



A Study on The Development of Pre-service Teachers' TPACK Competencies

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Abstract. In the era of education informatization 2.0, subject pedagogical knowledge of integrated technology (TPACK) is a new knowledge structure teachers should have to integrate technology and teaching effectively and achieve professional development. The study found that the TPACK level of teacher trainees has the following characteristics: the overall TPACK is at the middle-upper level, and the mean value of the composite factor is higher; there is a statistically significant difference between genders, with male students being significantly higher than female students; the highest correlation between the six elements and the TPACK level is that of the PCK factor, with a correlation coefficient of 0.678; the following highest correlation coefficients are those between TK and TPK and the TPACK level, which are 0.654 and 0.678 respectively. 0.654 and 0.640; from the regression equation, it can be seen that the TK of English teacher trainees has the most significant influence on TPACK.

Keywords: TPACK; correlation analysis; regression analysis

1 Introduction

TPACK is a new knowledge structure for teachers to integrate technology with teaching and learning effectively. Since the creation of this theory, a series of related studies have been conducted at home and abroad. Overseas studies have focused on TPACK measurement^[1], empirical studies of TPACK development^[2], and so on. From the research lineage, the trend of foreign research has gradually shifted from macro to micro and from single qualitative and quantitative research to mixed research. Since the introduction of the TPACK concept to China in 2008, domestic research has mainly focused on the following aspects: research on TPACK ontology^[3-4], research on the current status of TPACK^[5-6], research on the influencing factors of TPACK ability^[7] and research on.

This study refers to the international TPACK evaluation framework and proficiency test scale. It adapts them for use in the local context to clarify the current status of TPACK for teacher trainees. It provides some references and suggestions for developing a high-quality teaching force.

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2 Research design and implementation

2.1 Research Object and questionnaire

The sample of this study was taken from the teacher training students of a university in Yunnan Province. The questionnaires were distributed online by "Questionnaire Star." A total of 257 questionnaires were collected, and 234 valid questionnaires were obtained after the back-end of Questionnaire Star screened out invalid questionnaires with too short response time, resulting in an effective recovery rate of 91%.

Based on the relevant theories of TPACK, this study refers to many TPACK framework scales at home and abroad,^[8] mainly draws on Schmidt's (Schmidt) design and development of TPACK scales, and forms a questionnaire on the current status of TPACK for English language teachers with regard to the specific situation of the research participants.

2.2 Reliability and validity analyses

After the test, the alpha coefficients of the seven dimensions were all above 0.7, and the overall alpha coefficient of the scale was 0.973, which indicated that the scale's internal consistency was high, stable, and reliable. Meanwhile, using exploratory factor analysis to analyze the overall content of the scale, the KMO values of the dimensions of the TPACK scale ranged from 0.708 to 0.869 (all greater than 0.60), and the Bartlett's test of sphericity Sig was 0.000, which reached the essential requirement of significance level of less than 0.05. Thus, it was more suitable for factor analysis.

3 Conclusions and analyses

3.1 Overall level analysis

To grasp the overall level of TPACK for teacher educators, the mean and standard deviation of the seven dimensions of TPACK were calculated. As shown in Table 1, the mean value of the seven dimensions is 3.624, indicating that the TPACK of teacher educators is at the middle to upper level in general, with TK being the highest, followed by TPACK, which shows that teacher educators have a better mastery of the technical knowledge and the TPACK knowledge. In contrast, the mean value of CK is lower than the overall mean, and the level of PK is at the critical value, which indicates that teacher educators do not have a satisfactory mastery of the core knowledge of subject content and pedagogical method. Pedagogy should be better.

Table 1. Internal consistency reliability of TPACK level scales

Dimension	TK	CK	PK	PCK	TCK	TPK	TPACK	all
M	3.69	3.1	3.64	3.61	3.62	3.63	3.67	3.624
SD	0.738	0.771	0.704	0.722	0.738	0.680	0.835	

3.2 Meta-analysis

Table 2. Correlation between TPACK dimensions

	TK	CK	PK	PCK	TCK	TPK	TPCK
TK	1						
CK	.635**	1					
PK	.659**	.643**	1				
Spielman Rho							
PCK	.646**	.661**	.632**	1			
TCK	.608**	.617**	.592**	.621**	1		
TPK	.659**	.606**	.637**	.671**	.618**	1	
TPCK	.654**	.609**	.597**	.678**	.633**	.640**	1

The correlations among the TPACK dimensions are shown in Table 2, with positive correlations between the six predictor variables TK, CK, PK, PCK, TCK, and TPK, with correlation coefficients ranging between 0.592 and 0.671. There is a significant positive correlation ($P < 0.01$) between all six predictor variables and the validity variable TPCK with correlation coefficients between 0.597 and 0.678, and a strong positive correlation was found between the elements and TPCK except PK meaning with correlation coefficients exceeding 0.6. These results indicate that English teacher trainees' knowledge of the various components can influence their level of TPCK.

3.3 Predictive regression analysis

A regression equation is a type of equation used to describe the relationship between a dependent variable and an independent variable. In regression analysis, we need to predict the value of the dependent variable based on some independent variables.

Table 3. Stepwise regression model coefficients of TPACK dimensions on TPCK for English teacher trainees

model	UnStandardised coefficient		Standardised coefficient	t	significance	R ²	
	B	standard error	Beta				
1	(constant)	0.2	0.119		1.674	0.095	0.75
	TK	0.942	0.034	0.866	27.905	0	
2	(constant)	0.123	0.111		1.114	0.267	0.788
	TK	0.576	0.063	0.529	9.199	0	
	PCK	0.391	0.058	0.388	6.749		
3	(constant)	0.07	0.11		0.638	0.524	0.797
	TK	0.479	0.068	0.441	7.068	0	
	PCK	0.322	0.06	0.32	5.335		

	TCK	0.183	0.054	0.179	3.366	0.001	
	(con- stant)	0.034	0.11		0.306	0.76	
4	TK	0.399	0.074	0.367	5.378		
	PCK	0.265	0.064	0.263	4.142	0	0.802
	TCK	0.148	0.055	0.145	2.67	0.008	
	TPK	0.183	0.072	0.172	2.536	0.012	
a. implicit variable: TPACK							

Table 3 shows that the six predictor variables of the inputs have significant predictive power for the TPACK criterion variables. The four predictor variables, TK, PCK, TCK, and TPK, have four variables with substantial predictive power for the TPCK criterion variables, in order of the magnitude of the explained variance: TK, PCK, TCK, and TPK. The predictive power of the four predictor variables TK, PCK, TCK, and TPK for the TPCK criterion variables is 75%, 3.8%, 0.9%, and 0.5%, respectively, and a total of 80.2% of the variance of the TPCK criterion variables can be explained. 80.2% of the conflict of TPCK effector variables. Their effects on TPCK are all positive, with TK affecting the TPCK of English teacher trainees the most.

The standardized regression equation is as follows:

$$TPCK = 0.367 * TK + 0.263 * PCK + 0.145 * TCK + 0.172 * TPK \tag{1}$$

4 Conclusions and Implications of the Study

4.1 Conclusions

In the survey, the CK level of English teacher-training students was also not high, probably related to the fact that the current system stipulates that free teacher-training students are not able to sit for academic master's degree exams. In addition, once students chose to work as teacher-training students, they thought that their employment was guaranteed, and they entered the school with very good grades and high motivation for learning, but with the reduction of pressure and motivation, their attitudes towards learning the course changed. Some lecturers also reflected that some students were no longer proactive in their learning attitude after entering the university, believing that as long as they could cope with the examinations of the courses and obtain the corresponding credits, they could do so, and thus did not have a comprehensive and solid grasp of professional knowledge.

From the correlation analysis, the highest correlation between the six factors and the TPACK level is the PCK factor, with a correlation coefficient of 0.678; followed by TK and TPK with correlation coefficients of 0.654 and 0.640. By comparing the correlation coefficients, it is found that the correlation coefficients between TK and the composite elements (PCK, TCK, TPK, TPACK) are higher in the three core elements. The correlation coefficients are higher, thus it is learnt that pedagogical knowledge is a key factor in the TPACK structure of teacher trainees.

From the regression equation, it can be seen that the TK of English teacher trainees maximally influences the TPCK, which is in line with the findings of some scholars who have analysed the study using regression model and structural equation modelling. From the results of the study, TK, PCK, TCK and TPK of English teacher trainees have a significant influence on TPCK, which is the focus of future teacher trainees' teaching skills development. Teacher trainees' CK and PK are focussed and compulsory during their school years, so teacher trainees have general pedagogical knowledge and common sense, but how to support their teaching through technological aids, and how to reconstruct the current content of their teaching in a way that makes it easier for students to comprehend and accept, is the issue of TPK and PCK. Teachers who are more confident in PCK will likewise have higher perception and ability to integrate TK, PK, CK, TCK and TPK. The key issue in the process of technology integration is when, where and how teacher educators should intervene in technology, which essentially returns to the teacher educators' deep understanding of the content of the subjects they teach and their accurate grasp of the current situation of their students, i.e. the teacher educator's PCK (Subject Pedagogical Knowledge). Teacher trainees with high PCK will also have a matching "design thinking", which will enable them to remove barriers to technology integration. Therefore, in the subsequent training of English teacher trainees in technology integration in mathematics teaching, attention should be paid to strengthening the training in the four areas of TK, PCK, TCK and TPK, as well as providing opportunities for them to pay attention to the impact of CK and PK on TPACK.

4.2 Research Implications

First, the level of TPACK among teacher educators needs to be further improved, focusing on the development of core knowledge (CK, PK, TK). Teacher educators should have a sound foundation of subject content knowledge and a deep understanding of the concepts, theories, knowledge frameworks, and reasoning of their subject. Otherwise, they will receive incorrect information. They should understand how to use technology in the classroom and how to integrate technology into their teaching behaviors; and they should be familiar with the teaching-learning process and have knowledge of the techniques and methodologies used in teaching and learning, as well as a clear sense of the aims, values, and objectives of education, and learn to help students construct knowledge and acquire skills. They should be familiar with the teaching and learning process, know the techniques and methods used in teaching, have clear educational aims, values, and objectives, and learn to help students construct knowledge and acquire skills.

Secondly, they should place equal emphasis on both general and subject-specific technologies and strengthen the cultivation of information literacy and information-based teaching skills; CK has the lowest mean value among the seven dimensions of TPACK, and girls' technological knowledge is significantly lower than that of boys', so educational technology courses have a significant impact on the level of TPACK. Therefore, based on analyzing the learning psychology and needs of teacher trainees, teachers should place equal emphasis on general and subject-specific technologies.

Schools can help teacher trainees integrate information technology effectively by optimizing training programs and strengthening information literacy training in practical activities such as microteaching, teaching skills competitions, and information-based teaching application competitions. Teachers should give more recognition and encouragement to female students and provide them with necessary assistance in the learning process to help them overcome their fear of technology and narrow the gap between male and female students' TPACK levels.

Third, we should build a TPACK-based training system for teacher educators in all disciplines to ensure a balanced development of TPACK for teacher educators according to the needs of each field. Research has found that teacher educators in the sciences have lower TPACK levels than those in the arts, and there is a big difference in their grade levels. The study found that the TPACK level of science teacher trainees was lower than that of art teacher trainees, and there was a wide range of grade levels. The study also found that teacher trainees needed more understanding of the TPACK framework and the current information technology requirements in education and needed a self-competence development system. Therefore, it is recommended that the TPACK framework be introduced into the teacher education system and that a TPACK competency development model be constructed based on the characteristics of the discipline, with the concepts of each specific element and the tasks of each stage clearly defined, to enhance the ability of teacher educators to flexibly integrate content, pedagogical methodology, and technological knowledge, as well as their ability to adapt to the interaction of the elements in a specific context.

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