Scaffolding computer-supported collaborative lesson design: A spiral model

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Abstract: This paper presents a computer-supported collaborative lesson design approach supported by a spiral model of collaborative knowledge improvement (SMCKI) to develop pre-service teachers' competency in designing ICT-integrated lesson for the teaching and learning of Chinese language. The computer-supported collaborative lesson design approach served to deepen pre-service teachers' understanding of lesson design using the technology, pedagogy and content knowledge (TPACK) framework. Results showed that the SMCKI is effective in supporting pre-service teachers' collaborative lesson design. Commencing with an individual brainstorming phase, the SMCKI pedagogical model scaffolds the pre-service teachers through an intra-group synergizing phase, an inter-group critique phase and an intra-group refinement phase, to support the advancement of their collective and individual knowledge in the collaborative lesson design. The findings show that the employment of SMCKI on computer-supported collaborative lesson design was able to bring about a collaborative knowledge improvement to designing ICT-integrated lesson in the teacher preparatory course.

Keywords: computer-supported collaborative lesson design, collaborative lesson design, computer-supported collaborative learning

Introduction

The integration of Information, Communication and Technology (ICT) to facilitate 21st century Teaching and Learning (T&L) had become pervasive in educational institutes globally (Ghavifekr & Rosdy, 2015; Goh, Lee & Taylor, 2016; Valtonen, Sointu, Mäkitalo-Siegl & Kukkonen, 2015; Wilson, Tete-Mensah & Boateng, 2014; Wu, Yen-Chun, Chia-I & Chih-Hung, 2017). Therefrom, creating a technology-infused learning environment is no longer an alien affair. However, past research findings had shown that educators perceived ICT-integrated lesson design significantly difficult, challenging and demanding, especially when aligning among content, pedagogy and technology knowledge (TPACK) (Chai, Koh, Lim & Tsai, 2014; Koehler, Mishra, Bouck, DeSchryver, Kereluik,Shin & Wolf, 2011; Looi, So, Toh & Chen, 2011; Wong, Chai, Zhang & King, 2015). Hence, in order to prepare these pre-service teachers with the skillset to engage learners with meaningful use of technology, developing them with the relevant competency to design such lessons is exigent (Finger, Romeo, Lloyd, Heck, Sweeney, Albion & Jamieson-Proctor, 2015; Valtonen, Sointu, Mäkitalo-Siegl & Kukkonen, 2015).

In fact, past studies showed that collaboratively design technology-enhanced curriculum materials do support teachers in becoming TPACK competent (as cited in Agyei & Voogt, 2012). Effectively, research had also advocated that the engagement in design teams enabled productive sharing of knowledge, skills, experience and challenges related to technology-enhanced T&L (Kafyulilo, Fisser & Voogt, 2016; Voogt, Laferriere, Breuleux, Itow, Hickey & McKenney, 2015). Even though collaboratively designing a curriculum can be administered with different approaches, the use of technology to support collaborative learning and idea improvement is recommended (Chen, Looi, Wen, 2012; Jeong & Hmelo-Silver, 2016; Resta & Laferrière, 2007; Stahl, Koschmann & Suthers, 2006). Furthermore, not only would computer-support impacts the collaborative lesson design, but it could also improve learning in teacher education. Thus, we perceived that with Computer-supported collaborative lesson design (CSCLD), the learning potential of collaboration in higher education will be enhanced. In view of this, this study aimed to examine the process and outcome of scaffolding CSCLD via the pedagogical support – the Spiral Model of Collaborative Knowledge Improvement (SMCKI) (Chen, Zhang, Wen & Looi, 2019). The research questions (RQ) of the study are as follows:

1) How do the pre-service teachers collaboratively design the lesson ideas throughout the different phases of SMCKI?

2) How do the inter-group critique help with the collaborative lesson idea design?

Literature Review

Design for technology-enhanced learning (TEL)

Using TPACK as a framework for designing TEL had been long acknowledged as a useful approach to help build teachers' competency in integrating ICT in lessons design and implementation (Chai, Koh, Tsai & Tan, 2011; Koh, 2013; Koh & Chai, 2016). TPACK was defined as the dynamic, transactional relationship between the content, pedagogy and technology, and the combination of these 3 elements was aimed at developing appropriate, context-specific strategies and representations for ICT-infused lessons (Koehler et al., 2007). Offered to teachers as a framework for effective technology integration in T&L (Koehler, Mishra & Yahya, 2007; Mishra & Koehler, 2007). TPACK emphasizes the integrated use of technology, pedagogy and content knowledge for effective technology integrated lesson design (Thompson & Mishra 2007). However, past research studies that employed TPACK as a lesson design knowledge in pre-service education did not seem to yield satisfactory results, although perception and knowledge acquisition was relatively well established (Knoef & Lazonder, 2019).

So and Kim (2009) indicated that since content (CK), pedagogical (PK), and technological (TK) knowledge are all inter-related, teacher education programs should be structured in a holistic manner to allow pre-service teachers to see their connections as studies had found them less able to consider linkages between content and pedagogy when envisioning their lesson agendas as compared with expert teachers (Copeland et al., 1994; Leinhardt, 1989; Sabers et al., 1991). On this ground, Koh (2018) discovered that design scaffolds had positive effects on teachers' TPACK confidence and were useful to help them articulate pedagogical change in their lesson designs. In addition, Tanak (2018) also recommended including authentic experiences to create a practical experience in learning in a TEL environment. For this reason, the learning-technology-by-design approach was adopted in this study.

Learning by Design is an approach whereby an environment is created for teachers to naturally confront them through participating in the TPACK lesson design (Koehler & Mishra, 2005). This differs from a traditional technology workshop or class where teachers were trained to be consumer of tools, with the hope that they can apply them to their practice. By employing Learning by Design approach in this study, not only can pre-service teachers collaboratively worked on designing a TEL environment, they can experience such a learning environment as the capacity of a student as well.

Collaborative lesson design

Collaborative lesson design approach was deemed as a promising strategy for developing teachers' learning and supporting them in becoming TPCK competent (as cited in Agyei & Voogt, 2012; Voogt, Fisser, Roblin, Tondeur & van Braak, 2013). The benefits of the collaborative designing include: shared cognition, increases the effectiveness of creative and innovation processes, critical understanding of a product through reciprocal reasoning (Kangas, Seitamaa-Hakkarainen & Hakkarainen, 2013; Tschimmel, 2012). Specifically, this approach promotes trying out new tools, expertise sharing, reflection on pedagogy and collaborative work to improve teaching skills and the academic performance of students (Kafyulilo et al., 2015; Lee, Lee & Kuptasthien, 2018) to bring about divergent thinking among the teacher designers (Brown & Wyatt, 2010). In addition, findings had shown that design teams offered collaborative learning opportunities, at the same time, enhance the development of TPCK (Kafyulilo, Fisser & Voogt, 2015). Furthermore, collaborative and reflective practices were reported to increase teachers' understanding and thinking of their professional experiences in various situations, emphasizing that prejudices can be overcome through interactions and collaboration with peers (Aşık, Eroğlu İnce & Şarlanoğlu Vural, 2018).

Pedagogical model for collaborative lesson design

Although there are several models and approaches to collaborative lesson design, this study adopted the learning technology by design approach. This approach could provide theoretical grounding of including technologies in the pedagogical decisions as well as appreciating the constraints and

affordances of using technologies in the working environment (Benning, Linsell & Ingram, 2018). Indeed, this use of technology to support collaborative lesson design is also a form of Computer-Supported Collaborative Learning (CSCL) (Stahl et al., 2006) as its application did "provide communication, coordination and collaboration tools that ease group dynamic regardless of space-time location of group members" (Costaguta, Santana-Mansilla, Lescano & Missio, 2019, p. 159). While CSCL provided the means for CSCLD, SMCKI (Chen et al., 2019) was employed as the pedagogical model in this study. Elaboration on the 5-phase SMCKI will be delineated at the methodology section.

Methodology

The participants in this study were 23 pre-service Chinese language teachers who were in their 3rd year of the Bachelor of Arts programme with the National Institute of Education, Nanyang Technological University Singapore. They were enrolled in a course on designing effective ICT-integrated learning environments. Demographics of participants comprises: 78% between 20 – 25 years old and the remaining between 26 – 35 years old. The lecturer is the 2nd author of the paper, who had 2½ years of experiences in educating pre-service teachers on the effective use of technology for T&L of the Chinese language. Given the practical constraints, only a small sample size was recruited.

Among the 23 students, a total of 6 groups were formed by students themselves, with 5 groups of 4 members each and 1 group with 3 members. According to Chapman, Meuter, Toy and Wright (2006), self-selected groups may simulate "real-world" workgroups more closely than randomly assigned groups and evidence had suggested that self-selected groups led to better group dynamics and yield better group collaborative work results" (as cited in Chapman et al., 2006, p. 560).

The CSCLD was carried out in January 2019 with a 1-hour duration. During the face-to-face (F2F) lesson, participants were tasked to collaboratively design an ICT-integrated lesson unit for Chinese language T&L targeting at primary schools students in Singapore. The task requirements comprised: 1) content alignment with the Singapore Chinese language curriculum; 2) at least 2 language skills (listening, speaking, reading or writing); 3) CSCL with appropriate PK and TK. With CK as participants' prior knowledge, the lecturer taught them the necessary PK and TK. The PK for this task consists of 3 lesson design principles: 1) seven affordances of CSCL (Jeong & Hmelo-Silver, 2016), 2) the seven pedagogical principles for collaborative virtual environment (Rubens, Emans, Leinonen, Skarmeta & Simons, 2005) and 3) the seven principles of designing a student-centered learning environment (Aw, 2018). Among the various TKs taught the specific online collaborative platform Padlet was used as the media for the CSCLD process as well. The selection of Padlet was premised on an affordance analysis based on 3 online collaboration tools (Google doc, Linoit and Padlet) (Mallon & Bernsten, 2015). Padlet ranked highest as it possesses the feature of linking comments with the generated post (idea), which is important for ease of peer-comments visualization in this study.

Prior to the CSCLD, each group leader had to create their group Padlet board and share it with their group members. The hyperlink of the group's Padlet board was subsequently posted to the virtual class wall, Edmodo. Every participant within the class had an account in Edmodo. Edmodo class page served as a base camp for communication and dissemination of information. Through the hyperlinks, the lecturer could also monitor the online posts for each group at each phase. The following delineates the CSCLD procedure via SMCKI:

Phase 1 Individual brainstorming (10 minutes): Individual lesson ideas posting based on learners' needs on the Padlet group board.

Phase 2 Intra-group Synergizing (20 minutes): At the individual group level, members view the lesson idea of each other, discuss, consolidate and synthesize a highest quality group lesson idea.

Phase 3 Inter-group critique (15 minutes): Based on round-robin schedule, participants view other group's lesson idea and provide constructive comments and suggestions for idea improvement.

Phase 4 Intra-group refinement (15 minutes): Participants returned to their group board to read the comments/suggestions given by other groups. Intra-group discussion took place and to refine their lesson idea.

Phase 5 Individual perfection (after class): Individual participant reflects his/her take-away from the collaborative lesson design activity and writes a reflection report.

Data collection, Analysis and Results

Lesson ideas generated at phase 1 (P1), phase 2 (P2) and phase (P4), including peer comments at phase 3 (P3) from Padlet were collected to examine the learning process and outcome of the CSCLD activity.

To answer the RQ1 on whether SMCKI is effective in proving students' ideas through the CSCLD, both the quantity and quality of lesson ideas generated were examined via content analysis. The unit of analysis was each lesson idea posted at P1, P2 and P4 in the Padlet group boards. Given the context of the lesson design for ICT-integrated lesson, the coding scheme for evaluating lesson idea on using TPACK for meaningful learning with ICT (Koh, 2013) was adopted in this study. Koh's coding scheme was based on Jonassen, Howland, Moore, and Marra's (2002) and Howland et al.'s (2012) framework of meaningful learning with ICT. The 5 dimensions that characterized how ICT could support "Meaningful Learning" are:

1) active – where students were not passive listeners but actively manipulating objects and information, and observing results; 2) constructive – where students constructed knowledge, reflected, and articulated their personal understandings of the phenomenon; 3) authentic – where students engaged in the solving of real-world problems; 4) intentional – where students set their learning goals and planned their learning pathways; and 5) cooperative – where students worked with peers to learn.

Each post was coded from the 5 dimensions with a scale of 1 to 5 based on the quality of the content. Lesson ideas at P1 were individually scored and the mean score computed to compare against the group synergized idea at P2 and P4. Out of the 6 groups, 5 groups showed collaborative knowledge improvement from P1 to P2. The idea improvement at P4 was evident after P3 as well. Results showed that 5 out of 6 groups had productive intra-group discussions which led to improved lesson idea at P4. Therefore the RQ 1 is answered. Guided by SMCKI, the CSCLD, to a large extent, had supported pre-service teachers' collaborative knowledge improvement in the lesson design process.

To answer the RQ2 on how the inter-group critique helped with the collaborative lesson design, further content analysis was conducted on the inter-group peer comments data at P3 to examine if and how the inter-group peer critique help improve the quality of the lesson ideas. Based on the coded data, there were a total of 56 comments (M=2.4) made during the mere 15-minutes at P3. Of all the comments analyzed, 43% reflected relevant supporting evidence and reasoning using the lesson design principles and task requirement. The coding scheme from Clark and Sampson (2007) and Chen et al. (2019) was adapted to analyze the peer comments. The 4 dimensions in the coding scheme are: 1) Support (with relevant evidence or reasoning); 2) Rebuttal (attack an explanation with relevant shreds of evidence or reasoning); 3) Query (seek clarification with relevant evidence or reasoning), and 4) Emotive appeal (the comment is emotional in nature without relevant evidence or reasoning). Each comment was coded with a scale of 1-5 where 5 refers to perfect and 1 refers to absence or irrelevant for all the 4 dimensions above. Of the 4 dimensions, the rebuttal and query played a pivotal role both as a reminder and a trigger to induce further considerations to the lesson design objectives and procedures during P4. The improvements made to the lesson ideas at P4 can be tracked with the comments they received from other groups in P3. Out of the 6 groups, 4 groups demonstrated improvement to their lesson design at P4. Two cases were presented below to illustrate how each group's lesson ideas were improved by addressing comments from other groups.

Table 1
Translated critiques and lesson idea improvement for Case 1 (G5)

Phase	Lesson idea / Comments (Chinese texts translated to English)
P2	"Lesson objective: Students can list the ways and examples of a healthy lifestyle. Lesson Procedure: Students collaboratively complete a poster using multimedia. 1. Students type or use pictures to populate their idea on the WHITEBOARD on the ways to take good care of our body. 2. Group discussion on individual ideas. 3. Students to complete a group poster after discussion."
P3	Comments by G4: "What is the relationship between a poster and **oral**? " "Are students able to learn commonly-used **oral skills**? "
P4	"Lesson objective: Students can list the ways and examples of a healthy lifestyle. Students collaboratively complete a poster using multimedia with **recorded speech**. 1. Students type or use pictures to populate their idea on the WHITEBOARD on the ways to take good care of our body. 2. Group discussion take place referencing individual ideas. 3. Each group to complete a poster after discussion. **4. Inter-group assessment on the poster on the suitability of the content and make**

	corrections where necessary. 5. Group refinement on poster based on comments. 6. Homework: students to record their speech using the group poster. ”

The above Table 1 showed Group 5 (G5)’s synergized lesson ideas at P2, inter-group comments received from Group 4 (G4) at P3, and G5 improved ideas at P4 (bolded words). G5’s original synergized lesson idea (P2) was to engage students with oral ideas collected through the collaborative construction of a poster surrounding the topic. This lesson idea was commented with queries from G4 members (see Table 1). Addressing this at P4, an added lesson objective was included to align the purpose of cultivating oral skill using the poster. Additional activities were also included to help students practice their oral presentation skill. The improvement from P2 to P4 was characterized by the use of ICT tools to support students in investigating real-world phenomena (P4) rather than using ICT tools for mere presentation (P2). According to Koh (2013), “the more the activity facilitated students to make connections between their own experiences and the real-world phenomenon associated with the subject matter, the more it was considered as authentic” (p. 891). In this case, the improved idea served both the practical needs of school-based oral assessment and also as a life skill with poster presentation.

Table 2

Translated critiques and lesson idea improvement for Case 2 (Group 2)

Phase	Lesson idea / Comments (Chinese texts translated to English)
P2	Students brainstorm the letter-writing content at Mindmeister/ Popplet. This is to construct a group planning mind map.
P3	Comments from G1: “I felt that student would probably create different types of mindmap. To avoid that, the teacher could provide a standard template to help students with brainstorming.” “Multi-sensory principle: when working on the mindmap, can let students draw or write in text.” Comment from G4: “Lack of scaffold in the lesson design. The teacher can provide a template, let the students use the template to sprout their ideas and refine their own product using peer comments.”
P4	“At the individual brainstorming, allow each student to search for the information related to the country the group is assigned to. Thereafter, they can post their own ideas to the mindmap. We will provide a letter-writing mindmap template for the students to fill in (eg greeting phrase, what did we do during the last meeting, where do you intend to go during the holidays, what about the season and weather, conclusion./Weather in country N, places of interest ETC)”

Table 2 demonstrated how Group 2 (G2) improved the quality of “constructive” dimension of the idea of the lesson from P2 (quality score = 3) to phase 4 (quality score = 4) by aggressing comments from other groups. This improvement was characterized through the use of ICT tools to synthesize information in order to construct verbal, written, visual, conceptual or product-oriented expressions of the subject matter. The inclusion of the “template” with “scaffold” at P4 provided a concrete base where students can brainstorm and construct the letter-writing content more systematically. Although there was no change to the individual brainstorming procedure, including a “mindmap template for the students to fill in (see Table 2) provided the means for information synthesis. This “template” which served as a “scaffold” was suggested by both G1 and G4 at P3. According to Lim and Tay (2003), higher-order thinking would only be possible with appropriate support structures and informative tools. This suggested that the improvement at P4 provided higher levels of the constructive dimension, which was demonstrated by knowledge expressions through the scaffold (Koh, 2013).

From the 2 cases presented, we perceived that the inter-group critique (SMCKI-P3) did contribute to the collaborative lesson design. Not only did the online critiques served as explicit means for the participants to engage in a self-diagnosis and remediation of the learning gaps (Koh, 2013), the same critique was also used as an agent for improving their individual group lesson design at P4.

Discussion & Conclusion

Findings from this study suggested that the 5-phase SMCKI model supported pre-service teachers with fruitful CSCLD. While collaboration among designers is often seen as challenging (Leinonen & Durall-Gazulla, 2014), findings from this study revealed that through collaboration in design teams guided by SMCKI, participants were able to learn from each other and from their practices as they designed the ICT-integrated lessons (Kafyulilo et al., 2016). The application of this approach suggested that teacher

learning can be effective if it is situated in a meaningful context, with active engagement of their own learning process and collaborating with their peers (Voogt et al., 2011). Critical thinking was promoted throughout the SMCKI process as participants had to continually engage themselves with the design principles during the intra-group discussion and inter-group critique (Kafyulilo et al., 2016). Through the active participation of the activities scaffolded by SMCKI, a knowledge creation culture was well initiated (Scardamalia & Bereiter, 2006). Pre-service teachers could see themselves and their work as "part of the civilization-wide effort to advance knowledge frontiers" (Scardamalia & Bereiter, 2006, p. 98). The culture of knowledge improvement was hence fulfilled in this activity.

Being a small scale case study, there are several limitations. Apart from the small sample size, the current data analysis only focused on the artefacts generated on the online platform. Future study can be conducted to examine both students' online communication and F2F discussion during the various phases of SMCKI. In addition, individual reflections could also be analyzed to understand the perceptions of collaborative learning in higher-education setting. Finally, considerations can be made to explore the employment of SMCKI as a pedagogical model for other disciplines or tasks in CSCLD.

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