Cultivating Pre-Service Teachers' Technological Pedagogical Content Knowledge (TPACK) Through Interactive Negotiation and Reflection Community

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***Abstract*—Technological pedagogical content knowledge (TPACK) is the heart of good teaching. Teachers' TPACK is not only a mandate but also a manifesto in the information era. Pre-service teachers' education is of critical importance to promote teachers' TPACK. After the analysis of the present pre-service teachers' TPACK development main paths and the importance of reflection and collaborative learning, the pre-service teachers' development path of constructing interactive negotiation and reflection community among peers and mentors was put forward and expound in detail. The interactive negotiation and reflection community penetrates through the three stages of lesson plan, lesson presentation and lesson evaluation and modification to cultivate pre-service teachers' TPACK by means of not only personal but also collaborative reflection and negotiation. Moreover, each member of the community has different roles and tasks in turn in order to cultivating their individual TPACK.**

Keywords—TPACK; Pre-service teachers; Development path; Interactive negotiation and reflection community

I. INTRODUCTION

The increasingly ubiquitous availability of digital and net worked tools has the potential to fundamentally transform the teaching and learning process[1]. Matthew J. Koehler and Punya Mishra put forward the concept of TPACK [2][3] on the basis of Shulman's conceptual PCK[4][5]. In the information and technology era, TPACK is the essential knowledge and key factor for teachers to integrate technology into teaching. Teachers' TPACK is not only a mandate but also a manifesto [6]. In 2008, context was introduced into TPACK as the eighth component. So far, TPACK framework contains three core elements, content knowledge (CK), pedagogical knowledge (PK) and technology knowledge (TK), four interacted knowledge, pedagogical content knowledge (PCK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological pedagogical content knowledge (TPACK), and context[6],which can be shown in Fig.1. Specifically, three major knowledge components form the foundation of the TPACK framework and four components in the TPACK framework address how these three bodies of knowledge interact, constrain, and afford each other as follows[1]:

•CK is the subject-matter knowledge that teachers teach and students learn.

•PK refers to the knowledge of a teacher that how the teacher present the content knowledge to the students and make the students learn effectively and efficiently by means of different methods, strategies and approaches which are suitable for a particular group of students.

•TK is a kind of dynamic knowledge which is supposed to be modified and improved with the progress of information and communication technology and the appearance of new technologies that can be integrated into what is teaching and learning to make the content knowledge easier to learn and understand and the pedagogical knowledge more proper to students' learning.

• TCK refers to the interaction of technology knowledge and content knowledge which is of reciprocal relationship. Content knowledge is often defined and constrained by technologies and their representational and functional capabilities.

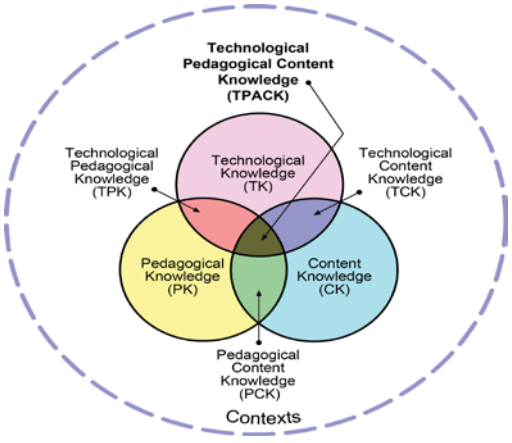

Fig.1. The technological pedagogical content knowledge framework

The source of the image is attributed as http://tpack.org

• PCK is to Shulman's (1986) notion of "an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p. 8).

• TPK refers to a certain kind of technology can constrain and

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afford specific pedagogical practices.

• TPACK is a kind of developing knowledge of the interaction and integration of technology, pedagogy, and content, which enable teachers to create and develop appropriate and context-specific teaching strategies for a particular group of students.

TPACK framework has made a great contribution to the area of teacher education and teacher professional development[7]. TPACK not only offers a framework but also emphasizes the importance of preparing pre-service teachers to make sensible choices in their uses of technology when teaching specific content to a specific target group[8].

II. Pre-Service Teachers' Tpack Development Paths

The quality and quantity of technology experiences of pre-service teachers in their teacher education program play a key factor that influences their adoption of technology in their daily in-service teaching[9][10]. Recent research has shown that teacher education program needs to help pre-service teachers to acquire the solid knowledge of content knowledge, pedagogical practices and technical skills and more important, the dynamic interactions between them in order to prepare them for future effective and efficient teaching with technology[11][12].

Because the construction of pre-service teachers' education curriculum system is one of the key factors to assure the quality of teacher education and professional development, so optimizing the curriculum of pre-service teachers education is an important way to promote teachers' TPACK. Liu Zhe (2016) carried out pre-service teachers' TPACK study by integrating curriculum on the basis of empirical analysis of the structural equation model[13]. Some other researchers also suggested integrating technology course with the course of teaching theory and methods of specific subjects[14], strengthening the integration between different teachers' courses and making different courses contents from scattered and isolated to integrated and connected[15].

Diversified teaching practice for pre-service teachers' TPACK development also was advised. For example, Huang Xuemei (2018) proposed promoting diversified teaching practice for pre-service teachers to accumulate experience to develop their TPACK in practice[16] . Wang Lizhen and Fu Liping (2015) advocated strengthening teaching practice and reconstructing education mode to develop pre-service teachers' TPACK[17] .

In the Learning Technology by Design approach [2][18], teachers develop TPACK by them working in teams to design solutions to ill-structured, real-world problems of teaching and learning over an extended period. Rose M. Cavin (2008) put forward that developing technological pedagogical content knowledge in pre-service mathematics teachers through microteaching lesson study[19]. Syh-Jong Jang(2012) suggested developing a peer-coaching model for enhancing the pedagogical content knowledge of pre-service science teachers[20].

III. Interactive Negotiation And Reflection Community

A. *The Importance of Interactive Negotiation and Reflection Community*

The importance of reflection for teachers professional learning has been stated by many scholars. Farrell (2012,2013) argued the importance of equipping teachers with strong reflective awareness and abilities in their professional learning[21][22]. Moradkhani, Raygan & Moein (2017) also put forward the influence of reflective practice on improving teaching quality[23]. A key to long-term professional development is the ability to be able to reflect consciously and systematically on one's teaching practices [24].

For a teacher, there are only two kinds of activities of teaching practices. One activity is in class by reflection and negotiation with specific teaching context including students, teacher-students relationships, curriculum, software and hardware in the classroom, etc. The other is out of class by means of reflection and negotiation with tutors, peers, colleagues, administrators and so forth on how to teach in class effectively and efficiently[25]. So, interactive reflection and negotiation are the two fundamental approaches for both pre-service and in-service teachers' TPACK development.

Social constructivists hold that "social interaction" is the basic form of individual learning. In other words, social individuals must interact with others to complete various cognitive activities[26]. Shulman and Hammerness. K also argued that community is a key element in teachers' learning framework[27][28]. Shulman(1998) and Yuan & Mak(2018) argue that reflection is most effective when conducted collaboratively in a community of practitioners[29][30].

B. *Lesson Plan Community, Lesson Presentation Community, and Lesson Evaluation and Modification Community*

Forming such interactive reflection and negotiation teaching and learning communities as Lesson Plan Community, Lesson Presentation Community, and Lesson Evaluation and Modification Community are more likely to guarantee and improve effective interactive reflection and negotiation to develop pre-service teachers' TPACK. To be specific, before each lesson presentation, there should be at least three meetings of interactive reflection and negotiation with the lesson plan in the community. After that, the community members will trace at least three lesson presentations presented by three different teachers. In each process of lesson presentation, besides the presenter, all the other members of the community also take part in the class with their own tasks respectively. After each lesson presentation, lesson evaluation and modification process will follow by means of interactive reflection and negotiation among the community members. The process of interactive reflection and negotiation on lesson plan, lesson presentation and lesson evaluation and modification in the community can be shown in Diagram 1.

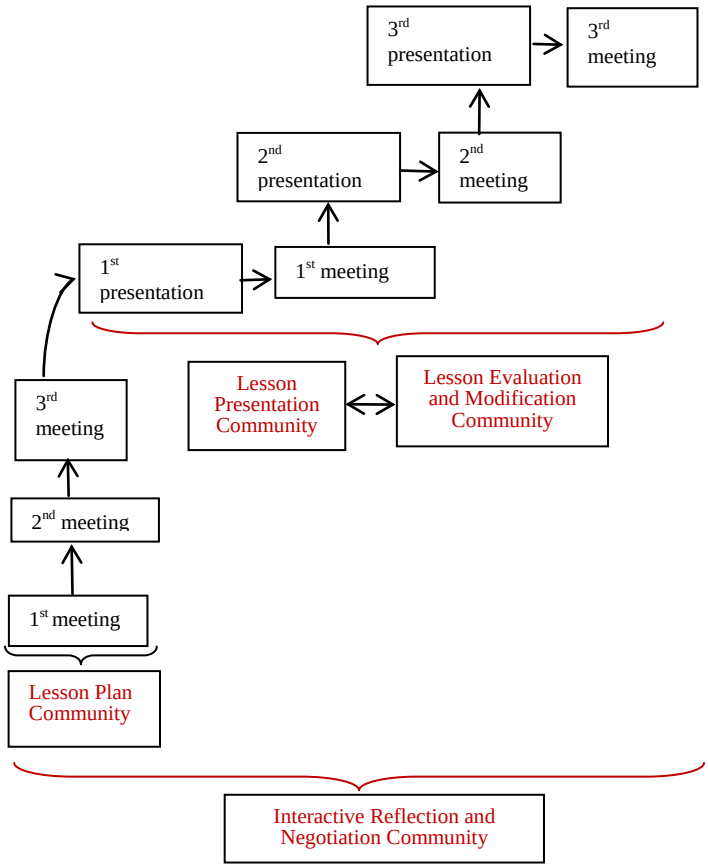

Diagram 1.Spiraling Interactive Reflection and Negotiation Community

Diagram footnote: "meeting" in the above diagram 1 refers to interactive reflection and negotiation among the community members in the process of the lesson plan, lesson presentation and lesson evaluation and modification.

The interactive reflection and negotiation community is responsible for three stages of the lesson plan, lesson presentation and lesson evaluation and modification. Each member of the community takes his or her roles and tasks respectively according to different stages, which can be shown in the following Table 1-3.

TABLE I. LESSON PLAN COMMUNITY

	1st meeting	**2nd meeting**	**3rd meeting**
Date			
Topics	Lesson Plan		
Roles	**Names**	**Names**	**Names**
Discussion Leader			
Content Commentator			
Pedagogy Commentator			
Technology Commentator			
Summarizer			

TABLE II. LESSON PRESENTATION COMMUNITY

	1st Presentation	**2nd Presentation**	**3rd Presentation**
Date			
Topic			
Roles	**Names**	**Names**	**Names**
Presenter			
Technology Observer			
Content Observer			
Pedagogy Observer			
TPACK Observer			
Mentor			

TABLE III. LESSON EVALUATION AND MODIFICATION COMMUNITY

	1st Meeting	**2nd Meeting**	**3rd Meeting**
Date			
Topic			
Roles	**Names**	**Names**	**Names**
Discussion Leader(the overall observer)			
Reporter(the presenter)			
Content Commentator			
Pedagogy Commentator			
Technology Commentator and Summarizer			
Mentor			

Table footnote: The idea of the roles of the members of interactive reflection and negotiation community comes from "Reading Circles" mentioned in Bookworms Club Reading communities Teachers Handbook published by Oxford University Press in 2011.

C. Lesson Presentation Community

Let's take lesson presentation community as an example to state the roles and tasks of each community member in the process of interactive negotiation and reflection. After at least 3 meetings of interactive negotiation and reflection on the lesson plan in the lesson plan community, the lesson can be presented in the classroom before students. The roles of each member of the interactive reflection and negotiation Lesson Presentation Community can be shown in Table 2.

Just as shown in Table 2, the members of the Lesson Presentation Community are composed of five pre-service teachers and one mentor. Each member of the community has his or her role and tasks. The tasks of each member can be described in the following.

The presenter's tasks are to present the lesson in the classroom.

The technology observer' tasks are to observe ...
- what kind of technology was used.
- how the technology was used.
- when the technology was used.
- how well the technology worked.

The content observer's tasks are to observe ....
- the accuracy of the content.
- the accomplishment of teaching and learning objectives.
- whether the teaching content is meaningful for the students.

In other words, whether the teaching content is in the zone of students' proximal development.

The pedagogy observer's tasks are to observe ....
- what kind of teaching approaches were used.
- how the teaching approaches were used.
- when the teaching approaches were used.
- how the teacher modify his or her teaching approaches to

encourage students to engage into the class

∗ how the teacher negotiates with the students and offer proper scaffolding to make the content meaning for the students.

The overall observer's tasks are to observe ....

∗ the teacher and students' emotions, relationship and engagement during the presentation.

∗ the accomplishment of the teaching and learning objectives.

∗ the presenter's technological pedagogical and content knowledge.

The mentor's tasks are to observe ...

∗ all the items of what the five pre-service teacher observers observe

∗ the behavior and performance of the five pre-service teacher observers

IV. SUMMARY

In the information and technology era, children are growing up with technology. Digital technology and applications has become an indispensable part of their lives. They are technology-natives. However, it is a known fact that teachers' technology-related knowledge, skills and competencies fall short when compared with those of their technology-native students. The Technological Pedagogical Content Knowledge (TPACK) framework is a framework that provides an excellent insight into the knowledge that teachers should have to teach effectively with technology[11]. Teacher education programs are responsible to prepare pre-service teachers for technology integration, especially for their teaching practices. TPACK should be introduced in teacher preparation programs and a central focus of such programs. Once pre-service teachers are familiar with TPACK components, they are better able to accommodate new and changing technologies because they have the initial knowledge needed to guide their technology implementation in their pedagogical knowledge[31].

With the guidance of the technological pedagogical content knowledge(TPACK) framework, based on the present pre-service teachers' TPACK development paths and the importance of collaborative negotiation and reflection, the interactive negotiation and reflection community was put forward in this study. The community includes lesson plan community, lesson presentation community and lesson evaluation and modification community. Moreover, each member of the community plays different roles and tasks in turn in the process of interactive negotiation and reflection in order to cultivate their TPACK.

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