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An Investigation of Early Childhood Teachers' Technological Pedagogical Content Knowledge (TPACK) in Taiwan

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ABSTRACT

This study aimed to investigate technological pedagogical content knowledge (TPACK) of early childhood teachers in Taiwan. Quantitative Data was collected from a sample of 335 in-service early childhood teachers in Taiwan. The instrument was translated and adapted from Schmidt et al. (2009) TPACK survey instrument with added items to fit the early educational context in Taiwan. Data analysis methods included descriptive statistics, Pearson correlation, and MANOVA. Findings from the study were summarized as follows: (a) The development of early childhood teachers' pedagogical knowledge (PK), content knowledge (CK) and pedagogical content knowledge (PCK) were the best among the seven knowledge sub domains in TPACK.(b)The number of years of teaching experience was significantly positively correlated with early childhood teachers' pedagogical knowledge (PK), content knowledge (CK) and pedagogical content knowledge (PCK). Besides, early childhood teachers with over ten years of teaching experience had better self-assessed pedagogical knowledge (PK), content knowledge (CK) and pedagogical content knowledge (PCK) than those teachers with less than ten years of teaching experience. (c) A significant positive correlation was found between pedagogical knowledge (PK), and pedagogical content knowledge (PCK) and age; however, a significant negative correlation existed with technology knowledge (TK) and age. Older early childhood teachers' self-assessed pedagogical knowledge (PK) was better than younger teachers while the young early childhood teachers had a better self-assessed technology knowledge (TK) (d) Early childhood teachers with a frequency of using information technology above 20 hours a week had better self-assessed technology knowledge (TK) and technological content knowledge (TCK) than those with a frequency under 5 hours a week Recommendations were also provided based on the findings from this study.

KEYWORDS: Teacher education, Early childhood teachers, Technological pedagogical content knowledge (TPACK)

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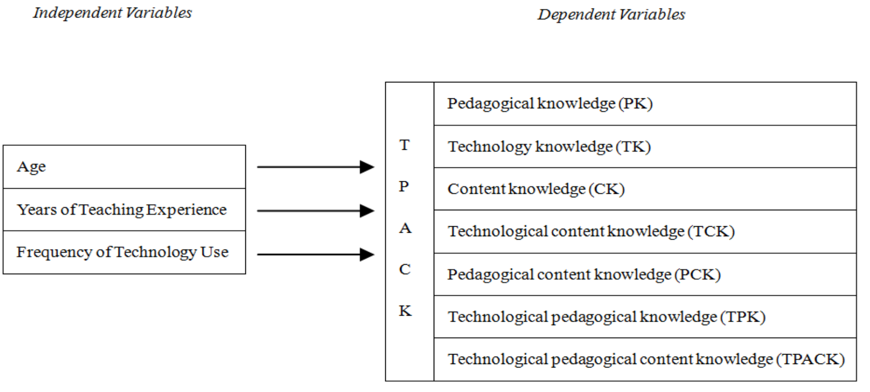
INTRODUCTION

There are strong evidences that teacher quality is a crucial factor in achieving remarkable learning outcomes for students. Meanwhile, technology is rapidly adopting a predominant role in education as nations and countries have increased their investments both in computer hardware/software and Information Technology (IT) infrastructure. The specific role of technology is not always understood or utilized to its full potential and thus has not always achieved its intended purposes and visions (Cuban, 2001). How to prepare teachers to advance in their knowledge of the use of technology in teaching and learning to the full potential and to enhance learning outcomes has been a focus of advocacy in education in the 21st century (Roschelle, Pea , Hoadley, Gordin, & Means, 2000; Sefton-Green, 2006). In addition, new understanding of the complex, and context-situated nature of teachers' technology integration knowledge or termed as technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006; Koehler & Mishra, 2008) has led to questions how this knowledge can be developed and evaluated. One of the various approaches is through the development of survey instruments based on the concepts of the components of TPACK to quantify the TPACK knowledge that a teacher possessed (Schmidt, et al. 2009; Archambault & Crippen, 2009). The development and presence of these quite robust measures provides a path for further investigation to access a tremendous amount of data that can be gained in different geographic locations and various content areas and content domains.

There is a substantial body of research on technology use with young children. A large portion of this research focused on the use of computers to enhance social, language, and cognitive skills (Anderson, 1999; McCarrick & Li, 2007). Studies highlighted the opportunities for language use (Kelly & Schorger, 2001) and social interactions that technology offers, along with increased motivation (Clements & Sarama, 2003; Heft & Swaminathan, 2002) for young children learning with technology. Computers also make possible experiences and representations that cannot take place in the real world, providing new experiences and improved understanding for young children .Used appropriately, technology can be a positive element of children's play and learning as they explore and experiment. Thus, given the increasing importance of technology in the early childhood classrooms, it has become urgent to investigate the level of early childhood teachers' technological pedagogical content knowledge (TPACK) to inform the development of guidelines for the design of technology professional development programs for early childhood teachers in Taiwan.

In this survey study, we translated and adapted Schmidt et al' TPACK survey instrument to fit into the exiting Taiwan context in early childhood teachers. After a rigorous pilot test, we developed a Chinese TPACK questionnaire items with good validity and reliability to be used by the early childhood teachers in Taiwan. This study aimed to investigate technological pedagogical content knowledge (TPACK) of early childhood teachers in Taiwan to identify Taiwan' early childhood teachers' self-assessed TPACK and to examine the relationships between demographic variables (e.g., years of teaching experience, the frequency, and variety of technology use) and their self-assessed TPACK (see Table 1.)

Table 1. *Research Framework*



Related Literature

Building on Shulman's idea of pedagogical content knowledge (PCK), Mishra and Koehler (2006) have added technology to PCK, and described Technological pedagogical content knowledge (TPACK) as the interweaving of technology, pedagogy, and content. Technological pedagogical content knowledge (TPACK) is a framework that the complex interactions between a teacher's knowledge of content (CK), pedagogy (PK), and technology (TK). The combination of technology in pedagogy in a particular subject must take into account the dynamic combination between the components and the intersections such as TPK (technological pedagogical knowledge), PCK (pedagogical content knowledge), TCK (technological content knowledge) among them. A teacher who can navigate between these interrelations represents an expert who is different from an expert only in the disciplinary field of knowledge, only in the technology field of knowledge or only in the pedagogical field of knowledge (Mishra & Koehler, 2006; Koehler & Mishra, 2008). No single solution exists to address technology use and integration in educational settings because different perspectives were chosen by the teachers. TPACK encompasses that teachers are able to make sensible and creative choices in their use of technology in the classroom. Seven components are included in the TPACK framework. They are defined as according to Mishra and Koehler (2006) and Koehler and Mishra (2008):

1. Technology knowledge (TK): Knowledge about various technologies, ranging from low-tech tradotioanl technologies, such as pencil and paper, blackboard to digital technologies, such as the Internet, digital video, interactive whiteboards, computer-mediated communicaiton software programs.

2. Content knowledge (CK): Knowledge about the actual subject matters and specific content domains such as math and science that teachers must know about and familiar with in order to teach.

3. Pedagogical knowledge (PK): Knowledge about the processes and practices of teaching and learning such as classroom management, lesson plan development, and student evaluaiton to achieve overall educational purposes, values , and goals.

4. Pedagogical content knowledge (PCK): Knowledge that deals with the teaching process and the transfornation of subject matter into teaching (Shulman, 1986). Pedagogical content knowledge is different for various content areas, as it blends both content and pedagogy with the goal to develop better teaching practices in each of various content areas.

5. Technological content knowledge (TCK): Knowledge of how technology can create new representations for specific contents and can impact the practices and knowledge of a given discipline. It suggests that teachers understand that, by utalizing a specific technology in teaching and learning, they can change the way learners practice and comprehend concepts in a specific content area.

6. Technological pedagogical knowledge (TPK): Knowledge of how various technologies can be used in teaching and understanding that using technology may change the way teachers teach. This includes the knolwedge of pedagocial affordances and constraints of different technological tools.

7. Technological pedagogical content knowledge (TPACK): Knowledge of the complex interplay and interaction among the three basic components of knowledge (CK, PK, TK) that a teacher possess when teaching content using appropriate pedagogical methods and technologies. It is the basis of effective teaching with technology.

There have been several recent studies that have used TPACK framework to look in depth at inservice teachers' (Graham, Burgoyne, Cantrell, Smith, St. Clair, & Harris, 2009), and preservice teachers' development in TPACK(Albion, Jamieson-Proctor, & Finger, 2010 ; Schmidt et al, 2009; Graham, Cox, & Velasques, 2009). In addition, studies also investigated teachers' efforts to use technology in their teaching in several domain areas such as Math (Niess, 2005; 2006), Science (Graham, Burgoyne, Cantrell, Smith, St. Clair, & Harris, 2009) and social studies (Hammond & Manfra, 2009). Angeli and Valanides (2009) rehearsed the argument for technological pedagogical content knowledge as a distinct body of assessable knowledge and proposed ICT-TPCK as a strand of TPACK based on the five domains of ICT, content, pedagogy, learners, and context. They then developed a combination of self, peer and expert assessment to investigate preservice teachers ICT-TPCK competence in two design tasks. Arguing that the World Wide Web is a specific case of technology, Lee and Tsai

(2010) developed an instrument to measure 558 Taiwanese teachers' self-efficacy in terms of their TPCK-W. Schmidt et al.' survey (2009) was designed for repeated use by preservice teachers as they progressed through their teacher preparation courses and then into their teaching practicum. Archambault and Crippen's survey (2009) was designed to be used by inservice teachers and was found reliable and valid with 600 K-12 nationally representative online teacher respondents. The development and presence of these quite robust measures provided a path for further investigation to access a tremendous amount of data that can be gained in different geographic locations and various content areas and domains. Other than self-report studies, Harris, Grandgenett, and Hofer (2010) utilized an assessment rubric approach to develop a rubric instrument to infer a teacher's TPACK by examining an instructional plan. They argued that results from the rubric instrument as an external assessment can be triangulated with self-report data collected from survey instrument. Niess (2005) further argued that PCK will gradually replaced by the concept of TPACK due to high availability of technology in the classroom in K-12 environments .She elaborated in TPACK as an overarching concept of what it means to teach, which included knowledge of instructional strategies, knowledge of representations with technology, and knowledge of students.

Almost all instruments were developed to measure either preservice or inservice teachers' TPACK in elementary and secondary schools, and teacher education programs. One of the gap from the recent studies is the lack of research studies aimed to provide a whole picture of teachers' TPCK in early childhood education, specifically in the Pre-K level. Although there have been arguments over introducing computers in early childhood education settings, the reality is that technology is already there. In addition, today's preschool and kindergarten children exist in a context where the technology is present in almost every aspect of their lives. According to Vandewater et al (2007), 27% of 5- to 6-year-olds used a computer (for 50 minutes on average) on a typical day. Today almost every preschool and kindergarten has computers, with the ratio of computers to students changing from 1:125 in 1984 to 1:22 in 1990 to 1:10 in 1997 in the U.S. (Clements, 1999). In 2001, the ratio of instructional computers with Internet access to students in public schools in the U. S. was 5.4 to 1 (NCES, 2002). Elsewhere in the in the 28 PISA participating countries, technology in the early childhood classroom is also a common scene (OECD, 2006). In Taiwan, private kindergartens comprise a large proportion of preschool education institutions, which are most independently operated, and most public kindergartens are affiliated with public primary schools. In 2009, the ratio of computers to students in public K-12 schools is 1:7 in Taiwan. The large number of private preschool institutions charge higher tuition fees than public ones and are often quipped with more computers and other digital devices to compete with public ones to recruit mores preschoolers and kindergarteners. Therefore, the question now is how to integrate the already existing technology into practice of the early childhood classroom. Several decades of research have clearly demonstrated the short- and long-term positive effects that high-quality early childhood programs have on children's development and high-quality programs depend on teacher effectiveness (Hamre & Pianta, 2005). According to Koehler, Mishra, and Yahya (2007), there is more to the teacher preparation and professional development than training teachers how to use the technology tools and they also argue that good teaching requires an understanding of knowledge of how technology is related to pedagogy and content.

Unique capabilities of computers could provide practice of the combination of visual displays, animated graphics and sound, instant feedback and record keeping. In addition to gains in the competence in reading and math from the early computer-assisted instruction studies (Lavin & Sanders, 1983), recent studies showed that the computer has become a recognized tool in the education of young children, particularly where it is used to promote problem solving skills, higher order thinking skills and social interactions amongst children (Anderson, 1999: Clements, 2002; Galen & Buter, 2000). The role and importance of computers in young children's educational lives was recognized in 1996 by the highly influential (American) National Association for the Education of Young Children's (NAEYC) position statement on the use of technology by young children (NAEYC, 1996). It is now generally agreed that young children can benefit intellectually and socially from the use of developmentally appropriate software. Furthermore, advocates for constructivism-based learning activities argued that young children should be provided with opportunities to actively engage with the computer and supporting software in exploring and learning new concepts (Clements & Nastasi, 1993; Bers, Ponte, Juelich, Viera, & Schenker, 2002). In addition, touchscreens have been claimed to be an optional input device for young children to prevent them being refrained in keyboarding and mouse device (Romeo, Edwards, McNamara, Walker, & Ziguras, 2003). Thus, to be effective in an early childhood classroom with available technology, early childhood teachers must develop technological pedagogical content knowledge (TPACK) to be sensitive to the demands of utilizing technology in ways to age appropriate youth development experiences that facilitate learning.

METHODS

Design of Survey Instrument

Given that there were no existing Chinese TPACK instruments, we started with the translation of Schmidt et al.'s (2009) TPACK questionnaire first 47 items of the seven components of TPACK (TK, PK, CK. TPK, PCK, TCK, TPACK) into Chinese. Three educational technology teacher educators reviewed the initial translated items to ensure their accuracy to the original English survey items. This panel of experts also provided professional feedback to make sure that the translation reads well and the meaning of the survey items is precise. Another early education subject matter expert then reviewed the TPACK measure to ensure its content related to the early childhood environment in Taiwanese early childhood education context. She recommended that we added items adapted from the curriculum content standard proposed by Ministry of Education in Taiwan in CK , TCK, PCK components. Therefore, we added 7 items in CK, 3 items in TCK and 8 items in PCK on top of the preexisting Schmidt et al's questionnaire survey. We also added 3 items in TK, 6 items in TPK, and 3 items in TPACK from Archambault and Crippen's survey items (2009).

To improve both validity and reliability of the developed instrument, a pilot test was conducted to examine and refine the items of the initial 75 TPACK questionnaire items. 202 valid inservice early childhood teacher responses in this pilot study were returned. In order to ensure content validity, we had the panel of experts of educational technology and early childhood educator to reexamine the TPACK items. Feedback from the in-service teacher respondents helped fix possible flaws. We asked them to check the feedback box indicating if the item is problematic. Based on their frequency of the checked feedback and the consent from the panel of experts, we deleted 2 highest frequency problematic checked items from the PK, 2 items form TK, 5 items form CK, 4 items form PCK, 3 items from TPK. Thus, there were 59 items in the refined overall TPACK questionnaire survey. A 5-point Likert scale , consisting of five different response choices (from 1 strongly disagree to 5 strongly agree, with 5 as the highest point of score) was employed . We then ran a factor analysis in each sub knowledge domains of the TPACK measure, investigating construct validity for each knowledge domain subscale using principal components factor analysis with varimax rotation and Kaiser normalization. A summary of the factor analysis results shows that there was one factor in PK, TCK, TPK and TPACK sub domains, 2 factors in TK and PCK, and 3 factor loadings in CK with Eigen values of all factors greater than 1. As measured by Eigenvalues (greater than 1) and factor loadings, these results showed a relatively high degree of construct validity (see Table 1). In addition, as Table 1 suggests, all subdomains had fairly high values of Cronbach's standardized item alpha, indicating a high order of scale reliability. The refined TPACK measure included 59 items for a total of seven components of TPACK. The Cronbach's alpha of the refined TPACK instrument is .87, that of PK, TK, CK, TCK, PCK, TPK, TPACK is .78, .92, .89, .92, .90, .92., and that of Modeling technology use is .92., indicating a fairly high reliability (see Table 2) and examples of each construct of TPACK survey are provided in Table 3.

Table 2. *Factor Matrix for Each of Seven Sub-knowledge Domain of TPACK*

	Number of Factor Loadings	**Total Variance**	**Internal Consistency (alpha)**
Pedagogical Knowledge	1	55.47%	.78
Technology Knowledge	2	71.70%	.89
Content Knowledge	3	69.19%	.92
Technological Content	1	69.48%	.92

Knowledge			
Pedagogical Content Knowledge	2	70.83%	.89
Technological Pedagogical Knowledge	1	53.39%	.90
Technological Pedagogical Content Knowledge	1	65.88%	.92

Table 3. *Examples of TPACK Survey Items.*

TPACK Constructs	Examples of Survey Items
Pedagogical Knowledge	My ability to adjust teaching methodology based on student performance and feedback. I can assess student learning in multiple ways.
Technology Knowledge	I have had sufficient opportunities to work with different technologies. I keep up with important new technologies.
Content Knowledge	My ability to decide on the depth, scope and extension of concepts taught within in my class. My ability to plan the sequence of concepts taught within my class.
Technological Content Knowledge	My ability to implement curriculum plan in an Internet environment. My ability to use various technological representations (e.g. multimedia, visual demonstrations, etc.) to demonstrate specific concepts in my content area.
Pedagogical Content Knowledge	My ability to anticipate likely student misconceptions in learning a specific topic. My ability to assist students in noticing connections between various concepts in a curriculum.
Technological Pedagogical Knowledge	I can adapt the use of the technologies to different teaching activities. I am thinking critically about how to use technology in my classroom.
Technological Pedagogical Content Knowledge (TPACK)	My ability to use technology to create effective representations of content that depart from textbook knowledge. I can select technologies to use in my classroom that enhance what I teach, how I teach and what early children learn.

Data Collection

The formal data collection started from April and May 2010 with the final refined survey questionnaires and a cover letter sent out to 390 early childhood teachers in five major cities and county areas in Southern Taiwan. In total, 335 valid survey responses were obtained with a response rate of 86%.

Data Analysis

The analysis of the survey data was generally quantitative in its approach. Data were analyzed for all the variables using the appropriate SPSS 17.0 statistical procedures to determine descriptive statistics with respect to respondents' personal and professional profiles. Descriptive statistics were used to present measures of central tendency such as mean and standard deviation for the TPACK measure in each of the seven knowledge subscale. We ran Pearson product-moment correlation analysis to examine the relationships between each of TPACK subscales and three demographic variables of age, years of teaching experiences, and frequency of technology use per week.

Multivariate analysis of variance of variance (MANOVA) was used to examine where there were significant differences between the respondents' personal and professional backgrounds such as age, years of teaching experience, and frequency of technology use per week and each of the sub domains of TPACK measure. MANOVA is a test of the significance of group differences in some multi-dimensional space where each dimension is defined by linear combinations of the original set of dependent variables. In addition, multiple comparison procedures were used to identify where there were differences between the self-assessed sub-domains of TPACK reported by the respondents and the personal and professional backgrounds after the omnibus null hypothesis of no difference in group means had been rejected.

RESULTS

Of all the 335 respondents, a majority of them were in the age groups of 20 to 40 with a highest percentage in the 20 to 40 years old group. The percentage drops sharply after the age of 40, which indicates a relative young respondent population. Therefore, most of the respondents had either 1-5 years of teaching experience or 6-10 years. Half of them used technology less than five hours a week while about 31 percent of them used technology between 5-10 hours per week and almost 20 percent uses technology more than 10 hours per week (see Table 4).

Table 4. Descriptive Statistics of Age, Years of Teaching Experiences, Frequency of Technology Use

	Items	N	Percent (%)
Age	20-30	141	42%
	31-40	144	43%
	41-50	43	13%
	Above 51	7	2%
Years of Teaching	1-5	107	32%
	6-10	108	32%

Experience	11-15	60	18%
	16-20	43	13%
	Above 21	17	5%
Frequency of Technology Use	Below 5 hrs per week	168	50.1%
	5-10 hrs per week	103	30.7%
	11-20 hrs per week	39	11.6%
	Above 20 hrs per week	25	7.5%

This group of early childhood teacher respondents has a self-assessed TPACK of an above leverage level according to Table 5 (with 5 indicating the highest score). The highest level falls into the PK and the lowest falls into TK.

Table 5. Descriptive Statistics of Respondents' Self-assessed TPACK

TPACK Domains	(M)	(SD)	(V)
Pedagogical Knowledge (PK)	4.06	.506	.256
Technological Knowledge (TK)	3.36	.644	.415
Content Knowledge (CK)	3.74	.525	.276
Technological Content Knowledge (TCK)	3.43	.639	.409
Pedagogical Content Knowledge(PCK)	3.78	.544	.296
Technological Pedagogical Knowledge(TPK)	3.52	.628	.395
Technological Pedagogical Content Knowledge (TPACK)	3.48	.682	.465

Note：N=335

What is worth noticing here is that the r value did not imply a high correlation, which might be the results of the uneven number of each age group and years of teaching experience specifically in the age groups of 41-50 and above 50 and that of above 16 years teaching experience, which contains a relatively small proportion of the respondent population. However, given their significant correlations, it is still valid to imply discussion to explain the significant correlations (Cohen, 1988). Thus, the correlations results showed that the number of years of teaching experience was significantly positively correlated with preschool teachers' pedagogical knowledge (PK), content knowledge (CK) and pedagogical content knowledge (PCK). In addition, a significant positive correlation was found between pedagogical knowledge (PK), and pedagogical content knowledge (PCK) and age; however, a significant negative correlation existed with technology knowledge (TK) and age. The frequency of using information technology was significantly positively correlated with pedagogical knowledge (PK), technology knowledge (TK), content knowledge (CK), technological content knowledge (TCK) and technological pedagogical knowledge (TPK) (see Table 6).

Table 6. Correlations between TPACK Sub-scale Domains and Years of Teaching Experience, Age, Frequency of Technology Per Week

	Years of Teaching Experience	Age	Frequency of Technology Use Per Week
Pedagogical Knowledge(PK)	.202**	.129*	.123*
Technological Knowledge (TK)	-.248**	-.223**	.224**
Content Knowledge (CK)	.119*	.107	.144**
Technological Content Knowledge (TCK)	-.065	-.058	.165**
Pedagogical Content Knowledge(PCK)	.156**	.111*	.089
Technological Pedagogical Knowledge(TPK)	-.018	-.021	.133*
Technological Pedagogical Content Knowledge (TPACK)	-.054	.047	.106

Note：N=335，* p<.05，** p<.01

Multivariate analysis of variance (MANOVA) was applied to investigate differences in four groups of years of teaching experience, three age groups, and four groups of frequency of technology use and the respondents' self-assessed seven sub-scale domains of TPACK measure. The four groups of years of teaching experience are group 1 (1-5 years of teaching experience), group 2 (6-10 years of teaching experience), group 3 (11-15 years of teaching experience), and group 4 (above 16 years of teaching experience). The three age groups are group 1 (20-30 years old), group 2 (31-40 years old), group 3 (above 40 years old). The four groups of frequency of technology use are group 1 (below 5 hours per week), group 2 (5-10 hours per week), group 3 (11-20 hours per week) and group 4 (above 20 hours per week). Post-hoc Games-Howell tests were used to perform pair-wise comparisons because of uneven group numbers.

Significant differences were found among the four groups in the years of teaching experience and the self-assessed overall TPACK measure（Wilks Λ= .808，η^2 = .069, p< .001）, specifically in three of the seven subscales- PK（p< .05）, TK（p< .001）, CK （p< .05）and PCK（p< .05）. Post-hoc tests showed that the group with 6 to 10 years （M=20.46, SD=2.107）, 11 to 15 years（M=20.83, SD=2.293）, and above 16 years of teaching experiences（M=20.77, SD=3.18）had a better self-assessed PK than the youngest group of 1 to 5 years of teaching experiences（M=19.62, SD=2.513）. However, the group of 1 to 5 years of teaching experiences （M=28.01, SD=4.268）and 6 to 10 years of teaching experiences （M=27.75, SD=4.497）had a better TK than the group of above 16 years of teaching experiences（M=24.52, SD=6.339）. In terms of CK, the group of 11 to 15years of teaching experiences（M=57.72, SD=7.77）was better than the group of 1 to 5 years（M=54.36, SD=6.781）. The group of 11 to 15 years of teaching experiences（M=30.95, SD=4.409）had a better PCK than the group of 1 to 5 years（M=29.14, SD=3.393）. In summary, those early childhood teachers within 10 years of teaching experiences were better in terms of TK while those with more than 10 years of teaching experiences had better PK, CK, and PCK (see Table 7).

Significant differences were also found among the three different age groups and the self-assessed overall TPACK measure (Wilks Λ=.862，η^2 = .071, p< .001), specifically in the PK and TK subscales. Post-hoc Games-Howell tests showed that the age group of 31-40（M=20.60, SD=2.319）had a better self-assessed PK that the age group of 20-30（M=19.89, SD=2.417）while the age group of 20-30（M=28.09, SD=4.505）had a better technological knowledge (TK) than the age group of 31 to 40（M=26.48, SD=4.825）and the age group of above 41（M=24.78, SD=6.774）(see Table 8).

Significant differences were also found among the five groups of different frequency of technology use per week and the self-assessed overall TPACK measure (Wilks Λ= .899，η^2 = .035, p< .05), specifically in TK and TCK. Post-hoc tests showed that the 11-20 hours per week group（M=28.82, SD=3.939）and the above 20 hours per week group（M=29.64, SD=5.559）had a better self-assessed TK than the group with below 5 hours per week（M=26.02, SD=5.236）spent on technology. In addition, the group with a frequency of technology use above 20 hours per week（M=25.76, SD=3.833）had a better TCK than the group of less than 5 hours（M=23.28, SD=4.873）spent on technology use per week (see Table 9).

Table 7. Differences among Different Groups in Teaching Experiences and TPACK Sub-domains

Domains	Years of Teaching Experiences		N	Mean	SD	F	Post-Hoc
Pedagogical Knowledge(PK)	1	1-5	107	19.62	2.513	4. 279*	2>1
	2	6-10	108	20.46	2.107		3>1
	3	11-15	60	20.83	2.293		4>1
	4	above 16	60	20.77	3.180		
Technological Knowledge (TK)	1	1-5	107	28.01	4.268	9.211***	1>3
	2	6-10	108	27.75	4.497		1>4
	3	11-15	60	25.72	5.478		2>4
	4	above 15	60	24.52	6.339		
Content Knowledge (CK)	1	1-5	107	54.36	6.781	2.791*	3>1
	2	6-10	108	56.52	7.378		
	3	11-15	60	57.72	7.770		

	4	above 15	60	56.15	9.566		
Technological Content Knowledge (TCK)	1	1-5	107	24.06	3.631	1.529	--
	2	6-10	108	24.55	3.720		
	3	11-15	60	23.78	5.327		
	4	above 15	60	23.22	5.721		
Pedagogical Content Knowledge (PCK)	1	1-5	107	29.14	3.934	3.221*	3>1
	2	6-10	108	30.55	4.281		
	3	11-15	60	30.95	4.409		
	4	above 15	60	30.77	4.869		
Technological Pedagogical Knowledge (TPK)	1	1-5	107	27.89	3.905	1.189	--
	2	6-10	108	28.82	4.993		
	3	11-15	60	28.20	5.535		
	4	above 15	60	27.58	6.198		
Technological Pedagogical Content Knowledge (TPACK)	1	1-5	107	27.34	4.341	.567	--
	2	6-10	108	28.19	5.551		
	3	11-15	60	28.22	6.084		
	4	above 15	60	27.92	6.381		

Note： N=335，* p<.05，***p<.001

Table 8. *Differences among Different Age Groups and TPACK Sub-domains*

Domains	Age		N	Mean	SD	F	Post-hoc
Pedagogical Knowledge(PK)	1	20-30	141	19.89	2.417	3.542*	2>1
	2	31-40	144	20.60	2.139		
	3	above 40	50	20.68	3.548		
Technological Knowledge (TK)	1	20-30	141	28.09	4.505	8.906**	1>2 1>3
	2	31-40	144	26.48	4.825		
	3	above 40	50	24.78	6.774		
Content Knowledge (CK)	1	20-30	141	54.98	6.913	2.166	--
	2	31-40	144	56.53	7.084		
	3	above 40	50	57.20	11.056		
Technological Content Knowledge (TCK)	1	20-30	141	24.09	3.565	.815	--
	2	31-40	144	24.20	4.468		
	3	above 40	50	23.28	6.430		
Pedagogical Content Knowledge (PCK)	1	20-30	141	29.67	4.145	2.013	--
	2	31-40	144	30.49	4.049		
	3	above 40	50	30.90	5.548		
Technological Pedagogical Knowledge (TPK)	1	20-30	141	28.23	4.285	.027	--
	2	31-40	144	28.21	5.096		
	3	above 40	50	28.04	6.621		
Technological	1	20-30	141	27.55	4.839	.431	--

Pedagogical Content Knowledge (TPACK)	2	31-40	144	28.08	5.378		
	3	above 40	50	28.29	7.129		

Note：N=335，* p<.05，** p<.01

Table 9. Differences among Different Groups in Frequency of Technology Use and TPACK Sub-domains

Domains	Frequency	N	Mean	SD	F	Post-hoc
Pedagogical Knowledge (PK)	1.Below 5 hrs per week	168	20.18	2.598	2.725	--
	2.5-10 hrs per week	103	20.08	2.371		
	3. 11-20 hrs per week	39	20.74	2.552		
	4. Above 20 hrs per week	25	21.48	2.383		
Technological Knowledge (TK)	1.Below 5 hrs per week	168	26.02	5.236	6.280***	3>1
	2.5-10 hrs per week	103	26.90	4.952		4>1
	3. 11-20 hrs per week	39	28.82	3.939		
	4. Above 20 hrs per week	25	29.64	5.559		
Content Knowledge (CK)	1.Below 5 hrs per week	168	55.05	7.897	2.345	--
	2.5-10 hrs per week	103	56.26	8.154		
	3. 11-20 hrs per week	39	57.41	6.672		
	4. Above 20 hrs per week	25	58.72	5.849		
Technological Content Knowledge (TCK)	1.Below 5 hrs per week	168	23.28	4.873	3.939**	4>1
	2.5-10 hrs per week	103	24.61	4.140		
	3. 11-20 hrs per week	39	24.49	3.300		
	4. Above 20 hrs per week	25	25.76	3.833		
Pedagogical Content Knowledge (PCK)	1.Below 5 hrs per week	168	29.96	4.629	1.104	--
	2.5-10 hrs per week	103	30.16	4.349		
	3. 11-20 hrs per week	39	30.56	3.803		
	4. Above 20 hrs per week	25	31.52	3.016		
Technological Pedagogical Knowledge (TPK)	1.Below 5 hrs per week	168	27.61	5.315	2.240	--
	2.5-10 hrs per week	103	28.49	4.966		
	3. 11-20 hrs per week	39	28.85	4.221		
	4. Above 20 hrs per week	25	29.88	3.919		
Technological Pedagogical Content Knowledge (TPACK)	1.Below 5 hrs per week	168	27.33	5.570	1.576	--
	2.5-10 hrs per week	103	28.14	5.290		
	3. 11-20 hrs per week	39	28.97	4.682		
	4. Above 20 hrs per week	25	28.76	6.254		

Note：N=335，* p<.05，** p<.01，** p<.001***

DISCUSSION and RECOMMENDATIONS

Results from this study showed that different age groups and years of teaching experiences, and the frequency of technology use demonstrated different profile in terms of the TPACK sub-domains. Specifically, the youngest group (20-30 years of age) had a higher level of technological knowledge (TK) than other two older age groups and age had a negative correlation with technological knowledge (TK). This finding echoed some previous studies regarding teachers' use of technology in the classroom that younger generations tended to be keener in attitude and practice to involve themselves in a technology related classroom activity (Moursund, & Bielefeldt, 1999; Russell, Bebell, O'Dwyer, & O'Connor, 2003). In addition, the two groups of longer hours (16-20 hours and above 20 hours) of technology use per week showed a higher level of technological knowledge (TK) than the group who spent less than five hours per week on technology use. The group with above 20 hours spent on technology use per week even had a higher level of technological content knowledge (TCK) than the group who spent less than five hours on technology per week. Younger groups in this study seemed to be what Prensky (2001a, 2001b) called Digital Natives while the older groups were Digital Immigrants. The Digital Natives of today are all native speakers of the digital language of computers, video games and the Internet. They are also the population that has a higher frequency percentage of technology use per week. Thus, it is worth noticing that even in our teacher groups today there are generation gaps in terms of digital technology exposure.

In terms of years of teaching experiences, a similar profile of TK was demonstrated as in the different age groups since those with more years of teaching experiences are naturally in the older groups. However, those who with more years of teaching experiences showed a higher level of pedagogical knowledge (PK) than the new teachers within five years of teaching experiences. In addition, the group of 11 to 15 years of teaching experiences showed a higher level of pedagogical content knowledge (PCK) than the novice teachers with five years of teaching experiences. Therefore, how the younger groups of technology users can diffuse the innovation and collaborate with senior teachers with more sophisticated knowledge in pedagogy and pedagogical content knowledge should be a professional development program design focus. We suggest that an intergeneration technology mentoring program should be an optimal solution for the faculty technology professional development (Thompson, Chuang, & Sahin, 2007).

What is worth noticing is that age, years of teaching experiences, and frequency of technology use per week were not significantly correlated with the technological pedagogical content knowledge (TPACK) subscale in the overall TPACK measure. In addition, differences in age, years of teaching experiences, and frequency of technology use did not show significant difference in terms of the respondents' self- assessed TPACK subscale. In general, the findings from this study revealed that younger groups of early childhood teachers demonstrated a better technological knowledge (TK) while the more experienced groups showed a more sophisticated pedagogical knowledge (PK) and pedagogical content knowledge (PCK). The complex, and context-situated nature of teachers' technology integration knowledge or technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006; Koehler & Mishra, 2008) has led to new understanding that technological knowledge alone could not make a good TPACK and that the choice of technology and pedagogy in a particular subject must take into account the dynamic combination between the components and the intersections such as TPK (Technological pedagogical), PCK (pedagogical content), TCK (technological content) among them. Therefore, approaches towards the development of TPACK of teachers of different age groups and years of teaching experiences should have different focus on the specific needs of the particular teacher groups.

CONCLUSION and FUTURE WORK

This preliminary survey study provided a general picture of Taiwanese early childhood teachers' TPACK profile and its findings helped to inform design guidelines and indicators for future professional technology development programs for the development of in-service teachers' TPACK. The findings showed that the early childhood teachers in Taiwan had an average self-assessed TPACK. In addition, different groups of teachers had different TPACK profiles. The younger generation weighted more on the technological knowledge and the experienced teachers had developed more sophisticated pedagogical knowledge and pedagogical content knowledge. Findings from this study provided guidelines for the development of technology professional development programs for the in-service early childhood teachers in Taiwan. Future work will include continual revision and refinement of the instrument and expanding the survey scope to other K-12 teachers in Taiwan. In addition, qualitative data such as interviews and observations will also be collected to provide more in-depth illustrations beneath the general profile of the development of TPACK for K-12 teachers in Taiwan. Meanwhile, future work on international collaboration is also recommended to provide a world view of TPACK in different culture contexts. In addition, due to the uneven number among the age groups, correlation r value did not project a strong yet significant coefficient relationship. Future research will aim to increase its sample size among those groups of older generation teachers in order to provide an paramount profile of K-12 teachers in terms of their self-assessed TPACK.

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