東海大學教育研究所

碩士論文

臺中市公立國中教師科技學科內容教學知識和科技自我效能現況調查

An Investigation of Public Middle School Teachers' TPACK and TSE in Taichung City

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臺中市公立國中教師科技學科內容教學知識和科技自我效能現況調查

摘　要

本研究目的在瞭解台中市公立國中教師的科技學科教學內容知識（Technological Pedagogical Content Knowledge, TPACK）和科技自我效能（Technology Self-efficacy, TSE）之現況。本研究採用調查研究法，以台中市四大地區（市區、屯區、山區、海線）的公立國中現職教師為研究對象。本研究自各地區任意選取三所學校，並於各校隨機邀請 30 位現職教師參與調查。共回收 314 份有效問卷。

本研究自文獻中整理歸納出「教師的科技學科教學內容和科技自我效能之調查問卷」，經預試具良好信效度。

在分析問卷結果後，本研究發現：

一、參與研究的教師其科技學科教學內容知識與科技自我效能呈現高度相關。

二、在「科技知識」層面，不同「性別」、「年齡」、「職位」、「教學經驗」及「教學科目」呈現顯著差異。

三、在「學科知識」層面，「教學科目」呈現顯著差異。

四、在「科技學科知識」層面，不同「性別」、「學歷」、「職位」及「教學科目」呈現顯著差異。

五、在「科技教學知識」層面，不同「性別」、「學歷」及「教學科目」呈現顯著差異。

六、在「科技學科教學內容知識」及「有意願學習科技產品」層面，不同「性別」、「職位」及「教學科目」呈現顯著差異。

七、在「有意願將科技融入教學」層面，不同「性別」、「年齡」及「教學科目」呈現顯著差異。

八、在「相信科技產品幫助學生學習」層面，不同「性別」、「年齡」、「職位」、「學校大小」及「教學科目」呈現顯著差異。

九、設備、學生學習動機和成效以及課程進度都是影響受試者是否繼續在課堂中使用科技。

關鍵字：科技學科教學內容知識、科技自我效能、國中在職教師

An Investigation of Public Middle School Teachers' TPACK and TSE in Taichung

Abstract

The purpose of the study is to investigate middle school in-service teachers' Technological Pedagogical Content Knowledge (TPACK) and Technology Self-Efficacy (TSE) in Taichung City. The Ministry of Education have been promoting the use of technology in teaching for years, especially the new curriculum guideline highlighted the importance of the use of information and computer technology. As a result, it is important for middle school teachers to be prepared for the new challenge.

Three hundred and fourteen public middle school teachers from different areas of Taichung City participated in the study and completed the questionnaires.

The findings of the study included that (1) teachers' TPACK and TSE were significantly correlated with the subject they taught. (2) The reasons that the teachers kept using technology or not using technology resulted from the problems of equipment, students' learning motivation and learning performance, and tight course schedule. (3) Significant differences were found in teachers' gender, age, position, teaching experience, and teaching subject toward the performance of technology knowledge (TK). (4) Significant difference was found in teachers' subject toward the performance of content knowledge (CK). (5) Significant differences were found in teachers' gender, educational background, position, and teaching subjects toward the performance of technological content knowledge (TCK). (6) Significant differences were found in teachers' gender, educational background, and teaching subject toward the performance of technological pedagogical content knowledge (TPCK). (7) Significant differences were found in teachers' gender, position, and teaching subject toward the performance

of TPCK and willingness of using technology. (8) Significant differences were found in teachers' gender, age, and teaching subjects toward the integration of technology. (9) Significant differences were also found in teachers' gender, age, position, school size, and teaching subject toward the confidence of using technology.

To sum up, teachers' experiences influenced their TPACK and TSE. The male teachers had higher TK than female ones. Teachers would keep on adopting technology in their teaching while students responded with positive feedback. Younger teachers had higher technology-related knowledge than elder ones. The art teachers had higher technology-related knowledge and TSE than language art teachers, including the ones who taught Chinese literature and English.

Keywords: technological pedagogical content knowledge (TPACK), technology self-efficacy (TSE), middle school in-service teachers

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CHAPTER ONE
INTRODUCTION

This chapter addresses the background of the study, followed by the research purposes, research questions, terminology, and the significance of the study.

1.1 Background of the Study

Information and computer technologies (ICT) have been successfully integrated into classroom teaching, and proven to be effective in enhancing students' learning and teachers' instruction. For example, in the field of English as a Foreign Language instruction, researchers and educators have also been seeking ways to integrate technology into classrooms. Studies showed that technology-enhanced language learning and benefit student learning and motivations (e.g., Yang & Chen, 2007; Hung, 2014).

With convincing evidence shown in studies, teachers are encouraged to apply technology in their classroom teaching. However, teaching with technology could be one of the biggest challenges that teachers are facing (Kent & Giles, 2017). As the result, how are teachers' confident to use technology in their teachings? Does the integration of technology in teaching require relevant technological knowledge? The present study attempts to identify these issues for middle school teachers.

Technological pedagogical content knowledge (TPACK; Mishra & Koehler, 2006) refers to the integration of technology knowledge, pedagogical knowledge, and content knowledge. The TPACK framework attempts to identify the knowledge required by teachers for technology integration in their teaching (Schmidt, Baran, Thompson, Mishra, Koehler, & Shin, 2009; Chai, Koh, & Tsai, 2010; Chai, Koh, & Tsai, 2013; Chen& Jang, 2014. Teachers with higher TPACK can be more advantaged to use technology in their teachings (Koh & Chai, 2014; Koh, Chai, & Tay, 2014).

Teachers' technology self-efficacy (TSE; McDonald & Siegall, 1992) refers to a teacher's confidence to his/her ability to successfully using technology in their teaching. As ICT develops rapidly in the past decade, it is important for teachers to be able to select and apply suitable ICT in their teaching and for students' learning (Abbitt, 2011).

The Ministry of Education in Taiwan proposed its latest curriculum guideline in 2014. The new curriculum guideline emphasizes the importance of ICT in the next decade, which encourages teachers to design and develop learning and teaching activities in the context of ICT. However, it is still not clear if teachers are ready for the challenge. TPACK and TSE are two important aspects that influence teachers' performance in utilizing technology in the classroom. Earlier studies focused more on math and science teachers' TPACK and TSE (e.g., Doering, Veletsianos, Scharber & Miller, 2009; Jimoyiannis, 2010). Little has been known about middle school teachers' TAPCK and TSE. Therefore, it is essential to identify teachers' preparedness of using ICT in class through understanding their TPACK and TSE.

1.2 Purpose of the Study

The purpose of this study is to understand public middle school teachers' TPACK and TSE in Taichung. Although the new curriculum guideline highlights the importance of ICT, it is equally important to identify middle school teachers' performance and preparedness of using ICT in their classes, so that proper training courses or workshops can be provided to teachers to improve their technological ability.

1.3 Research Questions

The present study attempts to understand public middle school teachers' TPACK and TSE in Taichung. The research questions are as follows.

1. What is the status of public middle school teachers' TPACK?
2. What is the status of public middle school teachers' TSE?
3. Is there any correlation between teachers' TPACK and TSE?
4. What are the difficulties teachers encountered when integrating ICT into classroom teaching?

1.4 Terminology

The terms used in this study are defined as follows.

1. Technological pedagogical content knowledge (TPACK): TPACK refers to the integration of technology knowledge, pedagogical knowledge, and content knowledge. It is a theoretical framework of knowledge that teachers can teach their

students a subject also teach effectively, and use technology in their teaching. It emphasizes how teachers connect, interact, and constrain all of the knowledge areas together.

Seven domains are included in TPACK questionnaire, TK, CK, PK, PCK, TPK, TCK, and TPACK. Each domain contains five or seven questions. In total, there are forty questions. All of those forty questions were adopted from previous studies (Schmidt, Baran, Thompson, Koehler, Mishra, & Shin, 2009; Chai, Koh, & Tsai, 2010; Bilici, Yamak, Kavak, & Guzey, 2013; Chen & Jang, 2013; Koh, & Tsai, 2014) and translated into Chinese.

2. Technology self-efficacy (TSE): TSE refers to a teacher's confidence to his/her ability to successfully using technology in their teaching. It also suggests how teachers believe their capacity for using technology effectively in their teaching.

   Three domains are included in TSE questionnaire. Each domain consists of six questions; therefore, there are in total eighteen questions. The first domain asks the participants' willingness of using and learning technology. The following domain investigates the participants' willingness to integrate technology into their teaching. The last domain wants to know whether the participants believe that integrating technology into teaching will benefit students' learning. All of the eighteen questions were adopted from Fanni (2014) and Farah (2012) and translated into Chinese.

CHAPTER TWO
LITERATURE REVIEW

This chapter contains four sections. The first section explains the theoretical framework of technological pedagogical content knowledge (TPACK). The second section addresses teachers' technological self-efficacy (TSE). The last section describes the relationship between teachers' TPACK and TSE.

2.1 Technological Pedagogical Content Knowledge

Technological pedagogical content knowledge (Mishra & Koehler, 2006) is a framework attempting "to identify the nature of knowledge required by teachers for technology integration in their teaching while addressing the complex, multifaceted and situated nature of teacher knowledge." It extends Shulman's (1986) conceptual framework of pedagogical content knowledge (PCK) and considers technology integration in teachings an interplay of technological knowledge (TK), pedagogical knowledge (PK), and content knowledge (CK).

The core of TPACK comprises three primary forms of knowledge, including TK, PK, and CK (see Figure 2.1). All three components and the interplay among them should be considered as a whole, instead of isolated ones. In other words, effective technology integration in teaching for a specific subject matter is the outcome of dynamic, reciprocal relationships among TK, PK, and CK in a given context.

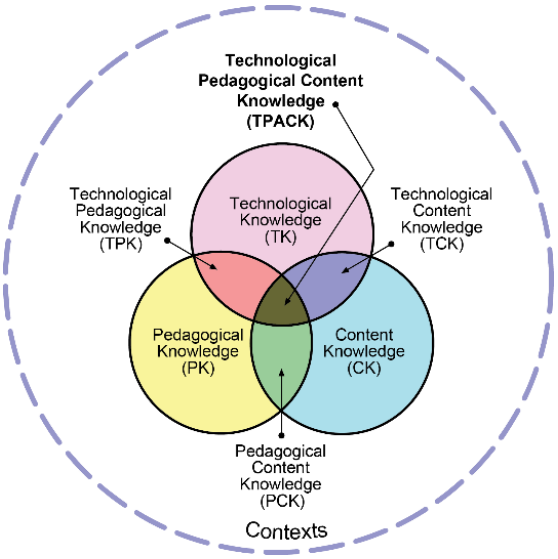

Figure 2.1 TPACK framework (http://tpack.org)

TK refers to the knowledge about certain ways of thinking about and working with technologies, tools, and resources. According to Mishra and Koehler (2006), as ICT changes from time to time, the essential TK changes accordingly. This includes understanding ICT, applying ICT effectively, and recognizing the necessity, strengths, and weaknesses of ICT.

PK refers to teachers' knowledge about the processes and practices or methods of teaching and learning. A teacher's PK includes understanding how students learn, general classroom management skills, course design, lesson planning, and assessment (Koehler & Mishra, 2009).

CK is teacher's knowledge about the subject matter to be learned or taught. Shulman (1986) noted that CK includes the knowledge of theories, concepts, ideas and developing practices and approaches of the subject matter.

Pedagogical content knowledge (PCK) concerns the transformation of the subject matter for teaching, which occurs when the teacher interprets the subject matter, finding ways to represent it, using multiple methods to deliver the content or guide students learning process based on students' prior knowledge.

Technological content knowledge (TCK) is the knowledge about how the subject matter can be delivered by technology (Mishra & Koehler, 2006; Schmidt, Baran, Thompson, Mishra, Koehler & Shin, 2010). Teachers need to fully understand the subject matter and the flexibility of particular technology to represent the subject matter.

Technological pedagogical knowledge (TPK) concerns the pedagogical affordances and constraints of technologies as they are employed in instructional designs and strategies. The use of technologies may change teachers' pedagogical strategies and students' learning performance (Mishra & Koehler, 2006).

Technological pedagogical content knowledge (TPACK) is the foundation of effective teaching with technology, which requires an understanding of the representation of the target concepts using technologies, and pedagogical techniques that use technologies in teaching subject matter. It is a dynamic interaction among TK, PK, and CK in a specific learning context. Teachers know how to integrate technology into their teaching and help students learn subject matter better.

The TPACK framework is helpful in explaining the technology integration in instructional practices and is gaining much attention from researchers. Researchers introduced TPACK framework and guide teachers to acquire the TPACK knowledge (Mishra & Koehler, 2008; Abbitt, 2011; Koehler, Mishra & Cain, 2013), measure in-

service and pre-service teachers' TPACK (Schmidt, Baran, Thompson, Mishra, Kohler & Shin, 2009; Chai, Koh& Tsai, 2010; Chai, Koh, Tsai & Tan, 2011; Koh& Chai, 2014) and investigate how teachers integrate technology into their teaching and students' learning and teachers' willingness of using technology in their educational setting (Martinovic & Zhang, 2012; Koh, Chai &Tay, 2014).

Mishra, Koehler, and Kereluik (2009) mentioned that it is not sufficient for teachers to learn how to use technology only but also learn how to integrate technology into an educational setting. They explained the role of teachers in TPACK is a decision maker. Teachers decided how to design their educational environment with needed technologies. The researchers added that teachers also need to have the willingness to experience and full of the flexibility of ideas to create their technological teaching and learning environments. Moreover, Koehler, Mishra, Akcaoglu, and Rosenberg (2013) suggested that how teachers integrate technology into their teaching setting is more important than what teachers integrate into their teaching environment. In other words, using technology in the educational setting, the technology should not be isolated with how to use the technology only but should be included in the teaching setting. Chai, Koh, and Tsai (2013) conducted a review of TPACK studies from 2003 to 2011. In the article, the researchers concluded positive results in the TPACK data-driven articles. The participants used ICT in their teaching environment more after they took the ICT courses. According to this findings, teachers are encouraged to take ICT-related training sessions to enhance their TPACK.

Some of the researchers also explored the pre-service and in-service teachers' willingness of using technology in their class. In 2012, Martinovic and Zhang compared a group of participants' willingness and expectations of using technology in their teaching before and after teaching in schools. Before the participants taught in schools, they showed fully confident and prepared to teach with technology. The participants who had taken technology-related courses in teacher training programs had more willingness to apply technology in their teaching than those who did not have taken technology-related courses.

In 2014, Koh, Chai, and Tay interviewed 24 elementary school teachers in Singapore. The researchers wanted to know what kind of factors influenced in-service teachers' TPACK. In the study, the cultural/institutional factors influenced the participants' TPACK the most. Some of the participants' intrapersonal factor, teachers' beliefs, was an important role that influenced them to use technology in their class. The

researchers found out that the participants' TPACK would be enhanced with an experienced facilitator. The researchers proposed that an experienced facilitator could help in-service teachers to make the connection between their students' learning and their technology knowledge (TK).

Several studies were conducted to investigate how teachers/researchers integrate technology into their educational settings. Jimoyiannis (2010) aimed to investigate the effects of science teachers integrating technology into their science classroom setting. The researcher found that (1) the teachers had increased their confidence and willingness to use technology in their teaching. The participants also reported that they saw the value and understanding of using technology in their science teaching setting. (2) The participants increased their abilities to integrate technology into their teaching. They integrated technology into their science content and lessons more effectively. (3) The educational and schools' systems were the difficulties for teachers to integrate technology into their science classes. Teachers had the pressures of the limited time of teaching, students' exams, restricted textbook materials, and school cultures.

Tsai and Shieh, (2011) explored how TPACK affected Hsinchu elementary school teachers' professional development. The researchers recommended that teachers team up an ITC team (Information Technology Coordinating Team). Moreover, the main purpose of ITC team is to eliminate teachers' concerns about using technology in the classroom, help teachers to design different and suitable technology lesson plans, and to encourage teachers to participate in different school organizations. The result showed that teachers who participated in ITC team had positive feedback toward it. The researchers also suggested that not just pre-service teachers need to take more courses but also in-service teachers should attend more teacher professional development sessions which were related to how to integrate technology into teaching.

Researchers not only investigated teachers from elementary school to senior high school but also in-service teachers and pre-service teachers (Tondeur, Braak, Sang, Voogt, Fisser & Ottenbreit-Leftwich, 2012; Liang, Chai, Koh, Yang & Tsai, 2013; Chen & Jang, 2014; Koh & Chai, 2014). Teachers who taught in senior high schools had higher TPACK and confidence than those teachers who taught in elementary schools (Liang, Chai, Koh, Yang & Tsai, 2013; Chen & Jang, 2014). In-service preschool teachers with higher education had the better competence of integrating technology in their teaching subjects (Liang, Chai, Koh, Yang &Tasi, 2013). On the other hand, pre-service teachers showed more confidence in using technology in their classrooms than

in-service teachers (Koh & Chia, 2014). Furthermore, schools in different areas provide different levels of technology for students and teachers to use (The Ministry of Education, 2016). Namely, teachers teaching experiences and the differences in their digital devices were all influential factors for teachers' TPACK.

According to the studies had mentioned above, teachers' TPACK can be influenced by teachers' previous technology teaching and learning experiences, school cultures or experienced facilitators, and teachers' beliefs. If a teacher had received positive teaching and/or learning through technology, his/her TPACK would be higher. If a teacher worked in a school that encouraged teachers to integrate technology in teaching, his/her TPACK would increase. If a teacher who has higher TPACK, he/she would believe that integrating technology would benefit his/her teaching and enhance his/her students' learning.

2.2 Technology Self-Efficacy

According to Bandura (1994), a person's self-efficacy is that one believes he/she is capable to exercise or carry out the desired action or performance affects his/her life. Self-efficacy also influences how people think, feel, behave, and motivate themselves. In the educational field, researchers have provided enough evidence that teachers' and students' self-efficacy influence their teaching and learning behaviors and decision making (Klassen & Tze, 2014). Technology self-efficacy is that one believes technology can increase his/her teaching and enhance his/her learning (Lumpe & Chambers, 2001). Teachers who have positive attitude and beliefs in using technology in their teaching can help their students learn better will integrate technology more in their teaching.

The relationship between TSE and teachers using technology in teaching has been widely investigated in pre-service teachers and in-service teachers. Researchers explored whether teachers' TSE would influence teachers' choices to apply technology in their instructions or not. For example, in 2013, Celik and Yesilyurt used computer supported education as a predictor to investigate the relationship between pre-service teachers' attitude toward technology, computer self-efficacy, and computer anxiety. The result showed that pre-service teachers who perceived computer related courses would decrease their computer anxiety. More importantly, pre-service teachers' attitude to technology and computer self-efficacy increased. From the results of the study, it

supported their idea that computer-related courses helped pre-service teachers to lower their anxiety toward the computer and reinforce their computer self-efficacy and positive attitude to technology.

Teachers still used technology in their teaching although they had low self-efficacy. Hillier, Beauchamp, and Whyte (2013) explored seven European countries teachers' self-efficacy who taught foreign languages by using an interactive whiteboard. The result showed that most of the teachers had a high level of self-efficacy, yet some of the teachers did not have high self-efficacy but still use an interactive whiteboard. Teachers who believed in using interactive whiteboard could help their students learn better. That's why they still used an interactive whiteboard with low self-efficacy.

In-service teachers' technology self-efficacy could be reinforced through teacher professional development. Kopcha (2012) completed a two-year research which involved eighteen elementary school teachers. Those participants attended a teacher professional development for two years long. The participants' self-efficacy or belief changed after their training sessions. The participants did not like to integrate technology into their teaching at first because they were lack of time to prepare the technology tools or find suitable technology materials to apply in the classroom. For them, integrating technology into teaching was a burden before joining the two-year teacher professional development. Furthermore, Kim, Kim, Lee, Spector, and DeMeester (2013) chose twenty-two in-service teachers who were involved in a four-year teacher professional development session. The result also showed the same as Kopcha (2012). The training sessions helped in-service teachers enhance their self-efficacy. All the above researchers pointed out that teachers took related technology lessons/courses/sessions would enhance teachers' technology self-efficacy.

Acher, Buuren, Kreijns, and Vermeulen (2011) also found that teachers' self-efficacy would influence their use of digital learning materials in their teaching. The researchers surveyed 1484 primary and secondary school teachers in Netherlands. The results of the study showed that the strongest predictors of how teachers used technology in their classroom were teachers' attitude and self-efficacy. Teachers' attitude and self-efficacy included their perspectives toward their ICT skills, ICT anxiety, and negative and positive outcome. The study found that teachers' ICT anxiety and negative outcome (e.g., extra workload) would decrease teachers' intention to use technology in their teaching. Teachers who considered themselves as skilled in ICT and believed positive outcome (e.g., make the class more interesting or exciting) would

increase their intention to apply technology to their teaching. The researcher suggested that teachers can attend more ICT skills related training programs/classes/sessions to enhance their ICT skills; therefore, their self-efficacy may improve. They may have more intention to use digital learning materials.

In 2014, Klassen and Tze reviewed the studies related with teachers' self-efficacy and personality but also their teaching outcome. With the findings in the study, the researchers concluded that teachers' self-efficacy was related to their teaching performances and achievement levels of their students. The researchers also made a policy implication to develop teachers' self-efficacy. They suggested that no matter pre-service teachers or experienced in-service teachers can build their self-efficacy through training or professional development programs

Teachers' teaching and/or learning experiences would enhance their self-efficacy and lower their technology anxiety (Farah, 2012). However, teachers would still integrate technology into their teaching because they believed it would help their students learn better (Hillier, Beauchamp & Whyte, 2013). These matched Bandura's (1977) hypothesis that mastery experiences, vicarious experiences, social persuasion, and emotional and psychological states would influence on a person's self-efficacy. The researcher based on the pervious literature results and theoretical framework concluded three major domains that would influenced teachers' technology self-efficacy. The three different domains were teachers' belief of integrating technology in teaching, teachers' willingness to integrate technology in teaching, and teachers' experiences of integrating technology in teaching.

2.3 The Relationship between TPACK and TSE

Many researchers have investigated the relationship between teachers' TPACK and TSE; however, not many of the studies were explored in-service middle school English/EFL teachers' TPACK and TSE. This section attempts to introduce some of the previous studies which explored the relationship between teachers' TPACK and TSE in different subjects' matters.

Koh & Chai (2014) suggested that teachers, pre-service, and in-service teachers, keep themselves expose in the ICT-integrated lessons would help them be more confident in using technology in their classes also change or enhance their TPK, TCK, and TPACK. With the positive result of their study, both pre-service and in-service

teachers' TPACK would change after an ICT lesson design activates. Both pre-service and in-service teacher who are younger were all more confident in all aspects of their TPACK. In-service teachers put more emphasis on CK; they changed after taking the ICT lesson actives. The findings showed a strong positive correlation between teachers' confidence in using technology and applying technology to their teaching.

Similarly, Saltan and Arslan (2017) compared in-service and pre-service teachers' self-confidence toward TPACK. The participants were science teachers, mathematics teachers, ICT teachers, and classroom teachers in Turkey. The results of the study showed some similarities to Koh & Chai's (2014) study. Both in-service and pre-service teachers had the highest scores on TCK. In the lowest scores, pre-service teachers and in-service teachers were different. Pre-service teachers got lowest in TPACK domains; in-service teachers' lowest scores were in TK. As for subject matters, pre-service and in-service teachers who taught the same subject did not show different levels of self-confidence in TPACK. To be specific, pre-service mathematics teachers had significantly lower TPACK scores than pre-service science teachers. In-service teachers who taught in ICT got significantly higher scores than the other groups of teachers.

In 2015, Liu and Kleinsasser aimed to investigate high school EFL teachers' TPACK (CALL knowledge) and self-efficacy (CALL competencies). Six vocational EFL in-service teachers were invited to the study. Before the study, the participants mainly applied PPT, e-mails, or other online resources. During the study, all of the participants were asked to attend four different professional development programs which were Moodle platform training, face-to-face workshops, design and implementation of WebQuest projects, and online discussion forums. By doing so, the participants increased their TPK, TCK, TPACK, and their computer self-efficacy after the study. The participants mentioned they had more confidence in using internet technology in their teaching to enhance their students' learning and learning motivation. The researchers found that the participants' computer self-efficacy were related to their technology knowledge more than their TPACK. Moreover, the researchers mentioned that teachers with more teaching experiences increased more computer self-efficacy than teachers with less teaching experiences.

Kim, Kim Lee, Spector & DeMeester (2013) investigated the relationship between teachers' beliefs and their TPACK. The participants' beliefs about effective ways of teaching were significantly correlated with their beliefs of subject knowledge and learning. Moreover, the participants' teaching with technology was significantly

correlated with their beliefs about effective ways of teaching. Teachers who believed technology could enhance their teaching would apply technology into their teaching.

Banas and York (2014) investigated whether 104 preservice teachers' technology self-efficacy would change after taking authentic learning exercises. The participants were asked to integrate technology into their curriculum design and lesson planning. After designing the lessons, the participants would demonstrate the lesson they designed. The other participants would need to provide feedback and discuss if there were anything needed to be changed or improved. The result of the study presented that the authentic learning exercises did influence their technology self-efficacy and their TPACK. The researchers pointed out the importance of authentic exercises/learning/courses to teachers' technology self-efficacy and their integration of using technology in their teaching.

Similarly, in Korea, Lee and Lee (2014) involved 136 pre-service teachers in a lesson planning course by using technology. Within the period of course time, the participants needed to learn different technology tools, listened to teachers' lectures, and designed lessons which integrated with technology. The result presented that the participants' technology self-efficacy and attitude toward computers were positively increased. The researchers said that the pre-service teachers could apply their technology knowledge, content knowledge and pedagogy knowledge by lesson planning exercises.

Tsai and Shieh's (2011) study found four major factors that why teachers TPACK or TK were low. First, most teachers would consider teaching technology knowledge was teaching students computer skills such as how to use Office software, how to create a web page, or how to make an audio or video clip. Second, school administrators were not actively involved in integrating technology into teaching, but they considered that enhancing technology knowledge was providing technology hardware, computers, and projectors for example. Third, the ways that teachers used technology in their teaching could not enhance students' learning motivation. Teachers who involved technology in their teaching used only Powerpoint or Word for instance. Teachers did not select more other technology like online discussion, long-distance teaching, or new and creative technology, to apply to their teaching. Last, teachers were not willing to integrate technology into their teaching because of two reasons. First, teachers needed to spend more time and efforts in searching for suitable on-line materials and technology resources. Second, the responsibilities of managing that hardware were too much for a

teacher. No teachers wanted to be responsible for it. Not to mention the cost of repairing hardware was also high for a school.

No doubt that teachers' TSE and TPACK would influence teachers on how to integrate technology into their teaching. Teachers with higher technology self-efficacy and TPACK will integrate more technology into their teaching. However, with different levels of technology resources to use (digital device), would it also be another influential factor for teachers to consider whether to integrate technology into their teaching or not? Or, are there any other factors that would influence teachers' TPACK or TK and willingness to apply technology to their teaching?

CHAPTER THREE
METHODOLOGY

This chapter consists of five sections. The first section introduces the research design. The second section describes the participants of the study. The third section presents the instruments of the study. The fourth section addresses the procedure of the study. The last section addresses data collection and data analysis procedures.

3.1 Research Design

The purpose of the study is to explore middle school teachers' TPACK and TSE in central Taiwan. The design of the study is presented in Figure 3.1. In Figure 3.1, the variables included teachers' TPACK and TSE. Teachers' demographic information is considered in the relationship between TPACK and TSE, including teachers' gender, teachers' highest degree, the years one has been a teacher, the school size, and teaching subjects.

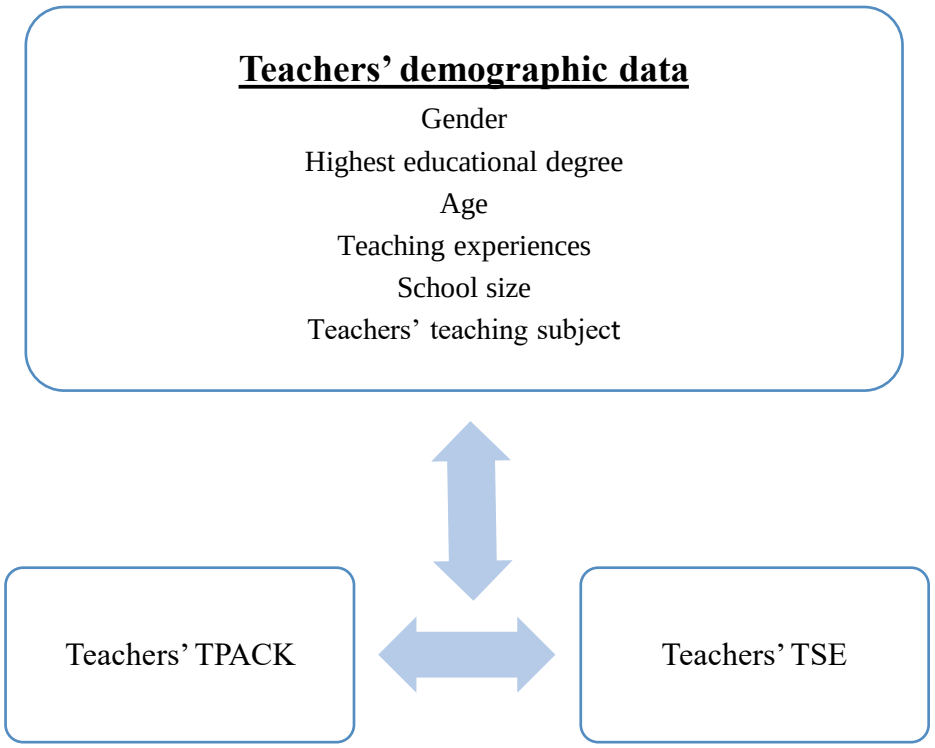

Figure 3.1 The research design

3.2 Participants

The participants in the current study were purposly sampled from public middle school teachers from different districts of Taichung. Eleven out of a total of 11 public middle schools in Taichung City participated in the study. Among the 11 schools, some school administrators encouraged their teachers to integrate technology in teaching, such as M1, M2, C3, and U2. C2 was the school that were just started to encourage teachers to integrate technology in teaching. C2 just provided every class a computer and a projector to use this school year.

Three hundred and fourteen teachers were arbitrary chosen or voluntarily to complete the questionnaire. As shown in Table 3.1, among of the 11 schools, there were three schools located in mountain areas, coastal areas, and suburb areas respectively. Two out of the 11 schools were urban. In mountain areas, coastal areas, and suburb areas. Thirty to thirty-five teachers from each school consented the participation in the study. The total number of teachers of mountain areas, coastal areas, suburb areas, and urban areas were 85, 90, 78, and 61 respectively.

Table 3.1

Distribution of the participants

Area	School number	Total numbers of participants
Mountain	1	34
	2	16
	3	35
Coastal	1	32
	2	34
	3	24
Suburb	1	30
	2	23
	3	25
Urban	1	33
	2	28

Three hundred and fourteen questionnaires were collected and analyzed. Among the 314 participates, 230 of them were female (73%). One hundred and ninety of the participants (61%) had a master degree and another one hundred and nineteen of the participants (38%) had a bachelor degree. The rest of the three participants had a doctor degree. One hundred and twenty-one out of the 314 participants' ages (39%) were 31 to 40, and one hundred and twenty out of the 314 participants' age (38%) were 41-50.

The majority of the participants (40%) were home class and full-time teachers. Most of the participants (41%)) had 15 years or above of teaching experiences. Within the 314 questionnaires, the three major teaching subjects were Chinese language art (19.2%), English (16.6%), and math (14.1%). One hundred and fifty-three participants taught in a large school size, where there were 25 or above classes. The participants' demographic data were summarized in Table 3.2.

Table 3.2
Summary of the participants' demographic data (N=314)

Variable	Category	Number (%)
Gender	Male	83 (26%)
	Female	230 (73%)
Highest degree	Bachelor	119 (38%)
	Master	190 (61%)
	Ph. D	3 (1%))
Age	30 below	29 (9%)
	31-40	121 (39%)
	41-50	120 (38%)
	50 above	40 (13%)
Position	Full-time teacher	39 (12%)
	Administrator and full-time teacher	90 (29%)
	Home class and full-time teacher	125 (40%)
	Sub teacher	50 (16%)
Teaching years	2 years or below	14 (4%)
	3-5 years	27 (9%)
	6-10 years	71 (23%)
	11-14 years	71 (23%)
	15 years or above	130 (41%)
School Size	6 or less than 6	19 (6%)
	7-24	141 (45%)
	25 or above	153 (49%)
Teaching subjects	Mandarin	60 (19.2%)
	English	52 (16.6%)
	Mathematics	44 (14.1%)
	Science	35 (11.2%)
	Social Science	36 (11.5%)
	Art	50 (16.0%)
	Others	36 (11.5%)

3.3 Instruments of the Study

The questionnaire for teachers includes the participants' demographic data information. Further, the participants' perspectives of the seven different categories of TPACK and the participants' technology self-efficacy. All of the questions were measured by five-point Liker scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Open-ended questions were also used to have a better understanding of teachers' opinions or difficulties about using technology in classes. Each of the questionnaire dimensions is described in the following sections. The questionnaire for the study is presented in Appendix A.

Demographic data

For the personal background information, the questions included the participants' gender, highest degree, ages, teaching experiences, position, their current teaching schools' size, and their teaching subject. The participants' demographic data would influence their TPACK and TSE. After gathering the participants' demographic information, the researcher used one-way ANOVA to analyze the data to evaluate the relationship between the participants' demographic data and their TPACK and TSE.

TPACK questionnaire

Seven domains were included in TPACK questionnaire, TK, CK, PK, PCK, TPK, TCK, and TPACK. Each domain contained five or seven questions. In total, there were forty questions. All of those forty questions were adopted from previous studies (Schmidt, Baran, Thompson, Koehler, Mishra, & Shin, 2009; Chai, Koh, & Tsai, 2010; Bilici, Yamak, Kavak, & Guzey, 2013; Chen & Jang, 2013; Koh, & Tsai, 2014) and translated into Chinese.

TSE questionnaire

Three domains were included in TSE questionnaire. Each domain consists of six questions; therefore, there are in total eighteen questions. The first domain asked the participants' willingness of using and learning technology. The following domain investigated the participants' willingness to integrate technology into their teaching. The last domain wanted to know whether the participants believe that integrating technology into teaching would benefit students' learning. All of the eighteen questions were

adopted from Fanni (2014) and Farah (2012) and translated into Chinese.

3.4 Procedure

To understand teachers' TPACK and TSE, the researcher revised the questionnaire based on the theoretical framework of TPACK and TSE. After designing and revising the questionnaire, a pilot study was conducted to test the reliability and validity of the questionnaire. The researcher based on the results of the pilot study revised the questionnaire again. Then, the researcher sent the revised questionnaires out to the 11 schools. Data analysis would be carried out to analyze the collected questionnaires. Discussion and conclusion would be presented based on the research findings. The procedure of this study is displayed in Figure 3.2.

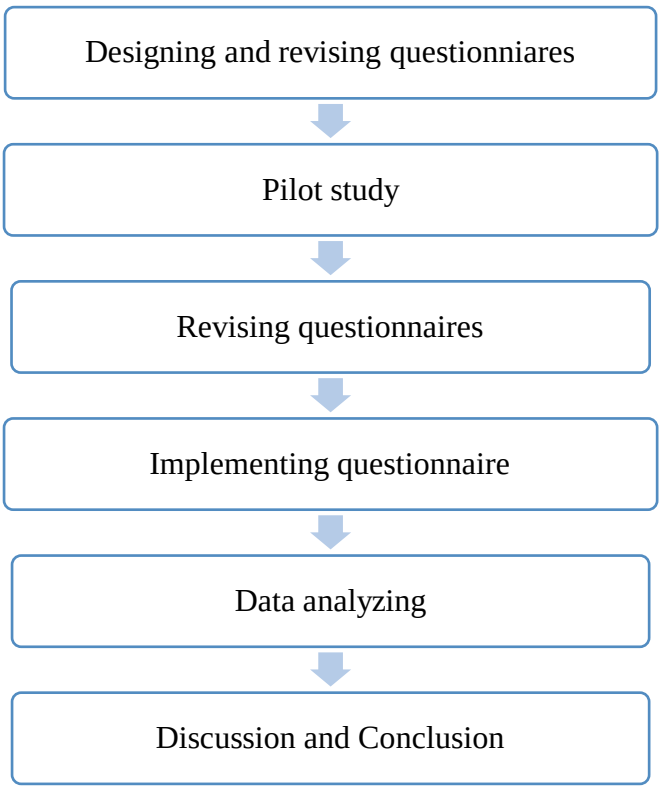

Figure 3.2 The procedure of the study

3.5 Data collection

Three hundred and fourteen teachers from 11 schools in Taichung were involved in the current study. The participants were invited to complete the TPACK and TSE questionnaires. The participants were told to answer the questions based on their actual

teaching experiences and situations. After a week or two, the questionnaires were collected.

3.6 Data analysis

The researcher sent 415 questionnaires to 13 schools, only 314 questionnaires from 11 schools were collected back, resulting in a return rate of 76%. After the data be collected, the researcher used SPSS 20.0 (Statistical Packages for the Social Science, Chinese version) to analyze it. Descriptive statistics were used to analyze the participants' demographic information. One-way ANOVA was used to see whether there is a significant difference between the participants' demographic data and their TACK and TSE. Pearson correlation coefficients were used to identify the relationship among teachers' TPACK and TSE.

The answers from the open-ended questions were coded independently by the researcher. The responses were listed and classified into different categories. The frequencies of each category were calculated. The top highest frequencies were highlighted.

3.7 Pilot study

Thirty-four teachers from the coastal area of Taichung and 24 teachers from a rural area of Changhua participated in the pilot study. The participants completed the questionnaire according to their actual situation and their opinions. All of the questions were measured by five-point Liker scale, ranging from 1 (strongly disagree) to 5 (strongly agree). Five open-ended questions were also included in the questionnaire. The results of the pilot study are described in the following sections.

Demographic data

Among the 54 participates, 40 of them were female (74%). Thirty-nine of the participants had a master degree, another thirteen participants had a bachelor degree, and one participant had a doctor degree. Twenty-three out of the 54 participants' ages (43%) were 31 to 40. Of the 54 participants, there were 11 Mandarin (20%) and seventeen math and English teachers (17%).

Reliability

Cronbach's α was used to evaluate the reliability of the questionnaire. The reliability coefficient for the overall questionnaire was .97 for both TPACK and TSE. They were .95, .89, .85, .80, .93, .91, and .94 for the seven domains from TPACK. It was .94, .90, and .94, respectively for the three domains in TSE. The reliability of TPACK and TSE questionnaire was shown in Table 3.3.

Table 3.3

Reliability of the questionnaires

Variable	Domain	Question items	Cronbach's α	Overall
TPACK	TK	1, 2, 3, 4, 5, 6	.95	.97
	CK	7, 8, 9, 10, 11	.89	
	PK	12, 13, 14, 15, 16	.85	
	PCK	17, 18, 19, 20, 21	.80	
	TCK	22, 23, 24, 25, 26, 27	.92	
	TPK	28, 29, 30, 31, 32, 33	.91	
	TPCK	34, 35, 36, 37, 38, 39, 40	.94	
TSE	Willingness	41, 42, 43, 44, 45, 46, 47	.94	.97
	Integrating	48, 49, 50, 51, 52	.90	
	Belief	53, 54, 55, 56, 57, 58	.94	

Questionnaire item analysis

TPACK questionnaires consisted of seven categories which were TK, PK, CK, TPK, CPK, PCK, and TPACK. Three categories, willingness of learning technology, willingness of integrating technology into teaching, and believing that integrating technology into teaching will benefit students' learning, were in TSE questionnaire.

The researcher used independent *t* test to evaluate the significance of each question item. First, the researcher divided the top 27% of overall questionnaire scores as high score group and the least 27% of overall questionnaire scores as low score group. Then, the researcher used the critical ratio from the result of independent *t* test as the standard whether to keep or delete the question items. All of the 58 questions were a significant difference ($p < .05$) and correlated with each domain. As a result, all of the 58 question items were kept. The results of item analysis of each question were presented in Table 3.4.

Table 3.4

Item analysis of each question

Domains	Question number	Critical ratio	Correlation	Keep / Deleted
TK	1	1.47***	.77****	○
	2	3.22***	.88***	○
	3	0.92***	.94***	○
	4	0.24***	.91***	○
	5	1.53***	.91***	○
	6	0.11***	.90***	○
CK	7	28.45***	.87***	○
	8	4.17***	.85***	○
	9	2.11***	.86***	○
	10	10.62***	.84***	○
	11	6.05***	.79***	○
PK	12	1.86***	.85***	○
	13	1.25***	.90***	○
	14	2.71***	.77***	○
	15	0.68***	.72***	○
	16	0.83***	.71***	○
PCK	17	2.05***	.74***	○
	18	1.80***	.77***	○
	19	1.14***	.78***	○
	20	8.88***	.81***	○
	21	1.31***	.67***	○
TCK	22	0.09***	.84***	○
	23	7.60***	.85***	○
	24	2.06***	.89***	○
	25	0.04***	.91***	○
	26	0.83***	.75***	○
	27	0.66***	.81***	○
TPK	28	0.22***	.84***	○
	29	0.73***	.85***	○
	30	6.54***	.87***	○
	31	0.72***	.89***	○
	32	2.01***	.88***	○
	33	0.03***	.66***	○
TPCK	34	1.09***	.84***	○
	35	0.74***	.90***	○
	36	0.01**	.88***	○
	37	0.14***	.86***	○
	38	0.36***	.69***	○
	39	2.62***	.90***	○
	40	0.70***	.90***	○

Willingness	41	5.34***	.83***	○
	42	2.51***	.86***	○
	43	0.15***	.84***	○
	44	10.49***	.90***	○
	45	2.77***	.78***	○
	46	1.19***	.82***	○
	47	0.19***	.91***	○
Integration	48	10.57***	.89***	○
	49	1.79***	.83***	○
	50	4.36***	.75***	○
	51	16.38***	.86***	○
	52	13.47***	.89***	○
Belief	53	2.37***	.84***	○
	54	0.15***	.82***	○
	55	0.03***	.91***	○
	56	2.04***	.94***	○
	57	0.50***	.90***	○
	58	0.19***	.88***	○

Note: $^{**}p<.01$, $^{***}p<.001$

CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter presents the results of the four research questions: (1) What is the status of public middle school teachers' technological pedagogical content knowledge (TPACK)? (2) What is the status of public middle school teachers' technology self-efficacy (TSE)? (3) Is there any correlation between teachers' technological pedagogical content knowledge (TPACK) and technology self-efficacy (TSE)? (4) What are the difficulties teachers encountered when integrating ICT into classroom teaching?

4.1 Descriptive statistics of Teachers' TPACK and TSE

This section presents the descriptive statistics results to understand the participants' TPACK and TSE. Seven domains, TK, CK, PK, PCK, TCK, TPK, and TPCK, were included in TPACK. TSE included three domains, willingness of learning technology, willingness of integrating technology into teaching, and believing that integrating technology into teaching will benefit students' learning.

The descriptive statistics of the seven domains of TPACK were shown in Table 4.1. Among the seven domains, the mean of CK was the highest. The mean scores of PK and PCK scored the second and third. The lowest mean sores were 3.43, 3.46, and 3.51, respectively for TPCK, TK, and TPK. The results implied that most participants were more confident in CK, PK, and PCK than in TPCK, TK, and TPK.

Table 4.1

Descriptive statistics (N=314) of seven domains of TPACK

Variable	Domain	Question items	Mean	S.D.
TPACK	TK	6	3.46	4.78
	CK	5	4.13	2.60
	PK	5	3.94	2.38
	PCK	5	3.86	2.40
	TCK	6	3.52	3.91
	TPK	6	3.51	3.71
	TPCK	7	3.43	4.39

In the three domains, the mean score of integrating technology in teaching was the highest. The mean scores for the other two domains were 3.39 and 3.41. The result may indicate that most participants had experiences of integrating technology in teaching. The descriptive statistics of the three domains of TSE were shown in Table 4.2.

Table 4.2

Descriptive statistics (N=314) of three domains of TSE

Variable	Domain	Question items	Mean	S.D.
TSE	Willingness	7	3.39	4.66
	Integration	5	3.56	3.30
	Belief	6	3.41	4.15

4.2 Factors influencing teachers' TPACK and TSE

In this section, the researcher discussed whether the participants' demographic data (genders, highest degrees, ages, positions, teaching experiences, school sizes and teaching subjects) influenced their TPACK and TSE. The researcher used descriptive statistic and One-way ANOVA to analyze the data. The dependent variables in One-way ANOVA were TK, CK, PK, PCK, TCK, TPK, TPCK, willingness, integration, and belief. Factors in One-way ANOVA were genders highest degrees, ages, positions, teaching experiences, school sizes, and teaching subjects.

The female participants were nearly three times more than the male participants. Nonetheless, the male participants still scored higher than the female participants in the domains which were involved with technology, TK, TCK, TPK, TPCK, willingness, integration, and belief. Significant differences also were found in those seven domains, TK, TCK, TPK, TPCK, willingness, integration, and belief. The statistically significant differences implied that male and female teachers had different opinions and knowledge in these seven domains, which were all related to technology. The results of TPACK and TSE status in teachers with different genders were presented in Table 4.3.

Table 4.3

TPACK and TSE status shown in teachers with different genders

Domain	Male (N=83)		Female (N=231)		Sig.
	Mean	S.D.	Mean	S.D.	
TK	23.61	4.29	19.75	4.54	.000***
CK	20.69	2.96	20.60	2.50	.788
PK	19.96	2.79	19.57	2.21	.197
PCK	19.63	2.60	19.22	2.32	.183
TCK	22.05	4.31	20.66	3.70	.005**
TPK	22.12	4.01	20.59	3.52	.001**
TPCK	25.37	4.69	23.34	4.16	.000***
Willingness	25.52	4.99	23.06	4.37	.000***
Integration	18.67	3.44	17.46	3.19	.004**
Belief	21.70	4.16	19.89	4.04	.001**

Note: $^{**}p < .01$, $^{***}p < .001$

The participants' educational background showed statistically significant differences in four domains, TCK, TPK, integration, and belief. The three participants who had a doctor degree scored the highest mean scores in every domain except the domain of integration. The participants who had a master degree scored the highest mean scores in the domain of integration. The descriptive statistic results of TPACK and TSE status in teachers with different educational background are shown Table 4.4.

Table 4.4

TPACK and TSE status shown in teachers with different educational background

Domain	Bachelor (N=119)		Master (N=190)		Doctor (N=3)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
TK	20.18	4.93	21.79	4.67	24.00	5.56
CK	20.50	2.86	20.73	2.34	21.33	5.51
PK	19.54	2.49	19.75	2.27	20.67	4.93
PCK	19.31	2.38	19.34	2.42	19.33	3.79
TCK	20.22	4.04	21.51	3.74	23.67	5.69
TPK	20.38	3.96	21.43	3.45	22.67	3.51
TPCK	23.19	4.59	24.32	4.22	26.00	3.61
Willingness	23.18	4.51	24.04	4.72	27.00	6.00
Integration	17.24	3.41	28.09	3.16	21.33	3.51
Belief	19.59	4.10	20.84	4.12	23.33	3.51

Post Hoc were used to examined the results. The result from Scheffe of TCK (F = 4.776, p<. 01) showed that the participants who had a master degree scored higher than the participants who had a bachelor degree. The same result showed in belief (F = 4.198, p<. 05). After using Scheffe to examine the data, no significant differences were found in the domains of TPK and integration. The result may suggest that the participants who had a master degree had more learning experiences with technology. That was why the participants had more integration and belief in using technology in teaching. The One-way ANOVA results of TPACK and TSE status shown in the participants with different educational background are shown in Table 4.5.

Table 4.5

One-way ANOVA Analysis of TPACK and TSE status shown in teachers with different educational background

Source	SS	df	F	Sig.	Scheffe
TK	7139.920	311	1.976	.140	
CK	2065.510	311	0.399	.671	
PK	1763.949	311	0.556	.574	
PCK	1802.654	311	0.004	.996	
TCK	4771.538	311	4.776	.009**	2>1
TPK	4215.538	311	3.310	.038*	
TPCK	5969.638	310	2.791	.063	
Willingness	6747.904	310	1.986	.139	
Integration	3379.679	311	4.265	.015*	
Belief	5355.923	311	4.198	.016*	2>1

Note: *p＜.05, **p＜.01,

The majority of the participants in the study were aged from 31 to 50, two hundred and forty-one out of 314 participants. In the domains of TK, TCK, TPK, and TPCK, the participants who were aged below 30 scored the highest mean scores. In the domain of PK, the participants who were 51 or more scored the highest. Interestingly, in the domains of willingness, integration, and belief, the participants who were 51 or more scored the highest. The descriptive statistic results of TPACK and TSE status shown in the participants with age differences are shown in Table 4.6.

Table 4.6

TPACK and TSE status shown in teachers with age differences

Domain	30 below (N=29)		31-40 (N=121)		41-50 (N=120)		51 or more (N=40)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
TK	23.52	4.79	20.79	4.76	20.63	4.52	19.03	4.92
CK	20.52	3.32	20.70	2.25	20.52	2.70	20.61	2.88
PK	19.97	2.40	19.41	2.16	19.74	2.62	20.18	2.21
PCK	19.52	2.67	19.03	2.24	19.43	2.63	19.78	2.41
TCK	22.69	3.68	20.82	4.10	20.88	3.77	20.75	3.77
TPK	22.99	3.87	21.02	3.71	20.85	3.55	20.63	4.08
TPCK	25.17	4.50	24.20	4.19	23.59	4.47	22.78	4.47
Willingness	22.87	5.06	24.20	4.93	22.82	4.21	25.84	4.33
Integration	17.26	4.00	18.33	3.07	17.34	3.11	18.42	3.43
Belief	19.38	4.91	21.13	3.81	19.58	3.89	21.82	4.16

Only TK showed significant differences. By using Scheffe to investigate the result, TK ($F = 5.193$, $p < .01$) showed that the participants who aged 30 or below scored higher than the other three groups of participants, 31 to 40, 40 to 50, and 51 and above. The result showed that the younger participants had higher TK than other groups of participants. Those younger participants might use more technology devices in their daily life. They might have more teaching and learning experiences with the integration of technology. The One-way ANOVA results of TPACK and TSE status shown in the participants with age differences are shown in Table 4.7.

Table 4.7

One-way ANOVA Analysis of TPACK and TSE status shown in teachers with age differences

Source	SS	df	F	Sig.	Scheffe
TK	7077.369	309	5.193	.002**	1 > 2 1 > 3 1 > 4
CK	2089.771	309	0.122	.947	
PK	1750.271	309	1.251	.292	
PCK	1794.439	309	1.201	.309	
TCK	4734.971	309	1.996	.115	
TPK	4263.987	309	0.901	.441	
TPCK	5934.201	308	2.098	.101	
Willingness	6673.786	308	1.800	.147	
Integration	3377.642	309	1.084	.356	
Belief	5323.678	309	1.431	.234	

Note: **$p < .01$,

Different positions presented different results of TPACK and TSE status in the participants. The descriptive statistic results of TPACK and TSE status shown in the participants with different positions are presented in Table 4.8. The majority of the participants were home class and full-time teachers (one hundred and twenty-five out of 314). Fifty out of the 314 participants were sub teachers. The sub teachers scored the highest in the domains of TK, TCK, TPCK, willingness, integration, and belief. Home class and full-time teachers scored the highest in the domains of CK, PK, and PCK. In the domain of TPK, the participants who were full-time teachers scored the highest.

Table 4.8

TPACK and TSE status shown in teachers with different positions

Domain	Full-time (N=39)		Administrator (N=90)		Home class (N=125)		Sub (N=50)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
TK	19.69	5.15	21.34	4.50	19.89	4.71	22.60	4.77
CK	20.85	2.90	20.42	2.84	20.87	2.23	20.32	2.62
PK	19.36	2.19	19.62	2.74	19.86	2.23	19.67	2.38
PCK	18.92	2.33	19.28	2.47	19.54	2.39	19.02	2.54
TCK	20.00	4.43	21.67	3.75	20.50	3.72	21.98	3.99
TPK	29.97	4.58	21.34	3.80	20.85	3.38	21.70	3.51
TPCK	22.87	5.12	24.45	4.37	23.30	4.11	25.02	4.23
Willingness	22.87	5.06	24.20	4.93	22.82	4.21	25.84	4.33
Integration	17.26	4.00	18.33	3.01	17.34	3.11	18.42	3.43
Belief	19.38	4.91	21.13	3.81	19.58	3.89	21.82	4.16

The One-way ANOVA results of TPACK and TSE status shown in the participants with different positions are presented in Table 4.9. In the domains of TK, TCK, TPCK, willingness of using technology, and belief all showed significant differences. According to Scheffe, sub teachers scored higher than home class and full-time teachers in TK ($F = 3.928$, $p<.01$). In the domain of willingness of using technology in teaching ($F = 6.003$, $p<.01$), sub teachers also scored higher than both full-time teachers and home class and full-time teachers. The same result also showed in the domain of belief ($F = 5.544$, $p<.01$). However, TCK and TPCK did not showed any significant differences after Post Hoc analysis. The results may indicate that sub teachers had more TK and willing to use technology in their teaching. The participants' background and

experiences influenced their TPACK and TSE. The participants who aged below 30, had less teaching experiences, and were sub teachers had higher technology-related knowledge. Koh and Chia (2014) also had similar result that pre-service teachers (age below 30, less teaching experiences, and sub teachers) had higher technology knowledge and willingness than in-service teachers.

Table 4.9

One-way ANOVA Analysis of TPACK and TSE status shown in teachers with different positions

Source	SS	df	F	Sig.	Scheffe
TK	6946.789	303	3.928	.009**	4>3
CK	2007.632	303	0.893	.445	
PK	1752.632	303	0.510	.675	
PCK	1787.105	303	0.971	.407	
TCK	4652.839	303	3.529	.015*	
TPK	4182.839	303	1.923	.126	
TPCK	5820.101	303	3.103	.027*	
Willingness	6603.347	302	6.003	.001**	4>1
					4>3
Integration	3304.158	303	2.556	.056	
Belief	5207.591	303	5.544	.001**	4>1
					4>3

Note: *$p < .05$, **$p < .01$

The descriptive statistic results of TPACK and TSE status shown in the participants with different teaching experiences are presented in Table 4.10. One hundred out of the 314 participants had 15 years or above of teaching experiences. Only fourteen of the participants had two years or below of teaching experiences. Fourteen of them scored the highest mean scores in the domains of TK, TCK, TPK, TPCK, and belief but scored the lowest in the domains of CK, PK, and PCK. The participants who taught for 3 – 5 years scored the highest in the domains of willingness and integration.

Table 4.10

TPACK and TSE status shown in teachers with different teaching experiences

Domain	2 years or below (N=14)		3-5 years (N=27)		6-10 years (N=71)		11-14 years (N=71)		15 years or above (N=130)	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.	M	S.D.
TK	24.00	4.74	22.48	4.76	21.48	4.56	20.39	4.67	19.89	4.75
CK	19.36	4.63	20.30	2.67	20.65	2.17	20.99	2.23	20.66	2.62
PK	18.50	4.20	19.41	2.08	19.41	2.19	19.82	2.34	19.92	2.27
PCK	18.79	2.97	19.15	2.52	19.17	2.04	19.08	2.61	19.63	2.39
TCK	22.21	3.89	22.37	3.61	21.28	3.76	20.64	3.76	20.64	3.76
TPK	21.71	3.75	21.59	3.78	21.25	3.50	20.65	3.83	20.65	3.83
TPCK	25.14	4.62	24.93	4.11	24.46	3.91	23.87	4.61	23.23	4.50
Willingness	25.00	4.37	25.15	4.21	24.18	4.09	23.25	4.85	23.29	4.94
Integration	18.21	2.94	18.52	3.21	17.99	2.88	17.97	3.25	17.38	3.58
Belief	21.50	4.01	21.26	3.61	20.62	4.04	20.39	3.90	19.93	4.44

Significant differences only found in TK ($F = 4.217$, $p<.01$). Only the groups which the participants taught less than two years and the participants who taught 15 years or more had significant differences in Scheffe. In other words, the participants who had less than two years of teaching experiences had significantly higher TK than the participants who had 15 or more years of teaching experiences. Less teaching experiences participants were younger than the other groups' of participants. The result would be consistent with the results of age matters. The One-way ANOVA results of TPACK and TSE status shown in the participants with different teaching experiences are presented in Table 4.11.

Table 4.11

One-way ANOVA Analysis of TPACK and TSE status shown in teachers with different teaching experiences

Source	SS	df	F	Sig.	Scheffe
TK	7144.895	312	4.217	.002**	1>5
CK	2065.923	312	1.319	.263	
PK	1766.760	312	1.590	.117	
PCK	1804.409	312	0.990	.413	
TCK	4787.796	312	1.623	.168	
TPK	4264.920	312	0.694	.597	
TPCK	6004.435	311	1.693	.151	
Willingness	6780.740	311	1.534	.192	
Integration	3394.083	312	0.995	.411	
Belief	5375.126	312	1.006	.405	

Note: **$p < .01$

The participants who taught in the school with 7-24 classes scored the highest mean scores in every domain. Especially the domains which were related to technology. The descriptive statistic results of TPACK and TSE status shown in the participants with different school sizes were presented in Table 4.12.

Table 4.12

TPACK and TSE status shown in teachers with different school sizes

Domain	6 or less classes (N=19)		7-24 classes (N=141)		25 classes or above (N=153)	
	Mean	S.D.	Mean	S.D.	Mean	S.D.
TK	20.79	4.52	21.10	4.56	20.47	5.03
CK	19.95	2.72	20.47	2.68	20.89	2.44
PK	19.53	2.55	19.84	2.58	19.54	2.16
PCK	19.21	2.40	19.52	2.58	19.15	2.23
TCK	20.26	3.98	21.55	3.71	20.63	4.06
TPK	19.95	3.71	21.40	3.70	20.80	3.69
TPCK	22.50	4.64	24.45	4.27	23.55	4.39
Willingness	23.74	4.33	24.33	4.74	23.16	4.60
Integration	17.32	3.56	18.21	3.38	17.46	3.17
Belief	19.89	3.89	21.17	4.17	19.71	4.06

Note: **$p < .01$

Significant differences only found in belief (F = 4.789, p<. 01). The participants who taught in the school which had 7-24 classes showed significant differences with the participants who taught in the school which had 25 classes or above. School size and school culture also affected the participants' TPACK and TSE. It is also similar to the finding of Jimoyiannis (2010). The One-way ANOVA results of TPACK and TSE status shown in the participants with different school sizes were presented in Table 4.13.

Table 4.13

One-way ANOVA Analysis of TPACK and TSE status shown in teachers with different school sizes

Source	SS	df	F	Sig.	Scheffe
TK	7144.895	312	0.632	.532	
CK	2065.923	312	1.727	.180	
PK	1766.760	312	0.599	.550	
PCK	1804.409	312	0.911	.403	
TCK	4787.796	312	2.425	.090	
TPK	4264.920	312	1.820	.164	
TPCK	6004.435	311	2.574	.078	
Willingness	6780.740	311	2.309	.101	
Integration	3394.083	312	2.148	.118	
Belief	5375.126	312	4.789	.009**	2>3

Note: **$p < .01$

The majority of the participants were Chinese language art teachers (60 out of 314) then followed by English teachers (52 out of 314). The participants who taught Chinese language art and English scored the lowest in the domains which were related to technology, TK, TCK, TPK, TPCK, willingness, integration, and belief. On the other hand, the participants who taught Art scored the highest in all of the domains which wer related to technology, TK, TCK, TPK, TPCK, willingness, integration, and belief. The descriptive statistic results of TPACK and TSE status shown in the participants with different teaching subjects were presented in Table 4.14.

Table 4.14

TPACK and TSE status shown in teachers with different teaching subjects

Domain	Chinese (N=60)	English (N=52)	Math (N=44)	Science (N=35)	Social Science (N=36)	Art (N=50)	Others (N=36)
	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)	M (SD)
TK	18.75 (4.81)	19.02 (4.77)	20.09 (5.32)	22.20 (3.70)	22.39 (4.02)	22.80 (4.24)	21.69 (4.34)
CK	20.85 (2.67)	19.88 (2.03)	20.64 (2.21)	20.29 (2.72)	21.28 (2.12)	21.36 (2.62)	20.11 (3.32)
PK	19.63 (2.39)	19.13 (1.93)	19.68 (2.13)	19.40 (2.52)	19.94 (2.12)	20.52 (2.23)	19.33 (3.23)
PCK	19.57 (2.32)	18.60 (2.23)	19.18 (2.51)	19.29 (2.44)	19.44 (2.24)	19.76 (2.27)	19.44 (2.85)
TCK	19.93 (3.98)	20.13 (3.73)	20.11 (4.81)	22.23 (2.54)	21.83 (3.54)	22.44 (3.49)	21.31 (4.03)
TPK	19.55 (3.80)	20.31 (3.53)	20.84 (4.29)	21.71 (3.11)	21.56 (3.22)	22.24 (3.37)	21.78 (3.61)
TPCK	22.22 (4.00)	22.63 (4.21)	22.93 (5.47)	24.77 (3.83)	22.50 (3.80)	25.73 (3.54)	24.68 (4.35)
Willingness	22.43 (4.37)	22.46 (4.70)	23.11 (5.62)	24.63 (4.10)	24.33 (3.70)	25.69 (4.44)	24.25 (4.59)
Integration	16.77 (3.27)	17.56 (3.51)	16.95 (3.82)	18.17 (2.60)	18.53 (2.59)	19.16 (3.13)	17.83 (3.14)
Belief	18.85 (3.86)	19.79 (4.06)	19.43 (4.82)	21.03 (3.58)	21.42 (2.72)	22.40 (3.92)	20.43 (4.65)

No significant differences exited in PK and PCK, but all the other domains showed significant differences. The result might imply that even the participants taught different teaching subjects still shared similar teaching methods and knowledge. That could be the reason why no significant differences were found in the domains of PK and PCK. The participants who taught science, social science and art had significantly higher TK than the participants who taught Chinese language art. In the domain of TPK, the participants who taught art had significantly higher TPCK than the participants who taught Chinese language art. Moreover, the participants who were art teachers had significantly higher TPCK than the participants who were Chinese language art teachers and English teachers. The participants who were social science teachers also had

significantly higher TPCK than the participants who were Chinese language art teachers. Similar results also showed in the domains of willingness and integration. In the domain of belief, the participants who taught art had significantly higher belief than the participants who taught Chinese language art and math. From the findings of the study, the participants who taught Art had significantly higher technology-related knowledge than the participates who taught language art (Chinese language art and English). The One-way ANOVA results of TPACK and TSE status shown in the participants with different teaching subjects were presented in Table 4.15.

Table 4.15

One-way ANOVA Analysis of TPACK and TSE status shown in teachers with different teaching subjects

Source	SS	df	F	Sig.	Scheffe
TK	7144.895	312	6.678	.000***	4 > 1 5 > 1 6 > 1
CK	2065.923	312	2.251	.038*	
PK	1766.760	312	1.807	.097	
PCK	1804.409	312	1.232	.289	
TCK	4787.796	312	3.732	.001**	
TPK	4264.920	312	3.580	.002**	6 > 1
TPCK	6004.435	311	5.645	.000***	5 > 1 6 > 1 6 > 2
Willingness	6780.740	311	3.539	.002**	6 > 1
Integration	3394.083	312	3.448	.003**	6 > 1
Belief	5375.126	312	4.724	.000***	6 > 1 6 > 3

Note: *p<.05, **p＜.01, ***p＜.001

4.3 The correlation between TPACK and TSE

For the third research question: Is there any correlation between TPACK and TSE? The answer is yes. The researcher used Person Correlation to analysis the data. The results of correlation between TPACK and TSE were presented in Table 4.16. TK showed highly significant differences with willingness to use technology (r = .558, p <.001), integrating technology in teaching (r = .549, p <.001), and believing technology can enhance learning (r = .591, p <.001). As CK, significant differences also exited in the three domains of TSE. The results of the correlation coefficients were 2.43, 2.87, and 3.03 respectively. The correlation coefficients between PK and willingness, integrating, and belief were .352, .375, and .419 (p <.001).

PCK and willingness, integrating, and belief were all presented significantly correlated. The results of the correlation coefficients were .422, .395, and .452 (p <.001). For the correlation between TCK (r = .739, .728, and .722 respectively, p <.001) and TPK (r = .753, .743, and .732 respectively, p <.001), the results were the same, all highly correlated. As the correlation coefficients between TPACK and the three domains were .797, .785, and .796 respectively (p <.001). Correlation also exited between the overall of TPACK and willingness, integrating, and belief (r = .764, .764, and .786 respectively, p <.001). In every domain of TPACK and TSE, all showed correlated and some even highly correlated with each other.

The finding of the current study presented the high correlation between TPACK and TSE. Similar findings can be found and discussed elsewhere (e.g., Koehler, Mishra, Akcaoglu, and Rosenberg, 2013; Kim, Kim Lee, Spector & DeMeester, 2013). Teachers with high TPACK would also come along with high TSE. Teachers had more positive technology teaching/learning experiences; they would gain higher TPACK and TSE.

The finding of the present study cannot identify whether teachers need to have the more TSE first or they need to have sufficient TK or TPACK first. Based on the previous related studies or theoretical framework of TPACK and TSE, the researcher suggested that teachers need to have sufficient TK or TPACK first. With the knowledge of technology and TPACK, teachers would have better understanding what a suitable technology tool would be (TCK) and how to integrate technology in their teaching (TPK). Without a good understanding of TK or TPACK, technology can be an ornament or supplementary/optional tool in teaching (Ekrem & Reccp, 2014).

Table 4.16

Correlations between TPACK and TSE

		TSE			
		Willingness	Integrating	Belief	Overall
TPACK	TK	.558***	.549***	.591***	.599***
	CK	.243***	.287***	.303***	.282***
	PK	.352***	.375***	.419***	.399***
	PCK	.422***	.395***	.452***	.441***
	TCK	.739***	.728***	.722***	.770***
	TPK	.753***	.743***	.732***	.787***
	TPCK	.797***	.785***	.796***	.847***
	Overall	.764***	.764***	.786***	.821***

Note: ***$p < .001$, N = 314

4.4 Teachers' experiences and difficulties of using technology in teaching

This is the section deals with the fourth research question: What are the difficulties teachers encountered when integrating ICT into classroom teaching? This part reports on the findings of the five open-ended questions in the questionnaire. For the first question: Have you ever integrated technology in teaching? Why do you integrate technology in teaching? Two hundred and sixty-nine out of the total 314 participants answered this question (question item #59). All the responses were coded and categorized. The top 5 were increasing students' learning motivation, creating the diversity of teaching and learning environment, enhancing students' understanding of the content knowledge, creating a lively classroom, and attracting students' attention and the convenience of using technology. From the feedback, some of the participants mentioned that using technology as a tool to increase their learning motivation. With technology, teachers can attract students' attention in class. Some of the participants believed that integrating technology can increase teaching and learning diversity. Fifteen of the participants pointed out that with the help of technology student would understand the content knowledge more and better. Fourteen of the participants believed by using technology can create more lively learning environment. According to the 13 participants, the accessible of technology would be one of the factors for teachers to consider integrating technology in their teaching. The five categories and their frequency from the participants' responds were listed in Table 4.17.

Table 4.17

Results of question 59: Reasons of integrating technology in teaching

Ranking	Item	Frequency	%
1	Motivation and students' attention	66/269	24.5%
2	Diversity	19/269	7.1%
3	Understanding	15/269	5.8%
4	Lively	14/269	5.2%
5	Convenience/Attention	13/269	4.8%

For the second question: To you, what is the biggest difficulties to integrate technology in teaching? Three hundred out of the total 314 participants answered this question (question item #60). All the responses were coded and categorized. Over one hundred of the participants mentioned the problem of equipment. The reasons mainly were the following: the equipment that schools can provide were limited or too old to run the newest software or programs. Not enough equipment for teachers and students to use. Setting up the equipment took too much time, the participants cannot teach a whole class period. Seventy-eight of the participants pointed out that the teaching hours were not enough for them to integrating technology in their teaching. The participants mentioned that their course schedule was too tight to do extra class activities or involved technology in teaching.

Thirty-six participants thought it was difficult to find a suitable material to integrate in their teaching. The participants needed to spend extra time on the material the participants wanted to use in class. Some participants also pointed out the expectation of more teaching materials. Twenty of the participants expressed the opinions of not being familiar with technology. That's why they did not feel willing or choose technology in their teaching. Some even mentioned that technology changed so fast that they always had to keep learning the latest technology. Bad internet connection was pointed out by 19 of the participants. Without good internet connection, the participants could not use the on-line material smoothly which would influence the teaching flow. The top 5 reasons were listed in Table 4.18 according to the participants' responds.

Table 4.18

Results of question 60: Difficulties to integrate technology in teaching

Ranking	Item	Frequency	%
1	Equipment	115/300	38.3%
2	Teaching hours and course schedule	78/300	26.0%
3	Material	36/300	12.0%
4	Updated / Familiar with technology or not	20/300	6.7%
5	Internet connection	19/300	6.3%

The third question: When you are going to integrate technology in teaching, what kind of factors will you consider? (Please listed according the importance of the factors). Two hundred and ninety-six out of the total 314 participants answered this question (question item #61). The first factor that the most participants mentioned was the equipment. For the participants, having a good teaching tool (equipment) to use was important. If the technology were easy to use or operate, the 33 participants would be willing to integrate technology in their teaching more. However, if the technology was not user-friendly, the participants might say no to use technology in their teaching.

Teaching schedule was one of the top five factors for the participants to consider. The participants needed to teach certain lessons within certain time. If integrating technology would not help the participants to teach better or save more time, they would not accept to integrate technology in their teaching. No suitable teaching materials for the participants, the participants would not agree to integrate technology in their teaching, Whether the material would fit with the teaching goals and objectives. Students' learning affected the participants whether to integrate technology in their teaching. By using the technology, the students did not improve their learning outcome. The participants would not keep using technology in their teaching. The top 5 of the participants' responds were listed in Table 4.19.

Table 4.19

Results of question 61: Factors of influencing teachers to integrate technology

Ranking	Item	Frequency	%
1	Equipment	91/296	30.7%
2	Operation	33/296	11.1%
3	Schedule	27/296	9.1%
4	Material	26/296	8.8%
5	Learning outcome	15/296	5.1%

The fourth question: If you keep integrating technology in teaching, what reasons would it be? Two hundred and seventy-six out of the total 314 participants answered this question (question item #62). The participants' students' learning outcome could be a positive effect for the participants. Ninety-one of the participants mentioned that they would keep integrating technology was because their students' learning outcome was better than before. The convenience of the technology encouraged the participants to keep using technology in their classes. It was easy to make and design their teaching material through technology. With the help of technology, some difficult content knowledge would also be easier to explain. It is also easy to organize the teaching materials.

Thirty-three of the partcipants mentioned about students' learning interest. The integration of technology can motivate Students' learning interest. Students can find out the answers by themselves. Twenty-nine of the participants listed motivation. When the participants integrated technology in teaching, students could be motivated and willing to learn more and pay attention in class. Students' learning motivation would be stimulated and wanted to know more. Eleven of the participants wrote down diversity. The participants pointed out that they can present other related information which was related to the subject. Students can learn more than just the knowledge in the textbook. Top 5 of the participants' responds were listed in Table 4.20.

Table 4.20

Results of question 62: Reasons of keeping integrating technology in teaching

Ranking	Item	Frequency	%
1	Leaning outcome	91/276	33.0%
2	Convenience	39/276	14.1%
3	Students' learning interest	33/276	12.0%
4	Motivation	29/276	10.5%
5	Diversity	11/276	4.0%

The last question: You had integrated technology in teaching, but you do not integrate technology in teaching anymore or seldom do so now. What is the reason that you don't integrate technology in teaching? Two hundred and sixty-two out of the total 314 participants answered this question (question item #63). The inconvenience of the equipment and hardware made the participants refuse to keep integrating technology in their teaching. Some participants pointed out that they were not familiar with the equipment or the hardware so they would not want to integrate technology in their teaching. Fifty-nine of the participants claimed that it would waste too much time on setting up or waiting for the internet connection. They could not teach effectively. Forty of the participants believed that students' learning outcome did not improve. To them, technology would distract students' attention. Students would pay attention on other functions but not listening and paying attention in class.

Twenty-eight participants claimed that integrating technology in teaching could not keep their teaching on the schedule. Thirteen of the participants claimed they still using technology in their classes because of the positive feedback from their students. Top 5 of the participants' responds were listed in Table 4.21.

Table 4.21

Results of question 63: "Reasons of not integrate technology in teaching"

Ranking	Item	Frequency	%
1	Equipment / hardware	70/262	6.7%
2	Time	59/262	22.5%
3	Learning outcome	40/262	15.3%
4	Course schedule	28/262	10.7%
5	Still using	13/262	5.0%

Form the responds of all the open-ended questions; the participants wrote their opinions of applying technology in their teaching. The participants concerned equipment, students; learning outcome and motivation, and course schedule. These findings can all find similar finding in previous studies (e.g., Jimoyiannis, 2010; Liu and Kleinsasser, 2015; Tsai and Shieh, 2011).

4.5 Summary

The finding of this study is summarized as following:

First, the participants had the highest CK (mean = 4.13), but the participants' willingness to integrate technology in teaching was the lowest (mean = 3.39). The participants' teaching experiences and learning background would influence their TPACK and TSE. The following will describe each different factors that affected the participants' TPACK and TSE.

For male participants, they had significant higher TK, TCK, TPK, TPACK, willingness, integrating and belief than female participants. The participants who had a master degree also had significant higher TCK TPK, integrating, and belief than the participants who had a bachelor degree. Ages also matters. The participants who ages 30 or below had significant higher TK than the other three groups of participants. Sub teachers scored significantly high TK, willingness, and integrating than home room teachers and full-time teachers. It also related to the result that less teaching experiences of the participants had significantly high TK than those who had 15 years or above of teaching experiences. School size would be an influential factor, too. The participants taught in 7-24 classes showed significantly high belief than the participants taught in 25 or above classes. Language teachers scored significant low in each technology-related factor such as TK. The mean of participant who taught Chinese language art was 18.75, and it was 19.02 for the participants who taught English. Others scored higher such as the participants who taught Art (mean = 22.80) and the particpatns who taught Social science (mean = 22.39).

Second, TPACK and TSE were highly correlated in every domain and as a whole. Especially, the correlation between TPCK and TSE ($r = .847$, $p < .001$) was the highest. Followed by the correlation coefficient of TPACK and TSE was .821 ($p < .001$).

Last, the participants' choices of keep integrating technology in their teaching were mostly related to equipment and hardware, students' learning outcome and learning

motivation, and course schedule. If students' learning outcome improved, the participants would keep integrating technology in their teaching. If it increased students' learning motivation, the participants would also keep using it. However, the participants still concerned about their course schedule, they were afraid they were behind schedule.

4.6 Discussion

In this section, the findings of the present study are compared with those various of previous related studies in Chapter Two. The current study found that male teachers had significantly higher TK and other six domains which were related to technology than female participants. The finding is similar with Ekrem and Recep (2014) and Koh, Sing and Tsai (2010). Ekrem and Recep found that male preservice English teachers' TK were significantly higher than female preservice English teachers. Same findings were found in Koh and Chai (2011). Moreover, Jordan (2013) let preservice male (12 participants) and female (52 participants) teachers self-rate their TPACK for two years. The results also showed that the male participants had higher TK than the female participants, but did not show significant differences.

The participants' educational background had significant differences in the domains of TCK, TPK, integration, and belief. The participants who had higher degrees had higher TCK, TPK, integration, and belief. This can match with the previous studies that teachers had related technology learning experiences would increase their TPACK and TSE (Celik & Yesilyurt, 2013; Chai, Koh & Tsai, 2013; Jimoyiannis, 2010; Martinovic & Zhang, 2012). The younger participants had significantly higher TK than other groups of the participants. This could be the reason that younger generation of teachers had more experiences of learning with technology and using technology in their daily life. Those two reasons may be the reasons why only TK showed statistically significant higher but no significant differences in other domains.

Sub teachers in the current study also had significantly higher TK, TCK, and TPCK than home room and full-time teachers. It can be suggested that most of the sub teachers were younger. Then, this is consistent with the result of the domain of age. Also, it can explain that the participants who had less than two years of teaching experiences had higher TK than the participants who had more than 15 years of teaching experiences.

School size can influence the participants' belief of integrating technology in teaching. The result is similar with Koh, Chai, and Tay's (2014) study. School cultures or institutional factors would influence teachers' TPACK. Some of the participants in the present study worked in the school that encouraged teachers to integrate technology in teaching. Some schools were started to encourage teachers to integrate technology in teaching in that school year. These would be the similar reasons that Koh, Chai, and Tay (2014) had mentioned.

Language teachers (Chinese language art and English) in the present study had significant lower than Art teachers and social study teachers. Most of the previous studies presented that teachers' TPACK and TSE changed after an ICT program or learning session (Celik & Yesilyurt, 2013; Chai, Koh & Tsai, 2013; Jimoyiannis, 2010; Martinovic & Zhang, 2012). Little studies were focused on comparing the status of teachers' TPACK and TSE with different teaching subjects. According to the responds from the participants of the present study, language teachers did not feel the need of integrating technology in their teaching. On the other hand, social studies and art teachers could explain the teaching context/knowledge better to their students by the help of technology. With the help of technology, art and social studies teachers could also provide more additional related knowledge and/or recourses to their students. This could be the reason why language teachers scored the top two lowest in almost every domain which was related with technology.

CHAPTER FIVE
CONCLUSION AND SUGGESTION

In this chapter, the major finding of the study will be summarized. Then, pedagogical implications will be provided. Finally, the limitation of the study and the recommendations for future research will be suggested.

5.1 Conclusion

The study aimed to investigate Taichung middle school teachers' TPACK and TSE. MOE have promoted the use of technology in teaching for years, especially the new curriculum guideline highlighted the importance of ICT. As the result, it is also important for middle school teachers to be prepared for the new challenge.

Three hundred and twelve middle school teachers from different areas of Taichung participated in the study. They completed the questionnaires which were conducted by the researcher. 58 questions and five open-ended questions were in the questionnaire which asked the participants' TPACK and TSE.

The findings of the study included that (1) the participants' TPACK and TSE were significantly correlated in each domain. (2) The reasons that the participants kept integrating technology or refusing to use technology were equipment, students' learning motivation and learning outcome, and course schedule. (3) The participants' genders, ages, positions, teaching experiences, and teaching subjects all showed significant differences were found in the domain of TK. (4) In the domain of CK, only teaching subjects were significant difference. (5) Significant differences were found in the variables of genders, educational backgrounds, positions and teaching subjects in the domain of TCK. (6) Genders, educational backgrounds, and teaching subjects all showed significant differences in the domain of TCK. (7) Two domains, TPCK and willingness, found significant differences in the variables of genders, positons, and teaching subjects. (8) Three variables, genders, ages, and teaching subjects, were found significant differences in the domain of integration. (9) Genders, ages, positons, school sizes, and teaching subjects all showed significant differences in the domain of belief. Summary of the significant differences of the study was presented in Table 5.1.

To sum up, the participants' teaching/learning experiences will influence their TPACK and TSE. The male participants had higher TK than female participants. The

participants' students' feedback or learning outcome were positive, then the participants would keep on integrating technology in their teaching. The younger generation of the participants had higher technology related knowledge than those elderly participants. The participants who taught Art had higher technology related knowledge and TSE than those participants who taught Chinese language art and English.

Table 5.1

Summary of the significant differences

	Gender	Education	Age	Position	Experiences	Size	Subjects
TK	✓		✓	✓	✓		✓
CK							✓
PK							
PCK							
TCK	✓	✓		✓			✓
TPK	✓	✓					✓
TPCK	✓			✓			✓
Willingness	✓			✓			✓
Integration	✓	✓					✓
Belief	✓	✓		✓		✓	✓

5.2 Pedagogical Implications

Pedagogical implications were drawn from the research findings. First, the findings showed that the participants' experiences would affect their TPACK and TSE, especially the factors that were related to technology. The results of the study suggested to provide teachers more positive of integrating technology in teaching and learning experiences. By doing so, teachers can enhance not only their TSE but also their TPACK.

Second, providing more workshops or seminars for teachers, teachers can learn more new techniques or materials to use in their class. The participants who did not integrate technology in teaching mentioned that the changing of the technology was so rapid that they cannot catch up.

Third, equipment is an important factor, too. The participants in the study pointed out that equipment and bad internet connection caused the inconvenience in their teaching. If school administers can help to avoid the technical problem, it may encourage teachers to use technology in their teaching more. If school administers even promote and encourage teachers to integrate technology in teaching, teachers may be encouraged to do so.

5.3 Limitations of the study and Suggestions for Future Studies

The present study provides the findings of Taichung middle school teachers' TPACK and TSE. Nonetheless, the present study still has some limitations, for future researchers who are interested in this topic.

First of all, the researcher only 11 schools from 4 different areas in Taichung were invited and completed the questionnaires. It could be difficult to generalize the result to middles school teachers in Taiwan. Future researchers can try to invite more middle school teachers from other cities in Taiwan.

Second, although open-ended questions were included in the questionnaire, some follow-up interviews can be conducted for the future researchers. The researchers can understand more about the participants' inner thoughts in TPACK and TSE. It is not easy to know the participants' thought through their short responds in the open-ended questions.

Third, various kinds of technology can be integrated in teaching. In the present study, the researcher did not include and ask what kind of technology that middle school teachers had used. To know more about the technology tools that teachers had applied, the better the school administers, or course designers can know how to help teachers to integrate technology smoothly in class.

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APPENDIX A

Chinese Version of the Questionnaires

一、性別： 1. □ 男性 2. □ 女性

二、最高學歷： 1. □ 學士 2. □ 碩士（含 40 學分班） 3. □ 博士

三、年齡： 1. □ 30 歲以 2. □ 31-40 歲

3. □ 41-50 歲 4. □ 51 歲（含）以上

四、任職類別： 1. □ 專任 2. □ 專任兼行政 3. □ 專任兼導師

4. □ 代理或代課

五、教學年資：

1. □ 2 年（含）以下 2. □ 3-5 年 3. □ 6-10 年

4. □ 11-14 年 5. □ 15 年（含）以上

六、任職學校類型：

1. □ 6 班（含）以下 2. □ 7-24 班 3. □ 25 班（含）以上

七、主要任教領域或學科：

1. □ 國文 2. □ 英文 3. □ 數學

4. □ 物理 5. □ 化學 6. □ 生物 7. □ 地球科學

8. □ 歷史 9. □ 地理 10. □ 公民

11. □ 健康 12. □ 體育

13. □ 音樂 14. □ 視覺藝術（美術） 15. □ 表演藝術

16. □ 綜合活動 17. □ 資訊科技

18. □ 其他（請填寫）_____

		非常同意	同意	普通	不同	非常不同意
1.	我經常使用科技產品。					
2.	我會使用許多不同種類的科技產品。					
3.	我通常可以很輕鬆地學會新科技產品的使用方式。					
4.	我有足夠的知識來使用不同的科技產品。					
5.	我跟得上新科技的發展腳步。					
6.	我通常能夠自行解決所遇到的科技問題。					
7.	我具備所任教學科應有的學科知識。					
8.	我具備所任教學科應有的情意。					
9.	我具備所任教學科應有的技能。					
10.	我對任教學科的領域有一套自己思考與理解的方式。					
11	我在任教的學科上有發展許多不同的理解方法和技巧。					
12	我能夠應用不同的教學策略來提升學生的思考和理解。					
13.	我能夠引導學生體驗各種不同的學習方法。					
14.	我瞭解學生在學習哪些內容時容易產生混淆或學習困難。					
15.	我能夠應用多元評量方式去評量學生的學習成效。					
16.	我能夠幫助學生掌握和反省自己的學習方式。					
17.	我能使用不同的教學方法將學科知識轉化為學生容易理解的概念。					
18.	我能夠選擇最適合學生的教學方法來引導學生學習。					
19.	我知道如何幫助不同學習成就的學生學習重要的學科概念。					
20.	我知道如何營造班級氣氛，提升學生的學習興趣。					
21.	我對於在常態編班的班級中進行有效教學感到					

	自信。					
22.	我能夠使用科技來呈現我所任教的學科知識。					
23.	我能夠選擇合適的科技來輔助我的學科教學。					
24.	我會留意那些可以應用在我所任教學科的資訊科技。					
25.	我能夠在設計課程或教案時，考慮不同的科技來呈現課程內容。					
26.	我在師資培育過程中所受的訓練，讓我在使用科技輔助教學活動時能得心應手。					
27.	我參與網路線上社群來學習科技融入學科教學的相關知識。					
28.	我能夠在教學上應用不同的科技來支援課程活動。					
29.	我會考量如何將科技融入在課堂教學中。					
30.	我能夠比較不同教學科技之間的優缺點。					
31.	我知道如何選擇用來提升學生學習成效的科技產品。					
32.	我知道如何選擇用來提升自己教學成效的科技產品。					
33.	我在師資培育過程中所受的訓練，讓我在使用教學科技時能權衡科技的使用對教學活動產生的影響。					
34.	我能適當地將科技知識、學科知識、和教學方法整合在我平常的課程設計中。					
35.	我能將所學的科技知識、學科知識、和教學方法運用於創新教學中。					
36.	我能選擇不同的數位媒材來幫助不同需求的學生學習學科知識。					
37	我能夠依據課程與教學的需求來製作所需要的數位媒材。					
38.	我在師資培育過程中所習得的方法和策略，讓我有足夠能力整合科技、教學方法、與學科內容。					
39.	我能應用科技來提升我的課程內容與教學品質。					
40.	對我而言，將科技融入學科內容與教學方法中是容易的事。					

41.	我會積極主動參加與教學科技相關的研習或是工作坊。					
42.	我使用科技媒材（例如：Office軟體、均一或1Know 網路教學平台、社群媒體臉書Facebook…等）收集學生的考試成績和作業成品。					
43.	我使用科技媒材（例如：Office軟體、均一或1Know 網路教學平台、社群媒體臉書Facebook…等）分析學生的考試成績和作業成品。					
44.	我能夠在我的課堂中自在地使用科技媒材。					
45.	我能夠選擇適合學科內容的科技媒材。					
46.	我會透過網路科技尋找適合的教學資源。					
47.	我會使用科技的輔助來評量學生的學習狀況。					
48.	我能夠選用合適的科技在教學活動中使用。					
49.	我可以有條理地將教學科技融入我的課堂中。					
50.	即使是在硬體設備不足的情況下，我依然持續在教學中運用教學科技。					
51.	我會思考如何將科技媒材融入教學中。					
52.	我會將我所學到的新科技媒材融入不同的教學活動中。					
53.	我有能力評估適合在教學上使用的軟體或網路平台。					
54.	我可以激勵我的學生使用科技媒材製作學科相關的專題或作業。					
55.	我可以藉由科技媒材，讓任課班級學生的學科表現進步。					
56.	我能有自信地與同事分享教學科技資源。					
57.	我藉由使用科技媒材讓學生保持學習動機。					
58.	我會使用科技媒材來增加學生的創意。					

60. 請問對您而言，將科技融入課堂教學最大的困難是什麼？

61. 請問，在思考是否要將科技融入教學時，您會考量哪些因素？（請依重要性敘寫。）

62. 若您一直持續在課堂教學中使用科技，請問持續使用科技的原因是什麼？

63. 若您曾經將科技融入課堂教學，但現在已較少使用或不使用，請問原因是什麼？

——————————問卷結束。謝謝您的填答！——————————