen, 1978). FACS is a coding of the movements of the facial muscles, and in particular of a set of basic human expressions, based on an analysis of facial anatomy.

In this paper we present the first results of an experiment with an Edutainment Virtual Theatre by which, through the writing of texts and the construction/manipulation of talking heads, it is possible to engage students in an immersive and entertaining learning. Virtual actors are constituted by parameterized actors, which perform famous personalities in different fields (i.e. History, Science, and Philosophy). In section 1 the general features of the software and its three Graphical User Interfaces (GUIs) are introduced. In section 2 the creation of virtual actors and scripts is analyzed, and in section 3 first results of Virtual Theatre laboratories are presented. Conclusions are presented in section 4.

1. The Virtual Environment

The software Face3D has been ideated and realized by Evolutionary Systems Group (ESG, http://galileo.cincom.unical.it/) at University of Calabria (Bertacchini, Bilotta, Cronin, Pantano, & Tavernise, 2007). It consists of three GUIs: Face3DEditor for modelling virtual heads, Face3DRecorder for animating them, and Virtual Theatre for the performing of the modelled and animated agents.

In Face3DEditor a generic parameterized head model has been realized for being adopted as starting point for the generation of each Talking Head and it is constituted by a low number of vertices (131) that can be moved in order to easily create a new face. A background image (photo or drawing) can be inserted as reference image (Bertacchini, Bilotta, Pantano, Battiato, Cronin, Di Blasi, Talarico, & Tavernise, 2007). The Talking Head can also be completed adding textures realized in other Computer Graphics software (Figure 1).

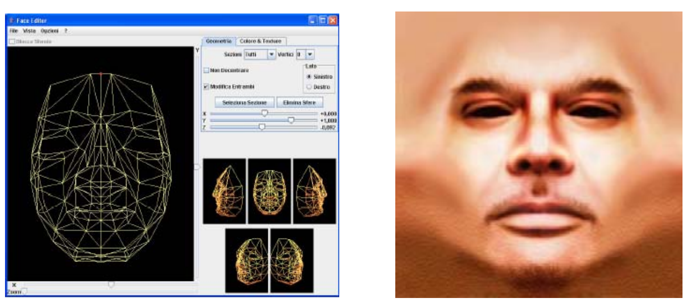

Figure 1. Face3DEditor and an example of texture

A main characteristic of this GUI is the possibility to insert the function "noise", inspired by Perlin's "responsive face" (Perlin, 1997), that allows a random movement of head and eyes, providing a more "human" appearance to the agents.

In Face3DRecorder (Figure 2) users can animate the Talking Head synchronizing facial expressions with pre-recorded files of speech. In particular, the user can select eight emotions (neutral, anger, surprise, sadness, fear, joy, disgust, attention) that have been standardized using FACS. Recognition tests of the implemented expressions have also been carried out (Bertacchini, Bilotta, Gabriele, Servidio, & Tavernise, 2006).

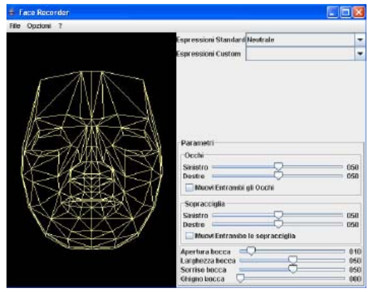

Figure 2. Face3DRecorder.

However, since human facial expressions are characterized by very rapid changes, Face3DRecorder allows both the creation of new small alterations in these emotions and the set of their speed.

In Virtual Theatre (Figure 3) it is possible to import the animations of the Talking Heads created in Face3DRecorder, as well as to create and to manage the performance of different virtual agents.

Figure 3. The "Virtual Theatre."

At the moment the only available version of the Face3D software is in Italian, but a multilingual version will be realized; moreover, it will be distributed to accompany a publication for schools.

2. The performance in the Virtual Theatre

Different agents can be created according to the contents; for example, characters like Albert Einstein or Pythagoras (Figure 4) can be very useful for the comprehension of their theories.

Figure 4. Albert Einstein and Pythagoras' Talking Heads

Talking Heads can also be characters of ancient comedies or tragedies, for the teaching of Greek and Latin works. In fact, the user can model the masks created by the Greek author Menander (342-290 A.C.) to represent characters of many comedies (Figure 5). Moreover, also characters modeled on the basis of a picture of a "real" person can be realized.

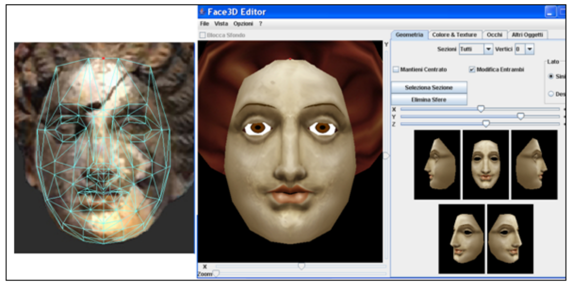

Figure 5. An example of modeling on the basis of a Greek mask picture.

Scripts can concern different subjects: starting from a given text, they can be elaborated by learners in creative writing laboratories or, in some cases, by teachers. Regarding the opportunity of interaction, students can also be a part of the cast, performing "live" during the virtual show. In particular, students have to follow different steps: choose the lesson to be represented in a given course, organize the script of the story, and then use the Face3D software to model/animate the faces of the characters. Finally, by the GUI Virtual Theatre, they can create and participate to the performance.

3. Virtual Theatre Laboratory

We have tested learners' satisfaction in using our Virtual Theatre as an educational tool in classroom situations; in particular, a laboratory at a grammar school in Cosenza (Italy) has been carried out. The sample was constituted by 40 children (20 male and 20 female) between 9 and 10 years old, belonging to two different classes, with a basic knowledge on personal computers. Their tasks have been: the choice of the topic in the "Foreign Language and Culture" course to be represented; the arranging of the script of the story in a group writing laboratory; the recording of the dialogues; the modeling of the characters on the basis of the content to perform; the synchronization of the recorded files with the facial expressions; the participation in the performance.

The following materials have been used: a questionnaire on students' data (age, sex, class) and familiarity with the use of personal computers; the Face3D software visualized on personal computers; the Questionnaire for User Interface Satisfaction by Lund (2001).The hypothesis is that the Face3D software, and Virtual Theatres in general, can be an effective device for educational aims, because more students are involved in the construction of their learning, more they learn. In each class the Virtual Theatre has been presented and a list of the tasks has been provided. Each student has compiled the data questionnaire and then has started a six-hour laboratory. Finally, each subject has compiled the Questionnaire for User Interface Satisfaction, which measures users' opinions on software utility, easiness of use and learning, satisfaction.

Since the starting of the laboratory, children have been enthusiastic and results of questionnaires have reflected their attitude. In fact, the 98% of the sample has shown great satisfaction in the use of Face3D software, the 94% has affirmed that the Virtual Theatre created is useful, and the 99% that it is easy to learn. Finally, the 97% has declared that it is also easy to use. No relevant gender differences have been found; for example, regarding satisfaction in the use of Face3D as learning tool, the 26.90% and the 64.1% of the male subjects has declared to be satisfied and very satisfied, respectively (91% of the sample); the 31.68% and the 63% of the female subjects has declared to be satisfied and very satisfied, respectively (94.68% of the sample).

4 Conclusions

Many studies have shown that an active learning can remarkably enhance students' learning efficiency as well as a rich interaction can provide fruitful feelings of participation in educational process. Therefore, an innovative virtual theatrical environment has been ideated and realized at University of Calabria (Italy). Positive results of a previous experimentation with 20 teachers and 30 high school students (Adamo et al., 2010) on the use of Face3D Virtual Theatre as leaning tool have been confirmed in a laboratory with children.

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AdMoVeo: Created For Teaching Creative Programming

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Abstract: Learning programming requires abstract thinking and modeling. In many cases, especially in programming for embedded systems, students also have to understand certain basics about electronics. Both come together, becoming a challenge. Most of the design students do not have inherent affinity towards programming and electronics. The AdMoVeo robotic platform is designed, purely for teaching the industrial design students basic skills of programming and for motivating and encouraging the design students to explore their creativity with their passions in graphical and behavioral design.
Keywords: AdMoVeo, robotics, playful learning, creative programing

1. Introduction

Industrial design of intelligent products and systems is a contemporary challenge which deserves more attention and better support by methods and tools [1]. Things becomes more complicated when intelligence is distributed over and embedded in the networked devices [2-7]. Like many other design departments, we are facing the challenge of teaching the engineering principles and practices such as computer science and mathematical modeling to design students that are neither mathematicians nor computer scientists [8]. Most of the students in our department do not have an inherent affinity towards programming and electronics. But they do have passion in visual designs and product behaviors. Traditional ways of teaching programming and electronics by lectures combined with exercises had been tried in our department, but the students found that it was hard for them to build the link between the theory and the practice. Design students are often eager to put the just learned knowledge into their practice, if not immediately, as quickly as possible [8, 9]. Any longer delay in delivering the hands-on experience only builds up their frustrations and disappointments. The AdMoVeo robotic platform [10, 11] is designed purely for the purpose of teaching the industrial design students basic skills of programming. Moreover we aim at a platform that motivates and encourages the design students to explore their creativity with their passions in graphical and behavioral design, which in turn gives them spontaneous and intrinsic drive in learning programming.

2. Creative Programming

We started with seeking for a programming language and environment that are relatively easy to get immediate hands-on experience yet sophisticated enough for introducing serious software design concepts and principles to the students. This seemed to be contradictory. For example the Logo programming language simplifies vector graphics coding by introducing using a relative cursor (the "turtle") upon a Cartesian plane and hiding the basic concepts and principles of functional programming. In the university education, these concepts and principles are however important elements for the students to learn. Programing languages such as C, Pascal and Java are used in the universities for the introductory courses for the students in disciplines such as computer science and electrical engineering. But these languages have higher hurdles to overcome and as we mentioned in the introduction they are not suitable for introducing programming to the design students.

We then discovered Processing. Actually it was the students who discovered Processing, after they were taught to use Java and found it to be difficult. The homepage of processing.org, it states that "Processing is an open source programming language and environment for people who want to create images, animations, and interactions. Initially developed to serve as a software sketchbook and to teach fundamentals of computer programming within a visual context, Processing also has evolved into a tool for generating finished professional work." It seems to suit our purposes. However in industrial design, students need to be motived and intrigued with things that have a physical form, especially a physical and dynamic form that is driven by embedded intelligence [12-14].

We were then looking for an "electronics prototyping platform based on flexible, easy-to-use hardware and software" (arduino.cc) that could be easily used with the Processing environment. The Arduino board seems to fit perfectly. However Arduino alone cannot create any dynamic behavior. It has to be connected to sensors and actuators to make it run and sing. Since the electronics was not the main purpose of a programming course, we did not want the students to spend too much of time on it. A robotic platform, driven by an arduino board, called AdMoVeo, is then created.

3. Hardware Design

The design of AdMoVeo (Fig. 1) features a detachable Arduino Diecimila board and two wheels integrated within the round shape of the chassis. The size of the chassis is increased from 10cm to 12cm in diameter, exactly the size of a CD. The chassis and motor mount are made from transparent acryl glass, giving it a see-through look into everything inside. The sensors include two line readers at the bottom, three infrared distance sensors at the sides and in the front with sensibility of 0 to 20cm, two light sensors in the front, two sound sensors at the sides and two optional encoders coupled to wheels. The actuators include two motors driving two wheels, a buzzer and a RGB color LED integrated into the acryl chassis. An XBee module is optional for wireless communication.

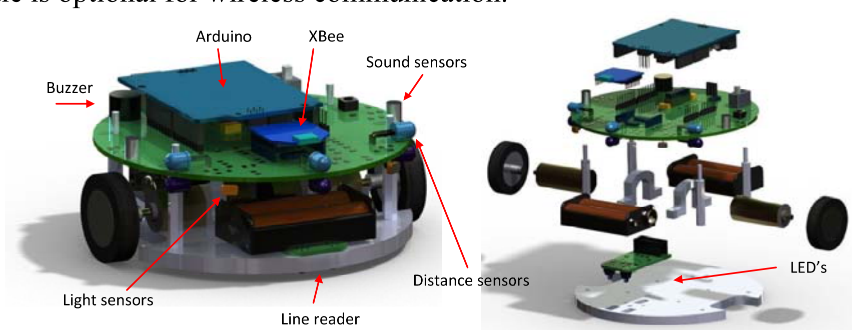

Fig. 1 AdMoVel Hardware design

The Arduino board is designed to be detachable, so that the students can take the Arduino boards with them after the course and further make use of them in their design projects. The hardware is designed to be easily assembled by students themselves. Experience with soldering and wiring the components together gives the student a lot of confidence in handling the electronics. Extra attention was also paid to the layout of the components, so that modifications and extensions can be done easily. For more experienced students, they can detach the preconfigured sensors and actuators, and connect different ones for their applications, without paying too much of efforts.

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4. Software Design

The open source Arduino board comes with a programming environment and language, which is very close to Processing. However, the Arduino language is based on C++, and we did not want to get the students into the complication and the confusion. We designed the software to separate the concern and to focus the students only on Processing. The software design is based on a layered structure of composition and inheritance (Fig. 2). It has mainly two major parts – the firmware IDuino running in the Arduino microcontroller of the AdMoVeo robot, and the Java API library for programming and controlling AdMoVeo in the Processing programming environment.

The firmware IDuino is an implementation of Firmata (see firmata.org), a generic protocol for communicating with microcontrollers from a host computer. At the host computer side, the Arduino object acts as a proxy to the firmware, hiding the communication details and providing transparent access to the digital and analog I/O pins of the Arduino board. The AdMoVeo class further wraps up the Arduino I/O details, providing transparent access to the sensors and actuators of the physical robot. Once the IDuino firmware is uploaded to the robot, the students only need to program the robot from the computer using the Processing language without leaving the Processing programming environment and touching any pieces of the Wiring code inside the Arduino microcontroller. Programming examples can be found in [10] and on the website of wiki.id.tue.nl/creapro.

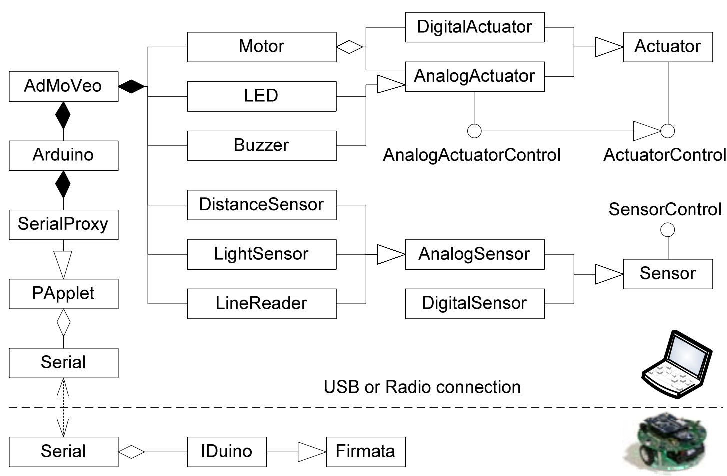


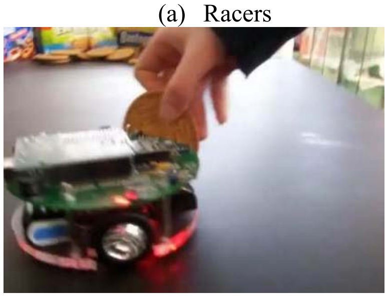
Fig. 2 Software Architecture

5. Examples of programmed AdMoVeo

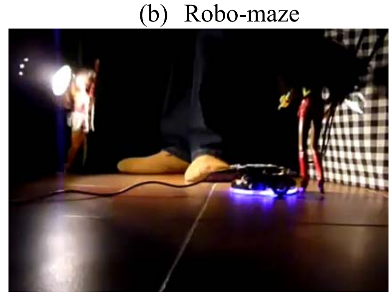
The AdMoVeo has been used for teaching Creative Programing in our department since 2008, for about 400 students. We were supersized by how well they could learn and by the creativity they had put in creating the behaviors for the robot. There were racer cars (Fig. 3a) using the light sensors to follow the lines on the floor; there were maze solvers using distance sensors to find the way out (Fig. 3b); there were cookie finders and Barbie chasers using the distance sensors to follow an object (Fig. 3c&d); there were also robots that were created to work with other systems, such as a music selector that detected the CD covers and sent the information to a music player(Fig. 3e), and a robot that could be controlled using Phidgets (Fig. 3f). More of these examples can be found on YouTube by searching for “AdMoVeo” and “Creative Programming”.

(a) Racers

(b) Robo-maze

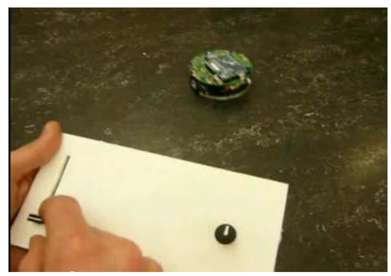


(c) Cookie

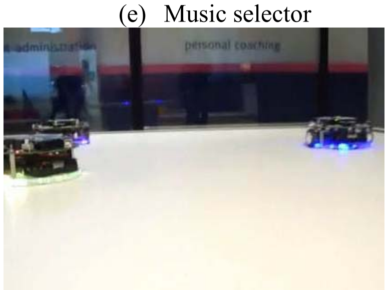


(d) After Barbie

(e) Music selector



(f) Phidget-admoveo



(g) AdMoVeo in Dutch Design Week

(h) De Food Robots by Knol-ontwerp

Fig. 3 AdMoVeo examples

AdMoVeo attracted the attention from designers and media. They were demonstrated in the exhibitions of the Dutch Design Week 2009 (Fig. 3g). The designers from Knol-ontwerp (www.knol-ontwerp.nl) used AdMoVeo to serve food in their techno-food exhibitions (Fig. 3h). Tom's Guide introduced AdMoVeo as one of these "Build Your Own Gadgets" for teaching “design students to bypass the complexities of hardware and circuit design and to instead focus on the programming aspect” [15].

AdMoVeo also attracted attention from the more or less technology-minded. It is used in the department of electric engineering at our university for the students to experiment with technologies used in automotive path-finding. They were also used in one of the primary schools in Eindhoven (Basisschool De Bijenkorf) for teaching children about robotics.

6. Concluding remarks

The AdMoVeo robotic platform is designed purely for the purpose of teaching the industrial design students basic skills of programming. Moreover we aim at a platform that motivates and encourages the design students to explore their creativity with their passions in graphical and behavioral design, which in turn gives them spontaneous and intrinsic drive in learning programming. In the design of AdMoVeo, the transparency provided by the software structure enables the student focusing on the programming aspects, and at the same time quickly being engaged in hands-on experience with embedded behaviors; the separation of the Arduino board from the robotic platform invites the students further apply and further develop the learned knowledge in their design projects.

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Using LEGO Mindstorms in Higher Education: Cognitive strategies in programming a quadruped robot

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Abstract: An Educational Robotics laboratory was organized for 102 students of the Cognitive Psychology course, at the Arts and Humanities Faculty (University of Calabria), to study the cognitive strategies they adopted to create a quadruped robot with the Lego MindStorms kits. Students worked in groups to solve a common task related to building and programming the robot, able to move on four dynamically coordinated limbs, at different speeds. We analyzed the students' reports, from which we grasped the strategies they adopted to solve the assignment. Moreover, we discussed some common aspects that characterized the teamwork: the problem solving processes, the learning by doing in an enjoyable way, the motivation and the deep interest showed by the subjects in exploring new knowledge, despite their humanistic background. The experiment demonstrates that by combining Edutainment with Robotics it is possible to teach students scientific concepts through objects manipulation, which allows not only to learn with pleasure but also to acquire knowledge of other scientific fields.

Keywords: Learning-by-doing, Educational Robotics, Teaching/Learning, Edutainment

Introduction

Educational Robotics is a relatively new field focused on student's interest to use robotics kits in the learning processes at different educational levels [1; 2; 3 4; 5; 6; 7]. In the framework of contemporary educational paradigm, building and programming small robots enable students to develop advanced cognitive skills in problem solving and in thinking strategies. These cognitive functions improve the acquisition of new knowledge. Educational Robotics is a theoretical and applicative field based on the constructivism approach [8; 9; 10], which aim is to support the traditional teaching/learning methodologies with entertaining hands-on tools.

Educational Robotics can serve to create perceptually grounded experiences that increase learning and understanding. Specifically, students can operate with tools useful to acquire concepts through mechanical devices, developing logical reasoning and creativity. Robotic applications represent a highly motivating activity for the students, thus also fostering their collaboration [11]. Jardón et al. [12] organized the CEABOT competitions, encouraging students to start with robotics, programming little humanoid robots constructed by their own or adapted from a commercial kit. Maia et al. [13] used Lego MindStorms to teach the programming languages with the support of the robotics kit. This approach helped students to improve their learning strategies in a creative way. They underlined the importance of robotics as a method of learning in various areas of education, where it assists the teaching-learning process of disciplines such as programming, software engineering or others, providing greater motivation and, above all, solidification of the concepts.

Mitnik et al. [11] described robotic activity based on face-to-face computer able to support collaborative learning, in this way highlighting that students, that use the robotic tools, achieve a significant increase in their graph interpreting skills. Kato & Tominaga [14] used the Lego MindStorms robot to introduce programming lesson for college freshmen and high school students. They emphasized the role of problem solving skill, motivation, and the importance of the collaborative work as educational strategies.

In this paper, we describe the results of a didactical experience that involved students, who attended the Robotics Laboratory connected to the Cognitive Psychology course. These students, working with the Lego MindStorms kit apprehended how to build and program a Lego quadruped robot able to move at different speeds. The next sections present the methodological proposal, the results analysis and the conclusions.

1. Methodological proposal

1.1 Objective

Our research is aimed at studying the cognitive strategies adopted by each team for the developing of their robotics projects, using motivating and innovative tools labeled as "Edutainment robotics" [1; 5]. These tools bring together students and robots, promoting a new learning method based on learning-by-doing approach [15; 9; 16].

In particular, we aimed to analyze how students work with Lego robot to reproduce cognitive processes, simulating their functioning. During the Cognitive Psychology course, the students learned the conceptual aspects and then reproduced them through the didactical activities carried out in the Robotics Laboratory.

1.2 Subjects

102 university students attended the Laboratory of Robotics, activated inside the Course of Cognitive Psychology. The students were enrolled in the Faculty of Humanities (University of Calabria, Italy), so they had a humanistic background. Indeed, the questionnaire results showed that the subjects were unfamiliar with the basic concepts of Computer Science (i.e., algorithm, computer programming, visual language and so on). Besides, they did not know about the Lego MindStorms robotics kit functionalities. Nevertheless, they used the computer only to surf the Internet or to play videogames. The subjects worked in small groups in a cooperative way.

1.3 Materials

In order to carry out the robotics activities with the students, we used the Lego MindStorms robotics kit. This kit includes over 700 traditional Lego bricks and also consists of motors, sensors, gears of different dimension, a microcomputer (RCX) and a building guide (Constructopedia). The elements of the kit allow the user to design, build and program (with a special software RCX code) a Lego robot.

To build a Lego robot, users can choose either to consult the guide or to work creatively, assembling not only the robot's body, but also the physical structure with touch and light sensors. Then, subject's activity involves the robot behavioral programming. To each group we administered a questionnaire with closed format questions, asking the students to indicate: "How did you come to solve the problem?", "What kinds of processes were used in the implementation of the robot?" and "How did you come to design the functioning model of the robot?"

1.4 Procedure

All the students attended the Laboratory of Robotics for two hours a week, for eight weeks. The researcher organized the didactical activities as follows:

- 4 hours to introduce some basic computer science concepts (e.g. algorithm, flowchart, and programming) and the RCX code (Robotics Command System) a visual programming language useful to program the Lego robots.
- 4 hours to introduce the key concepts related to the educational robotics (comparison between traditional robot and Lego, sensors and actuators devices, and the Lego robot mechanism).
- In the last 8 hours of the laboratory activity, students built various kinds of robots and then programmed them by using the RCX code commands.

The didactical plan comprised two main activities that engaged all the students. In the first activity, students worked with the robotics kit, thus constructing many kinds of Lego robots. Then, the researcher introduced the programming concepts. After this initial hands-on session, the researcher assigned to the students the following task: "*Try to build a quadruped able to move at different speeds*". We gave to each group a Lego MindStorms robotics kit, necessary to build the robot, and a computer equipped with the RCX code to program the robot. During the course, students could perform several tests on quadruped to ensure an accurate result from a physical and behavioral standpoint. Moreover, in the last meeting, they had to assemble the final version of the robot. In order to achieve the goal, during the session test each group could modify the robot behavior, chancing both software program and hardware structure. Each group had to report and explains in details the working modalities, which were adopted to build the robot. In addition, to each group it was suggested to:

1. analyze the goal of the task (subjects had to study how to articulate the dynamic behavior of the robot, analyzing its movement). Each group discussed how to set the optimal gear ratios configuration. Through the gear reduction, this fast-but-weak motor power could be transformed into a powerful but slow rotation, suitable for powering wheels, gripper hands, elbow joints, and any other mechanisms;
2. describe the hardware components, that were used to build the Lego robot (sensors, gears, etc.). Subjects had to explain the choice of the Lego pieces and their appropriate position in relation to the robot architecture;
3. observe the robot's behavior in the real environment. Robot performance was a crucial point to achieve the goal of this task. Thus, taking into consideration that the scientific knowledge is based and/or derived from the observation of natural phenomena, each group applied the direct observation to analyze the robot's movement. Considering that, in educational robotics the explanation is a key aspect of the scientific work, the students were invited to report, analyze and discuss what they observed during the empirical evaluation.

Consequently, when the robot didn't work correctly, subjects had to identify the problems and to change the hardware structure and/or the programs according to the assigned task.
Finally, in order to investigate both read-up and planning modalities, adopted by each group of students to complete the task, there was prepared and administered a questionnaire.

1.5 Methodology of data analysis

The aim of data analysis was to analyze the cognitive strategies adopted by the students to design and build the Lego robot in order to achieve the task. After having considered the strategies adopted by students (such as behavioral categories), we could analyze the relationships between educational robotics concepts and didactical activities. Thus, we *explored the following aspects: the cognitive design of the Lego robot, carried out by each group to identify the different cognitive adopted strategies; the robotic agent hardware (analysis of the physical structures of the robot); the robotic behavior (analysis of the robot movements).*

2. Results analysis

2.1 Cognitive design of a robotic agent

The analysis required to identify the cognitive strategies adopted by each group to design and build the Lego robot. At the same time, we provided information on the robot's structure carried out by each student's group that had to perform the assigned task. In order to identify the kinetic characteristics of the quadruped movement, the 34% of the subjects affirmed that, before designating robot, they acquired some information about animal behavior and hardware robotics mechanisms. The 50% of the subjects worked applying trial and error strategies; while the 6% of the subjects said that they tried to interact with other subjects of the groups. The remaining 10% used both observational analysis and worked through trial and error approach. Moreover, the 26% of the subjects, before building the final artifact, sketched a general scheme of the robot structure; the 9% of the subjects initially built the single structures of the robot (for example, legs, sensors) and, going from the particular to the general, they created the artifact's body. Finally, the 65% of the subjects affirmed that they utilized a mixed approach, both sketching a general scheme of the robot's structure and building the single structures of the robot, after they had assembled the final structure.

2.2 Hardware Analysis

All students' workgroups, that attended the Laboratory of Robotics activities, solved the assigned task: so they built and programmed a quadruped Lego robot. Observing the robot's movement, carried out by the students, we found that only two quadrupeds were able to move at different speeds. We find that the students implemented the quadruped robots using different strategies. Thus, we identified three main typologies of the Lego robot that were built (Figure 3a, 3b, 3c).

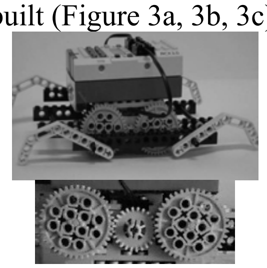

Figure 1a – First type of robot constructed by Group A

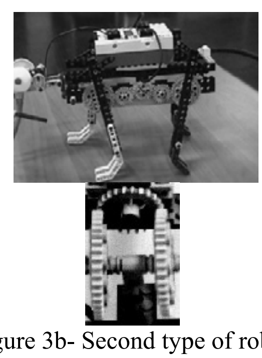

Figure 3b- Second type of robot constructed by Group B

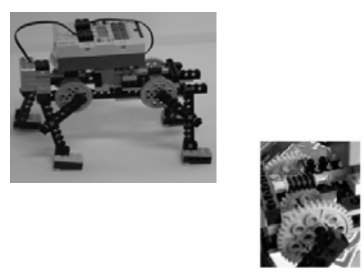

Figure 3c- Third type of robot constructed by Group G

The subjects carried out the Lego quadruped movement by designing and implementing specific gear ratio configurations. Most of the groups (89%) completed the first type of robot, equipped with simple gears mechanism (Figure 3a). In fact, in order to build the robot, the subjects used always the same kind of gears. The subjects were able to design a support structure that mounted dissimilar gears in different positions (Figure 3a). The subjects of the Group B and G were able to create a complex gears mechanism. Figure 3b and Figure 3c show the gears configuration. In particular, the Group B used an angular gear. The Group G created a worm gear, connecting it to the motor through an axis. Although this gear mechanism was not showed in the guide, each group was able to accomplish this configuration. The three typologies of robot showed different levels of behavioral complexity, enabling the robot to perform specific movements.

2.3 Analysis of the software programmes

We collected 19 software programs, implemented by 19 groups to control the quadruped's movement. The programmes were analyzed applying the following criteria:

1. Programs working according to the given task.
2. Programs not working according to the given task.

The programs, that didn't perform the task correctly, were analyzed to identify the most frequently errors in correlation with the physical design of the touch sensors and motors. We founded the following errors:

- Setting errors includes failure in the configuration of the commands.
- Code errors include omissions of commands.

Using this methodology [2] to analyze the software programs, we found that the 11% of the robots performed the task correctly, while the remaining 89% didn't work according to the given task (though the robot moved, it didn't accomplish different speeds). It seemed interesting to analyze the different types of errors presented in the programs as "Programs not working according to the given task", considering that the presence of these errors not only prevented the robot to operate successfully in the real world, but also reflected in the subject an unclear conceptual understanding regarding the system functioning. The analysis revealed that 50% of programs as "Programmes not working according to the given task" presented "Errors of setting", while the other 50% of the errors were due to the "Omission of commands". It is worth pointing out that the setting errors referred to the choice of commands, which did not fit to the task. While, the "Omission of commands" prevented the robot to properly operate. In many situations, the robot is not able to move or to execute commands adequate to the task.

3. Conclusions

This paper deals with the analysis of how, through the use of entertainment technologies, such as Lego MindStorms kit, students can learn to design, build and program complex Lego robot able to operate autonomously in the real world. Usually, students involved in the traditional educational processes, develop higher cognitive strategies operating with scientific tools to reproduce and experiment their own hypothesis and ideas. In particular, the used approach required each team to define the objectives, working methodologies and cognitive strategies necessary to create the Lego quadruped robot. Accordingly, we explored the cognitive strategies that each student group had adopted to solve the didactical assignment. The results showed that some student groups preferred to operate, going from the particular to the general; other groups preferred the opposite procedure. Moreover, by using classroom projects, we intended to promote a deep learning, where students can experiment technology and to study how they can be engaged with issues and questions relevant for their curricula. Indeed, different groups deepened their study, improving their knowledge regarding the Lego mechanism, the programming and other activities, which are very far from their humanist background. Nevertheless, from the practical point of view, students consider it more stimulating to learn new concepts using scientific tools because this enables them to create practical objects. The described kind of Laboratory activity stimulates students to develop different cognitive abilities such as logical thinking, problem solving strategies, creativity, planning the actions of the workgroups (exchange of knowledge and integration of collaborative learning programming, applying the concepts learnt in the classroom). All these strategies are useful to students to create a complex prototype of Lego robot (constructing and reconstructing it). Eventually, the obtained results were satisfactory, considering that all teams solved the goal through cooperation and knowledge exchange. We perceived that the task enhanced the students' motivation, especially when they observed how their robot worked according to the assignment. Therefore, students, through learning-by-doing approach, not only built their robots, but also improved their own mental knowledge. Furthermore, they learnt by a playful setting which is the ultimate goal of *Edutainment Robotics*.

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Parents' Perception Toward Topobo

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Introduction

In recent years, robots were received more attention in educational fields (Liu, Lin & Chang, 2010). Liu（2010）interviews 48 elementary school students, included fourth, fifth and sixth graders, and found that students perceived educational robots as a plaything, source of employment, and way to high technology. Moreover, the result reflects that the parents start focus on children's technological capabilities from students' perception of educational robots. The previous study (Liu, 2010) did not collect the perceptions of parents, however the parents is the most important person in deciding whether or not to attend the robotics course. Therefore, the purpose of this study is to investigate parents' perception of programmable bricks.

Methods

1.1 Participants

The questionnaires were sent to 55 parents whose children were study in a kindergarten in northern Taiwan, and 26 questionnaires were returned. All the 26 questionnaires were valid. The response rate is 47%. Among the 26 parents, 10 were male, 16 were female. This kindergarten is in a research-oriented university, and 1 parent were 26 to 30 years of age; 9 parents were 31 to 35 years of age; 12 parents were 36 to 40 years of age; 4 parents were above 40 years of age.1 parent graduated from elementary school, 2 parents graduated from senior high school, 11 parents held bachelor's degree, and 12 parents held master's degree.

1.2 Instrument

The scale developed from Liu (2010) was adopted to evaluate parents' perception of programmable bricks. This questionnaire included two subscales: usefulness of programmable bricks; confidence in teaching kindergarten children with programmable bricks. The exploratory factor analysis was used in this study. The factor loading for all the item were higher than .70, and the total variance explained reached 77.76%. It showed this questionnaire has construct validity. The value of Cronbach's α of this questionnaire were ranging from .768 to .928, and it showed this questionnaire is reliable.

Results

The result showed that the mean of the subscale, usefulness of programmable bricks ($M=4.51$, $SD=.84$), was significantly higher than the score of the subscale, confidence in teaching children with programmable bricks ($M=3.35$, $SD=1.15$) ($t= 5.00$, $p<.001$). The result showed that parents considered that programmable bricks were beneficial for their children. However, the parents are not confident that to teach their children with programmable bricks.

Conclusion

This study found that parents' perception of usefulness of programmable bricks is positive, and the result enhances the potential of using programming bricks in children education. However, mention to the confidence in teaching children with programmable bricks, the result showed that parents did not have much confidence to teach their children with programmable bricks. The future study may further investigate what kinds of training or support do parents need, and design related training courses to help them improve the knowledge or skills to play programmable bricks with their children.

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Demonstration of Multimedia Instructional Media for Teaching Robot

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Introduction

These years, robotics has become a hot topic (Liu, 2010; Liu, Lin, & Chang, 2010). This study focused on the design and development of multimedia material for teaching LEGO MINDSTORMS NXT robotics. The multimedia material would guide the learners how to build a farm planning robot, and how to control the robot to draw lines via a sound sensor.

Methods

1.1 Multimedia instructional material of farm planning robot

The instructional material included five elements: story, design journal, assembly, and programming. The story element would used to attract students' motivation, and present the task they have to complete. The story of this learning content was about the immigration in a whole new plant, and the students have to design a robot to arrange and plan how to use the farm of the plant. In this material, the students learn how to design a robot which can draw lines on a poster, and students learn how to use sound sensor to control their robots. The design journal would guide the students to brainstorm and design their robots. The assembly element would help students to construct their robot, and the program element would guide the students how to write a program to control their robots. In this instructional material, the students have to design their own farm planning robots. The learning objectives included: 1. understanding how to use sound sensor to control their robot. 2. Learning how to control and use the motors on the robots.

1.2 Participants

19 students rolled in the course participated in this study. All the students were pre-service teachers. Six were undergraduate students, thirteen were graduate students. 9 were male, and 10 were female.

1.3 Instruments

The evaluation form was adapted from the evaluation form of instructional material of robotics developed by (Liu, Kou, Lin, Cheng, & Chen, 2008). This evaluation form was used to collect students' perception about the necessity, importance and satisfaction of the instructional material. This evaluation form was design in six-point style (6 means very agree, and 1 means very disagree).

Results

The result showed that the mean of necessity, importance, and satisfaction of all elements (story, design journal, assembly, and programming) were higher than 4.5 (Table 1), and it showed that the students considered the material were important and necessary for them to learn robotics, and they felt satisfied with the learning material.

Table 1. Necessity, importance, and satisfaction of multimedia instructional material

	Necessity	Importance	Satisfaction
	M (SD)	M (SD)	M (SD)
Story	4.64 (.59)	4.91 (.45)	5.38 (1.86)
Design journal	4.76 (.54)	4.95 (.59)	4.64 (.73)
Assembly	5.11 (.49)	5.19 (.50)	5.04 (.63)
Programming	5.12 (.54)	5.16 (.54)	4.86 (.64)

Conclusion

In this study, we design a multimedia instructional material for teaching robotics. The instructional material included four elements: story, design journal, assembly, and programming. This material could use to teach students how to assemble a farm planning robot and use the sound sensor to control their robots. The student considered that the material was important and necessary for them to learn robotics, and they felt satisfied with the learning material.

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