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Research on TPACK and Teacher Professional Development of Secondary Physical Education Pre-service Teachers

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Abstract: The main purpose of this study was to explore the relationships between teachers' Technological Pedagogical Content Knowledge (TPACK) and their Teacher Professional Development (TPD). A total of 305 secondary physical education pre-service teachers (S-PEPT) participated in this study. In this study, two questionnaires, TPACK and TPD, were used. As a result, the confirmatory factor analysis showed that the two questionnaires used in this study were valid and reliable. In addition, S-PEPT's TPACK highly correlated with their TPD. Finally, according to path analysis, the result indicated that S-PEPT's PCK and TCK could significantly predict their TPD. The implication of this study showed that S-PEPT with more knowledge of IT-assisted teaching may therefore increase the IT usage in the classroom, and then have more competencies to face the diverse students and environment of the 21st century.

Keywords: Teacher Professional Development, Physical Education Pre-service Teachers

1. Introduction

1.1 TPACK of PE (Physical Education)

With the rapid development of technology applications, it has become a basic quality that teachers teaching should use now. Facing the new opportunities and impacts brought by information technology and the internet to education, teachers in the 21st century should not only possess content knowledge (CK) and pedagogy knowledge (PK), but also could apply technology knowledge (TK) to enhance students' learning effectiveness.

In order to help teachers effectively combine the CK, PK and TK in the teaching process, and solve the complex teaching activities that may be faced with, Mishra and Koehler (2006) further proposed technological pedagogical and content knowledge (TPACK) based on pedagogic content knowledge (PCK).

The practical application of the integration of technology into physical education has been quite common. Compared with other disciplines, physical activity has the peculiarities of physical activity, and the nature of its teaching methods is quite different from other disciplines. Therefore, technology-assisted physical education not only breaks the barriers of traditional physical education classrooms, but also extends the infinite horizon and space of physical education teaching, helping learners improve their learning motivation, and promote learners' learning effectiveness (Pasco, 2013; Semiz & Ince, 2012).

This shows the importance of technology to physical education teachers, and back to the source, how to promote the ability of future teachers is very important, because physical education teachers and students will step into more challenging teaching scenes in the future. There are more diverse learners nowadays, so teachers should use the technology to improve their teaching effectiveness for the diverse learners (Arslan, 2015; Cengiz, 2015). Physical education teachers learn how to integrate technological knowledge into the teaching and make the TPACK knowledge support the physical education will be more important.

1.2 Teacher Professional Development of PEPT

Teachers' professional development is a dynamic learning process, which is the development of professional connotation through continuous maintenance of learning and research momentum (Armour, Quennerstedt, Chambers, & Makopoulou, 2017). The process is a long-term, purposeful, uninterrupted, and systematic professional growth activity, in which a series of in-depth reflection and practice are carried out on new affairs and the changing environment. Teaching is a professional field, so teachers need to improve professional knowledge and teaching quality for promoting students' learning effectiveness and meeting their needs (Avalos, 2011).

The professional development of physical education teachers can be carried out in various forms, including empowerment study and related research conferences, so as to promote their professional development (Brent, 2015). As a new PE teacher who will step into the teaching field in the future, he needs to ensure that he has the cognitive view of professional development with the highest standard (Coulter & Woods, 2012).

Therefore, the professional development of physical education teacher education is very important because it will be an opportunity to create a win-win situation. We hope to pay more attention to and cultivate the lifelong professional development of S-PEPT. Although this needs to be accumulated over time, it is a very important conceptual starting point and urges teachers and students to learn how to improve their critical reflection ability (Braga, Jones, Bulger, & Elliott, 2017; Tannehill, Demirhan, Čaplová, & Avsar, 2020).

Therefore, this study will explore which knowledge and viewpoints of S-PEPT will be associated with their TPD, and the main purposes of this study were to:

- What is the validity of the questionnaires for measuring the two constructs?
- Explore the relationships between TPACK and TPD.

2. Method

2.1 Participants

The participants in this study were 305 secondary physical education pre-service teachers from selected universities in Taiwan. There were 207 male and 98 female pre-service teachers. These pre-service teachers included sophomores to masters students.

2.2 Instrument

In this study, two questionnaires, including Technological pedagogical and content knowledge (TPACK) and teacher professional development (TPD) were used. The two questionnaires were filled out at the same time.

The first questionnaire was TPACK. It had four dimensions, includes PCK, TPK, TCK, TPCK. Mainly to understand the teachers' perceptions of Technology-related Pedagogical Content Knowledge. An example of PCK is as follows, I can encourage students to try to find problems related to the learning of motor skills in PE. An example of TPK is as follows, I can use technology to assist physical education in PE. An example of TCK is as follows, I can use technology to prepare for PE classes, such as mobile phones and tablets. An example of TPCK is as follows, I know how to use technology and equipment to design PE content and teaching strategies.

The second questionnaire was about teacher professional development. It had four dimensions, which include curriculum design and teaching (CDT), class management, and counseling (CMC), research development (RD), and Advanced Study (AS). For an example of CDT, I can use various teaching methods according to the needs of PE class. For an example of CMC, I can properly handle students' deviations in

PE class. For an example of RD, I am willing to absorb new knowledge in education and innovative teaching. For an example of AS, I am willing to make educational commitments for the future of the students.

2.3 Data Analyses

In this study, the Confirmatory Factor Analysis (CFA) with all of the items and dimensions of the two questionnaires included in one model was performed to clarify the reliability and validity of all of the questionnaires. Moreover, to further understand the relationships among the dimensions of these two questionnaires, correlation analysis and SEM were performed.

3. Results

3.1 Verification of the validity of the two questionnaires

A total of 32 items were retained in the version (i.e. 15 items for TPACK, and 17 items for TPD) as shown in Table 1. It shows the results of the confirmatory factor analysis for the two questionnaires in one model as well as the descriptive statistics for each variable. Each dimension has five questions. The goodness of fit for the CFA of the structure, Chi-square = 789.161, P < .001, degree of freedom = 450, GFI = .86, IFI = .93, TLI = .92, CFI = .93, RMSEA = .050, RMR = .026, Factor loadings = .58-.84, CR = .71-.87, AVE = .45-.60, and Alpha value = .70-.87, was ere obtained, thus confirming the convergent and construct validity of this model for these two questionnaires.

Table 1. *The CFA analysis for the TPACK and TPD (N= 305)*

Construct and measurement items	Factor loadings	*t*-value	CR	AVE	Alpha value
TPACK					
PCK, mean = 3.98, S.D. = .53	-------	-------	0.71	0.45	0.70
PCK1	0.66	-------			
PCK2	0.76	9.28***			
PCK3	0.58	8.00***			
TPK, mean = 3.89, S.D. = .64	-------	-------	0.86	0.60	0.85
TPK1	0.77	-------			
TPK2	0.74	12.94***			
TPK3	0.84	14.73***			
TPK4	0.75	13.11***			
TCK, mean = 4.19, S.D. = .52	-------	-------	0.77	0.46	0.76
TCK1	0.62	-------			
TCK2	0.71	9.56***			
TCK3	0.69	9.38***			
TCK4	0.67	9.21**			
TPCK, mean = 3.82, S.D. = .62	-------	-------	0.85	0.60	0.85
TPCK1	0.70	-------			

Construct and measurement items	Factor loadings	*t*-value	CR	AVE	Alpha value
TPCK2	0.79	12.46***			
TPCK3	0.81	12.73***			
TPCK4	0.77	12.19***			
Teacher Professional Development					
Curriculum Design and Teaching (CDT) mean =4.35, S.D. = .48	-------	-------	0.86	0.60	0.86
CDT1	0.77	-------			
CDT2	0.85	15.07***			
CDT3	0.75	13.17***			
CDT4	0.75	13.03***			
Class Management and Counseling (CMC) mean = 4.11, S.D. = .59	-------	-------	0.79	0.55	0.78
CMC1	0.69	-------			
CMC2	0.78	11.26***			
CMC3	0.76	10.70***			
Research Development (RD) mean = 4.42, S.D. = .49	-------	-------	0.87	0.58	0.87
RD1	0.71	-------			
RD2	0.79	13.04***			
RD3	0.82	13.38***			
RD4	0.78	12.77***			
RD5	0.69	11.15***			
Advanced Study (AS) mean = 4.46, S.D. = .50	-------	-------	0.86	0.56	0.86
AS1	0.71	-------			
AS2	0.77	11.98***			
AS3	0.83	12.87***			
AS4	0.66	10.60***			
AS5	0.78	12.28***			

3.2 Correlation between TPACK and TPD

In this study, Pearson's correlation analysis was use to measure the relationship between TPACK and TPD as shown in Table 2. The correlation analysis results showed that all of the factors of the TPACK Scale were significantly positively correlated with all of the factors of the TPD, as shown in Table 2. To be more specific, PCK was positively correlated with TPD ($r = .35\text{-}43$, $p < .001$). TPK was also positively correlated with TPD ($r = .22\text{-}33$, $p < .001$). TCK was positively correlated with TPD ($r = .32\text{-}44$, $p < .001$), and TPCK was positively correlated with TPD ($r = .24\text{-}42$, $p < .001$).

In addition, CDT was positively correlated with TPACK ($r = .22\text{-}40$, $p < .001$). CMC was positively correlated with TPACK ($r = .22\text{-}40$, $p < .001$). RD was positively correlated with TPACK ($r = .33\text{-}44$, $p < .001$), and AS was also positively correlated with TPACK ($r = .24\text{-}37$, $p < .001$). These findings indicated

that TPACK was highly correlated with TPD. Moreover, the discriminative validity proved that each dimension existed individually and independently

Table 2. *The correlation between TPACK and TPD*

	PCK	**TPK**	**TCK**	**TPCK**	**CDT**	**CMC**	**RD**	**AS**
PCK	.67							
TPK	.30***	.77						
TCK	.43***	.58***	.68					
TPCK	.47***	.65***	.59***	.77				
CDT	.43***	.33***	.44***	.42***	.77			
CMC	.40***	.22***	.32***	.31***	.46***	.74		
RD	.38***	.33***	.44***	.33***	.62***	.39***	.76	
AS	.35***	.24***	.37***	.24***	.45***	.31***	.59***	.75

*p<.05, **p<.01, ***p<.001

Note 1: The value of the diagonal line is the square root of the average variation extraction (AVE) of the potential variable, and this value should be greater than the value of the off-diagonal line.

3.3 Path analysis

To explore the roles that S-PEPT TPD in their TPACK, this study utilized the path analysis technique to examine the relationships between these variables. The TPACK factors were considered as predictors, while the TPD factors were viewed as a second-order outcome variable. The model was indicated several significant associations between the factors in the TPACK and the second-order TPD (See Figure 1).

In this model, PCK could significantly predict the TPD ($\beta = 0.39$, $p < .001$). The result means that the S-PEPT's PCK was associated with their development on professional.

In addition, TCK could significantly predict the TPD ($\beta = 0.46$, $p < .001$). The result means using technical knowledge to prepare physical education may predict the future professional development of S-PEPT.

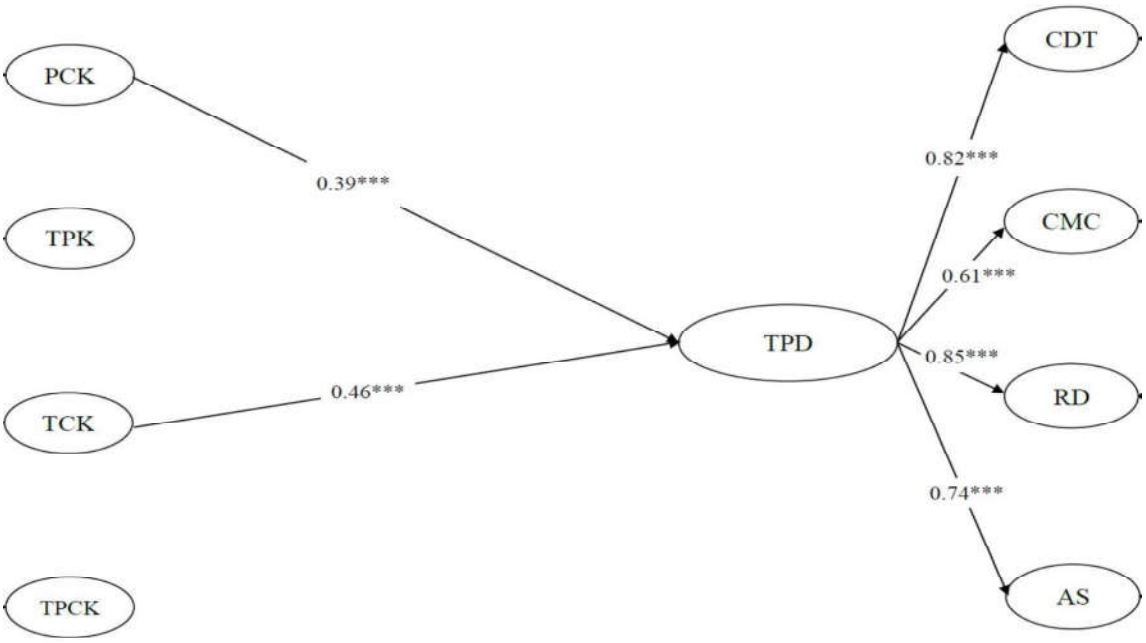

Figure 1. The structural model between TPACK and TPD.

4. Discussion

The PCK and TCK in TPACK can predict TPD, showing that pre-service teachers teach physical education under the construction of basic knowledge, and they can also use the knowledge of technology to prepare courses and teaching materials. This research also showed that S-PEPTs' perceptions of IT-assisted teaching, therefore should increase the opportunities for IT integration in the teacher education stage to face the diverse students and environment of the 21st century.

In addition, in the face of the impact of the current Covid-19 epidemic on global school education, the application of technology has become the main way to sustain learning, and technology for physical education is the solution that physical education teachers urgently need. The future study is suggested to increase the number of samples, so that the relationships between TPACK and TPD can be clearer and representative. Finally, the further study also can assess the difference of the TPACK and the TPD between in-service and pre-service teachers.

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