Development of Technological Pedagogical Content Knowledge through Constructionist Activities

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Abstract

The aim of this case study was to better understand how TPACK can be developed through constructionist activities. Accordingly, a course was designed and a purposively sampled group was selected for collecting in-depth data. The findings of the study demonstrated that teachers’ knowledge and conception of using technology for teaching developed in three levels. With each level, there was an improvement of teachers’ TPACK and its components as a result of performing constructionist activities. First level was limited to usage of technology for exhibiting curriculum information. In the second level, the participants focused on using technology to present content and materials. The results indicated that in this level although two components of the participants’ TPACK, viz. TCK and PCK developed, considering technology as a learning tool (TPK) appeared to be missing. However, in the third level they developed the ability to use technology for enhancing teaching and learning. The result of the study highlighted inter and intra group interactions and learning-through-making as two aspects of constructionist activities that were more influential in the development of TPACK.

1. Introduction

Researchers have argued that teaching technology skills out of context and as separate skills is not adequate to prepare teachers for teaching with technology in their classroom (Vrasidas & McIsaac, 2001; Flick & Bell, 2000; Koehler, Mishra & Yahya, 2007). Thus, the integration of technology into curriculum for effective technology usage
is suggested by many studies (Lee, 2002; Cradler, et al 2002; ISTE, 2000; Woodbridge, 2004; White, Ringstaff,& Kelley, 2002; Willis, 2001) in order to prepare teachers for teaching with technology. Accordingly, the TPACK framework introduced by Mishra and Koehler (2006) is offering opportunities for teachers to learn how to integrate technology in curriculum. TPACK refers to the complex interplay between a teacher’s technology use, knowledge about teaching and learning process and understanding of the subject matter. The development of TPACK has received the attention of educators and researchers because it appears to be instrumental in enabling teachers to effectively use technology in teaching. However, there is a need to understand more about how TPACK can be developed through different approaches and activities.

A number of studies (Koehler, et al., 2004; Koehler, Mishra & Yahya, 2007; Cavin, 2008; Harrington, 2008; Suharwoto, 2006) have shown the potential of constructivist environments to develop TPACK. Constructivist approaches have emerged from the work of psychologists and educators such as Piaget, Bruner, Vygotsky, and Seymour Papert. Accordingly, many types of constructivism have been proposed such as radical constructivism, cognitive constructivism, social constructivism and constructionism (Karagiorgi, & Symeou, 2005).

Papert developed the constructionism framework, based on Piaget’s constructivism, with more emphasis on learning and educational view than overall cognitive potentials (Ackermann, 2001). Papert’s constructionism focuses more on the art of learning and learning-through-making. According to Papert, executing a project is the key to learning. During the project, learners engage in social interaction with artifacts. They produce their artifact and share their understanding through collaboration. Students develop their self-directed learning, and construct their new knowledge through these activities. Papert’s constructionism emphasizes the role of tools, media, and context on development of human. As such, the current study focuses on exploring two research questions as how teachers develop TPACK in a constructionist teaching method and what constructionist activities are influencing in the development of TPACK.

2. Methodology

This study utilized the case study method to answer the research questions. The course which appeared in-line with this research at an Education College in a private university was selected as the setting of the study. The class met at a technology lab for 4 hours, once a week for 14 weeks. Sample of this case study included 30 pre-service teachers enrolled for the particular course.

The current study used a constructionist environment as the research setting and the activities were planned and conducted based on constructionism approach. The constructionist environment provided a learner-centric environment. In this environment, the role of the instructor was not to prescribe which kind of technology a teacher should use for teaching, but to provide opportunities for helping the pre-service teachers to learn how to use technology and pedagogy for the particular content. During the program, the participants learned the technology through design tasks and conducting the projects. They received feedback during their activities from each other and the instructor.

The data collection methods included observations, interviews, artifacts and documents that were gathered while doing constructionist activities. Subsequently, the data was coded based on two sets of factors. The collected data was coded and categorized based on the strategies, conditions and also teachers’ behaviors, activities, actions, feelings and experiences in order to find the patterns which were helping teachers in the development of their TPACK. Every category was considered as a conceptual element that covers many individual examples to find the patterns that help in the development of TPACK. These coded data led the researcher to determine which activity helped the participants to make the relationship between their knowledge about pedagogy, technology and content and their development of TPACK.

3. Finding

This study was addressed to answer two research questions:

3.1. Research Question one
To answer the first research question of how teachers’ TPACK developed in a constructionist setting, the finding of the study demonstrated that teachers’ knowledge improved in three levels. With each level, there was a development of teachers’ TPACK and its components as a result of performing constructivist activities.

3.1.1. First Level: Using Technology for Exhibiting Curriculum Information

The participants’ initial perception of use of technology for teaching was limited to using software and the Internet facilities for exhibiting curriculum information corresponding to the content. However, the constructionist environment developed some basic knowledge of TPACK in the participants at this level through general guidance from the instructor, interaction and learning by doing.

3.1.2. Second Level: Using Technology to Present Content and Materials

In this level of development of TPCK, the participants began to change their views on using technology for presenting after receiving feedback from the instructor.

3.1.3. Third Level: Using Technology to Enhance Teaching and Learning

Teaching with technology as using a combination of technology, pedagogy and content knowledge formed only after the participants received feedback on the second version of their project implemented in the class which gave the opportunity to the groups to experience implementing their teaching with technology in a real classroom.

3.2. Research Question Two

To answer the second research question, the result of study indicated two aspects of constructionist activities which were more influential in the development of TPACK including learning through interaction and learning through making.

3.2.1. Learning through Interaction

Many types of social interactions normally occur in a teamwork setting like discussion, sharing, peer review, group activities, etc. In this study, participants developed their knowledge through different forms of interaction:

A) Intra Group Interactions

During the development of TPACK intra group interaction developed from cooperation to collaboration. Although the goal of the project in this program was based on collaboration activities more than cooperation, it was observed that members in most groups usually divided the tasks according their respective abilities. The cooperation in doing initial tasks helped the participants to develop different kinds of knowledge individually. For example, in the group student [A] was improving her Technology (TK) and Technological Content Knowledge (TCK) while student [B] was developing her Pedagogical Knowledge (PK) and Pedagogical Content Knowledge (PCK). Most of the time, activities related to TPK were missing among individual tasks. Also, tasks related to TCK needed student [B]’s approval to be done. In any case, all activities performed during the week needed to be corrected and rectified through discussions and collaboration.

The participants acquired the new concepts and skills during discussions and problem solving. For example, student [A] did not have any practical experience in teaching. Thus, she did not know about technology tools for learning. In contrast, student [B] was an experienced teacher but was not confident about her knowledge of technology. In fact, none of the participants had any experience of applying technology in learning and both TPK and TCK seemed to be new knowledge for them. They gained this knowledge through discussions. After discussions, the group members experienced how to fit technology affordances for implementing a pedagogical (developing TPK).
B) **Inter Group Interactions**

The groups interacted among themselves to seek answers to their questions when the instructor was busy with addressing other group’s questions. For example, they asked simple questions about technology like how to edit an image to fit it with the project (TK) and questions about Internet resources to find materials like images, videos or text and developed their TCK as a result. Interaction between groups appeared in many forms: in one way groups exchanged their knowledge through transaction. For example, one member from another group, joined the case study group to learn from them. She asked their permission to spend one session with them to learn what and how they were working on the project. Although she claimed she wanted to participate in the group for her learning, she engaged in the activities of the study group and offered some suggestions.

In addition, interaction among groups led the participants to follow common practices in their project design, particularly in presenting their projects. Although they did not emulate each other’s work, they tried to accomplish the same style or format when they found it to be good. For example, when group B saw that group A had created children’s activities in files, they also followed that practice. On the other hand, group A selected animated images for their project when they saw group C used it for their project. Symmetry in style was observed in many general domains such as in designing, technology formats, and in using other techniques. Because of difference in content area across groups, symmetry developed participants’ knowledge about technology (TK) and using it for pedagogical purpose regardless of content (TPK).

C) **Feedback**

Different forms of feedback received from the instructor and other participants helped the participants to develop their knowledge. The instructor offered instant feedback when the participants needed it. It usually happened in some situations like when: 1) the participants asked questions about using software or hardware, common addresses in different fields or the progress of their work; 2) the participants were going in wrong path like preparing text documents or a guidance handbook for teaching a content; and, 3) the group stopped working and started to do something other than doing the project, like surfing the internet and talking about something else.

Further feedback was received from the participants. After the presentation of a few groups, other groups received many important concepts. Feedback from the class cleared some important concepts such as realizing children to be the audience for the project and what was really expected from the project.

3.2.2. **Learning through Making**

The participants experienced usage of technology for instruction through making the project. For this purpose, they redesigned the lesson study and according to implementation of new design, provided material and new content for their teaching. Learning by making in groups activities included guided learning by doing and learning by trial and error.

A) **Guided learning by doing**

The participants received the guidance from the instructor in the orientation session at the first stage of doing the project. Yet, when they started to do their project, they had problem to realize the right path. Mostly, because of lack of technology knowledge, they were not able to find the right addresses to find what they needed. Guided learning by doing was completely different from traditional teaching because of the variety of required skills in different groups. Guidance was offered to the participant particularly when they failed to do a job and stopped working due to disappointment.

In short, guidance of the instructor was facilitating the progress of the project. Further, the participants received some guidance from educational sites and their peers. However, guidance did not prescribe the specific path to the learners that they should follow. The participants drew their own conclusions through creative experimentation and making of the project. Guidance was more like introducing resources and software to them to select and use it.

B) **Learning by Trial and Error**
Since each project was varied from the others, the participants learned many new technology applications by trial and error. Also, trial and error was important to expand their knowledge of TCK. Learning with trial and error created effective learning. The participants felt more motivated, independent and confident to use different applications of computer for their project. Student [C] stated: “What we learned here we can never forget, because it was like discovering activities. We made everything by struggling. We made it. We didn’t find it and it has a lot of meaning” (last session).

Trial and error activities made participants’ learning deeper and more effective. It might develop some TK or TCK as a separate activity but it was not enough for development of TPK and TPACK.

4. Conclusion and Recommendation

The findings demonstrated the potential of constructionist setting for the development of TPACK. The findings showed how intra and inter group interaction and also receiving feedback from the instructor (Oster-Levinz and Klieg, 2010) and from other groups (Tee and Lee, 2011; Cavin, 2008) helped the participants to develop TPACK.

Further, similar to previous studies on the development of TPACK, the results of this study suggests the crucial role of collaboration in the development of TPACK (Niess, 2006; Kocoglu, 2009; Suhawoto, 2006 Mishra & Koehler, 2006, 2007; Cavin, 2008; So & Kim, 2009; Guzey and Roehrig, 2009; Harrington, 2008; Riales, 2011). Intra group collaboration along with inter group interactions created a fruitful ground for the development of TPACK and changed the perception of pre-service teachers’ use of technology for teaching by making the relationship between technology, pedagogy and content knowledge. Furthermore, learning by doing helped in the development of TK. Also, doing constructionist activities provided the opportunities to develop TPACK.

In brief, the study revealed strong evidence that constructionism can help facilitate the development of TPACK. However, with emphasis on effective use of technology, further research is needed to track the participants to know how they transfer TPACK into practice in the actual classroom.

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