

Investigating the Changes in Teachers' Technological Pedagogical Content Knowledge through Mobile Material Development Activities

Pei-Shan TSAI^{a*} & Chin-Chung TSAI^b

^a*Center for Teacher Education & Institute of Education, National Sun Yat-sen University, Taiwan*

^b*Graduate Institute of Digital Learning and Education, National Taiwan University of Science and Technology, Taiwan*

*sandra.pstsai@gmail.com

Abstract: This study investigated the changes in teachers' technological pedagogical content knowledge (TPACK) through the mobile material development activities. The TPACK for mobile learning were administered to 25 pre-service and in-service teachers who participated in a semester course for mobile material development activity. The results indicated that through the mobile material development activities, the teachers had significant changes in their TPACK in all scales, including content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), knowledge about mobile technology, technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK). Moreover, the relationships among their TPACK and scores were also examined.

Keywords: Technological pedagogical content knowledge (TPACK), mobile learning

1. Introduction

Many studies revealed the important of the teachers' knowledge about pedagogy, content and technology (Chai, Koh, & Tsai, 2013; Mishra & Koehler, 2006; Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009). In those studies, a well-known framework, namely the technological pedagogical content knowledge (TPACK), has been applied to investigate the teachers' knowledge about the integration of information and communication technology (ICT). The TPACK framework has seven factors, including content knowledge (CK), pedagogical knowledge (PK), technological knowledge (TK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK). CK, PK and TK are the main knowledge sources, and others are derived from the interactions among these three main knowledge sources.

Since the rapid progress in information technology, many researchers explored pre-service and in-service teachers' TPACK in different conditions, such as web-based learning environments (Archambault & Crippen, 2009; Lee & Tsai, 2010), game learning (Hsu, Liang, Chai, & Tsai, 2013), professional development activities (Chai, Koh, Tsai, Ismail, & Rohman, 2013; Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013). Lee, Chai, and Koh (2012) indicated that the effective of professional development course can support teachers to improve their TPACK. Recently, according the popular of mobile devices, mobile learning plays an important role in educational contexts. Many studies showed that students had better learning outcomes in mobile learning environments than those in traditional learning environments (Hwang, Wu, Zhuang, & Huang, 2013). However, there are a limit number of studies which have explored teachers' knowledge about pedagogy, content and technology in mobile learning. This study attempts to investigate the changes in teachers' TPACK through mobile material development activities. In additional, the relationships among teachers' TPACK and the works of mobile materials (as learning outcomes) are also investigated. The research questions are:

- Are there any changes in the teachers' TPACK for mobile learning through the mobile material development activities?
- What are the relationships among teachers' TPACK for mobile learning and the works of mobile materials (as learning outcomes)?

2. Method

2.1 Participants

The participants in this study were 25 per-service and in-service teachers, including 5 males and 20 females. All of them did not have any teaching experience for mobile learning. They were enrolled in semester courses to develop learning materials for mobile devices, such as start phone and tablet computers. Figure 1 shows the examples of mobile learning materials the teachers developed.



Figure 1. The examples of mobile learning materials the teachers developed.

2.2 Instrument

In this study, the TPACK for mobile learning (TPACK-M) survey which was developed by Chai et al. (in press) was adopted to investigate teachers' knowledge about content, pedagogy, teaching methods and technology integration. The TPACK-M survey consisted of seven scales, including content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), knowledge about mobile technology (TK_M), technological pedagogical knowledge (TPK), technological content knowledge (TCK), technological pedagogical content knowledge (TPACK), and pedagogical beliefs (PB).

The survey was undertaken before and after the activities to investigate the changes in teachers' knowledge about content, pedagogy, teaching methods and technology integration before and after the mobile material development activities. 7-point Likert scale was utilized for scoring the teachers' responses, such as 1 for strongly disagree and 7 for strongly agree. The reliability of the teachers' TPACK-M scales before activity were from 0.79 to 0.94, and those of after activity were from 0.72 to 0.96, showing that the TPACK-M survey had reliability to investigate teachers' TPACK for mobile learning. The definitions of each TPACK-M scale are as follows:

- Content knowledge (CK) indicated teachers' subject matter knowledge.
- Pedagogical knowledge (PK) presented teachers' teaching methods knowledge.
- Pedagogical content knowledge (PCK) indicated teachers' knowledge about teaching their teaching subjects.

- Knowledge about mobile technology (TK_M) presented teachers' knowledge about mobile technology.
- Technological pedagogical knowledge (TPK) explored teachers' knowledge about using technology to teach.
- Technological content knowledge (TCK) indicated teachers' knowledge about technology used in their subject area.
- Technological pedagogical content knowledge (TPACK) presented teachers' ICT integration knowledge.

2.3 Data collection and analysis

The survey was undertaken before and after the activities to investigate the changes in teachers' knowledge about content, pedagogy, teaching methods and technology integration before and after the mobile material development activities. In addition, the works of mobile materials teachers developed were scored by two experts as participants' learning outcomes. Inter-rater reliability was 0.92, showing the high level of reliability.

For explore the changes in teachers' knowledge about content, pedagogy, teaching methods and technology integration before and after the mobile material development activities, paired-samples t tests were utilized in this study. Moreover, Pearson's correlation was also utilized in this study to explore the relationship among the teachers' TPACK and learning outcomes.

3. Results

3.1 The changes in teachers' TPACK

As shown in Table 1, the average scores and standard deviations on the seven scales of TPACK-M survey for each of the pre-test and post-test are presented.

Moreover, the results of paired-samples t tests showed that there were significant differences found for all of seven scales of TPACK-M survey. The teachers' agreements after the mobile material development activities were significantly higher than those before the activities. It implies that through the mobile material development activities, the teachers held more knowledge about content, pedagogy, teaching methods and technology integration, including content knowledge (CK) ($t(24) = -2.20, p < 0.05$), pedagogical knowledge (PK) ($t(24) = -4.16, p < 0.001$), pedagogical content knowledge (PCK) ($t(24) = -2.13, p < 0.05$), knowledge about mobile technology (TK_M) ($t(24) = -3.36, p < 0.01$), technological pedagogical knowledge (TPK) ($t(24) = -2.98, p < 0.01$), technological content knowledge (TCK) ($t(24) = -3.07, p < 0.01$), and technological pedagogical content knowledge (TPACK) ($t(24) = -2.14, p < 0.05$).

Table 1: Average scores, standard deviations and results of paired-samples t tests.

Surveys	Factors	Pre-test		Post-test		t -value
		Mean	SD	Mean	SD	
TPACK	CK	5.46	1.04	5.90	0.76	-2.20*
	PK	5.13	1.01	5.66	0.93	-4.16***
	PCK	5.03	1.37	5.58	0.93	-2.13*
	TK_M	5.08	1.09	5.70	0.84	-3.36**
	TPK	5.25	1.00	5.66	0.86	-2.98**
	TCK	5.15	0.83	5.71	0.86	-3.07**
	TPACK	5.17	0.83	5.64	0.99	-2.14*

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

3.2 The relationships between teachers' TPACK and learning outcomes

Pearson's correlation was utilized to show the relationships among teachers' TPACK after the activities and learning outcomes. The results are shown in Table 2. It was found that teachers with stronger agreement with the TK_M (correlation coefficient = 0.49, $p < 0.05$) and TCK (correlation coefficient = 0.44, $p < 0.05$) factors tended to have higher scores of learning outcomes. This implies that the teachers held more knowledge about mobile technology and technology used in their subject area tended to have higher learning outcomes.

Table 2: The relationships between teachers' TPACK and learning outcomes.

TPACK scales	CK	PK	PCK	TK_M	TPK	TCK	TPACK	Learning outcomes
CK	1	0.38	0.43*	0.26	0.23	0.34	0.19	0.12
PK		1	0.82***	0.12	0.72***	0.02	0.78***	-0.02
PCK			1	0.21	0.60*	-0.05	0.65***	-0.11
TK_M				1	0.50*	0.44*	0.24	0.49*
TPK					1	0.42*	0.84***	0.27
TCK						1	0.06	0.44*
TPACK							1	0.04
Learning outcomes								1

* $p < 0.05$; *** $p < 0.001$

4. Discussion and conclusions

The present study explored the impact of mobile material development activities on changes in teachers' TPACK. The results showed that through the activities, the teachers held more knowledge about content, pedagogy, teaching methods and technology integration, including content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), knowledge about mobile technology, technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPACK). Chai et al. (2013), Lee et al. (2012) and Nadelson et al. (2013) revealed that the effective of professional development courses help teachers to improve their TPACK. The similar findings are shown in this study that the effective of developing learning materials for mobile learning can support teachers to improve their TPACK for mobile learning.

Moreover, this study also examined the relationships among teachers' TPACK and learning outcomes. The results showed that teachers with more knowledge about mobile technology and technology used in their subject area tended to have higher learning outcomes. This implies that the roles of mobile technology and teachers' knowledge of subject matter representation with technology are the basis in the mobile material development activities. The teachers learned those perceptions in the mobile material development activities, and also represented in their works. It is suggested that educators should consider more TPACK factors when design the professional development activities

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