Examining the relationships between in-service teachers' technology and non-technology related knowledge of TPACK

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Abstract: This study examined the relationships between Singaporean in-service teachers' technology and non-technology related knowledge aspects of technological pedagogical content knowledge (TAPCK) through second order factor analysis. The technology related knowledge aspects involved TPCK, TCK, TPK and TK, and the non-technology related knowledge aspects included the CK, PCK and PK. A survey was conducted to for 262 in-service teachers. The results revealed that teachers with better performance in applying ICT to their teaching had higher pedagogical, content, and pedagogical and content knowledge. This implies that the technology related knowledge aspect may play an important role in improving teachers' pedagogical and content knowledge for teacher professional development.

Keywords: In-service teachers, technological pedagogical content knowledge (TPCK), ICT

1. Introduction

The concept of the technological pedagogical content knowledge (TPACK), a well-known framework for unpacking teachers' expertise in ICT integration, was developed to analyze teachers' ability to integrate technology into instruction [6,13]. The TPACK framework included seven types of knowledge: technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPCK). In Mishra and Koehler's study [12], three main knowledge components of teachers, which were classified as teachers' basic knowledge component in ICT integration, are technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK). The interactions and synthesis among these three basic components promote the growth of the other four advanced components: pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical content knowledge (TPCK).

Many studies utilized the TPACK framework as a theoretical basis to investigate teachers' technological skills and pedagogical expertise [6,13]. Given the TPACK emerging importance in educational technology, many researchers has tried to develop instrument to survey teachers' efficacy. For example, researchers developed a survey based on TPACK framework to explore pre-service teachers' knowledge of teaching and

technology [13]. Moreover, some research developed specific survey for TPACK in K-12 teachers' online instruction [1], active and constructive learning in Science [6], integrating web-based resources [11], and constructivist-oriented instruction [4]. In Chai, Koh and Tsai's study [4], they adapted a generic TPACK survey from [13], and integrated the perspectives of Jonassen, Howland, Marra and Crismond's five dimensions of meaningful learning [8] to assess teachers' constructivist-oriented TPACK. These studies of TPACK surveys gave educators and researchers an insight into the factors influencing teachers' abilities for integrating technology into Instruction. One common problem with the survey developed to date is the cross loading of factors (see [1,11]). Reported literature has only surface two studies that could identify all seven factors when the factors are analyzed together through valid factor analyses [4,9].

Nonetheless, studies of the inter-relationships among TPACK components showed that the seven factors are significantly correlated [2,3,5]. For instance, researchers explored the relations among TPACK components using structural equation modeling (SEM) method, and found that pre-service teachers' PK and TPK contributed to their constructivist-oriented TPACK development [5]. It implied that improving one of TPACK components may promote the other. In addition, researchers indicated that providing teachers with educational technology courses focusing on PK and TPK through different forms of ICT tools can help them to better develop TPACK, especially when the preservice teachers are tasked to design ICT integrated lesson [10]. The issue of the relationships between technology and non-technology related knowledge has, however, received limited attention among researchers. Therefore, this study utilized the TPACK for Meaningful Learning Survey [4], and divided the components of TPACK into two aspects (including technology related knowledge: C-TPCK, TCK, C-TPK, and TK, and non-technology related knowledge: CK, PCK and C-PK) to explore the relationships of teachers' technology and non-technology related knowledge factors of TPACK through the use of structural equation modeling (SEM) method. The research model of this study is shown in Figure 1.

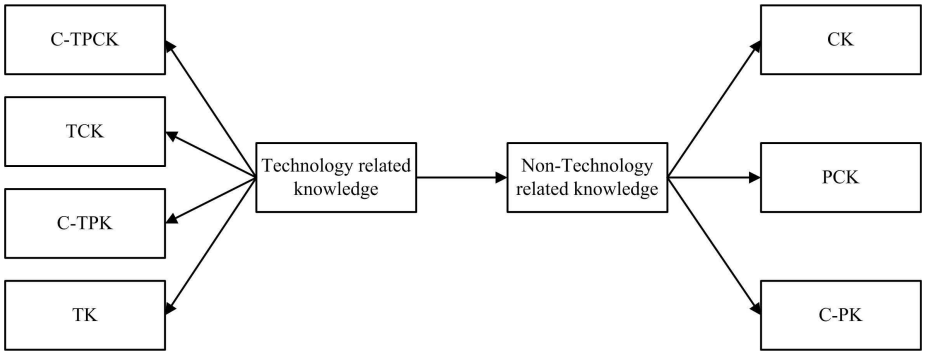

Figure 1. Path model represent the relationship of technology and non-technology related knowledge factor

In other words, since ICT integration requires teachers to consciously draw upon their knowledge of technology-related factors and synthesize them with what they already knew about teaching the subject matter without using technology, we hypothesize that working on the technology-related factors can contribute to the non-technology related factors.

2. Methods

Participants

The participants of this study included 262 in-service teachers in Singapore, who had responsibility for the performance of ICT course design in their respective schools. All of them participated in an ICT professional development program. The investigation was undertaken after the activity by using a web-based survey. The teachers had an average of 8.78 years of teaching experience and their mean age is 34.8 years. 36.6% of the teachers were male.

Instrument

To explore the teachers' constructivist-oriented TPACK, this study utilized the TPACK for Meaningful Learning Survey (TPACK-MLS) which was developed by [4]. The questionnaire consisted of seven scales, as shown in the following:

- The Content Knowledge (CK) scale measure teachers' knowledge of subject matter, e.g., "I have sufficient knowledge about my first teaching subject."
- The Pedagogical Content Knowledge (PCK) scale explores teachers' knowledge of teaching methods with respect to subject matter content, e.g., "Without using technology, I can address the common misconceptions my students have for my first teaching subject."
- The Constructivist Pedagogical Knowledge (C-PK) scale explores teachers' knowledge of teaching methods, e.g., "I am able to guide my students to adopt appropriate learning strategies."
- The Constructivist Technological Pedagogical Content Knowledge (C-TPCK) scale measures knowledge of using technology to implement constructivist teaching methods for different types of subject matter content, e.g., "I can create self-directed learning activities of the content knowledge with appropriate ICT tools (e.g. Blog, Webquest)."
- The Technological Content Knowledge (TCK) scale measures teachers' knowledge of subject matter representation with technology, e.g., "I can use the software that are created specifically for my first teaching subject."
- The Constructivist Technological Pedagogical Knowledge (C-TPK) scale explores teachers' knowledge of using technology to implement teaching methods, e.g., "I am able to use technology to introduce my students to real world scenarios."
- The Technological Knowledge (TK) scale measures teachers' knowledge of technology tools, e.g., "I keep up with important new technologies."

These scales' reliability coefficients were 0.87, 0.90, 0.92, 0.94, 0.93, 0.84, and 0.87, respectively. Each item utilized a seven-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree). In other words, the higher average scores on the scales, the advanced constructivist-oriented TPACK were held by the teachers.

3. Results

Teachers' scores on the TPACK-MLS scales

Table 1 shows the teachers' average scores and standard deviations on the TPACK-MLS scales. The teachers' highest scores were for the CK, PCK, and C-PK scale. It implies that the teachers perceived more confidence in CK, PCK, and C-PK. The lowest score on the TCK scale implies that the teachers perceived less confidence in TCK.

Table 1. Teacher' scores on the TPACK-MLS scales

Scale	Mean	S.D.	Range
CK	5.96	0.72	1.0–7.0
PCK	5.64	0.88	1.0–7.0
C-PK	5.52	0.92	1.0–7.0
C-TPCK	5.00	1.13	1.0–7.0
TCK	4.64	1.49	1.0–7.0
C-TPK	5.12	1.16	1.0–7.0
TK	5.27	1.09	1.0–7.0

Confirmatory factor analysis for the TPACK-MLS

This study explored the relationships between the technology related and non-technology related aspects of TPACK-MLS by using SEM analyses with AMOS 18, as shown in Figure 1. Hence, the technology related knowledge was employed as exogenous variable to predict the non-technology related knowledge. The model fit indices showed that the relationship between technological and non-technological aspects of TPACK-MLS attained a good fit (χ^2/df = 2.25, $p < 0.01$, CFI = 0.95, RMSEA = 0.07). The recommended values included root mean square error of approximation (RMSEA) below 0.08, comparative fit index (CFI) over 0.90 [7]. Hence, the results revealed that the technological related knowledge is powerful in predicting the teachers' non-technological related knowledge. In addition, the derived path coefficients (path coefficient = 0.40, $p < 0.001$) shows significant positive relationships between the technology and non-technology related aspects of TPACK-MLS. The positive impact of technology related knowledge on non-technology related knowledge could be explained by the fact that the teachers' ability to integrate ICT into their instruction makes significant positive contributions to their pedagogical and content knowledge for teacher professional development.

4. Discussion and conclusions

This study was undertaken to examine the relationships between in-service teachers' technology and non-technology related knowledge of TPACK through second order factor analysis. The results indicated that teachers with better performance in applying ICT to their teaching had higher pedagogical, content, and pedagogical and content knowledge. This implies that improving teachers' ability to integrate ICT in the classroom may be a good approach to foster their pedagogical content, and pedagogical and content knowledge for teacher professional development. Researchers revealed that the effective of ICT integration course can help teachers improve their technology related knowledge components more than non-technology related knowledge [10]. Hence, Educators and researchers should pay more attention in the teachers' ICT training that could prompt how they design and plan technology-based learning, and then enhance their pedagogical and content knowledge for teacher professional development.

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