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Research Article

Influencing Factors Of Technological Pedagogy Content Knowledge's Development For Pre-Service English Teachers In China

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ABSTRACT

Technology has been highly integrated into almost all the domains of society, including educational fields. As a reserve resource of teachers, the training of pre-service English teachers' educational informatization ability has to be placed in a highly valued position. A quantitative method was used to investigate Technological Pedagogy Content Knowledge (TPACK) of 215 pre-service English teachers with questionnaires. Statistical Package for Social Science 26.0 (SPSS 26.0) was used to analyze the collected data. Results show that 1. Gender has no significant effect on TPACK of pre-service English teachers. 2. Internship experience has a significant impact on TK of TPACK framework; and Educational Technology Course has significant impact on both TPACK and TK, CK, PCK of TPACK framework for pre-service English teachers. 3. Linear multiple regression was employed to ascertain that TPK, TCK and TK have significant predictors of TPACK. It is suggested that Class Teaching, Instructors Training, Assessment Requirements and Internship Experience should be optimized to cultivate pre-service English teachers to satisfy the requirements of information age.

Keywords: TPACK; pre-service English teachers; regression equation

1. Introduction

With the COVID19 pandemic bringing home the importance of technology in teaching and learning (Mishra & Warr, 2021; Zhang, 2020), information technology has been used comprehensively and deeply to promote the process of educational reform and development, and gradually to build the digitalization, networking, intelligence and multi-media of education. Technology has become an indispensable part of the lives of educators and students (Aktaş & Özmen, 2020), and has prompted innovations in teachers' pedagogical practice (Janssen et al., 2019). To promote professional competence, teachers must conscientiously master the new trends and new ideas in the area of education based on valuable digital competence framework (Cabero-Almenara et al., 2020), and study new methods and new skills in practical teaching. Therefore, how to improve teachers' information teaching ability in order to better carry out teaching effectively has been an important topic of current academic research. As the reserve force of teachers in primary and secondary schools, educational institutions should constantly strengthen and improve the cultivation of informatization teaching ability for pre-service teachers **(**normal students) (Guo, 2019), which is of great significance to make it meet the needs of basic education curriculum reform and education modernization development. In 2014, the Ministry of Education of China issued the Standards for Information Technology Application Ability of Primary and Secondary School Teachers (Trial) (Ministry of Education, 2014). Informatization teaching ability has become an essential professional quality for pre-service teachers, which has become the core content of the professional development of pre-service teachers in the information age (Li, 2020). Thus, the cultivation of pre-service teachers' information teaching ability becomes particularly important (Reisoğlu & Çebi, 2020), and also English pre-service teachers' abilities to integrate technology into subject teaching needs to be improved.

Therefore, normal colleges or universities should closely focus on the current trend of basic education reform in the training process of normal students, and pay attention to the cultivation and promotion of normal students 'informatization teaching ability. The present study intends to research the current situation and path of promoting information teaching ability for the pre-service English teachers so as to cultivate more excellent future teachers to meet the development of information technology.

2. TPACK（Technological Pedagogical and Content Knowledge）

TPACK (Technological Pedagogical and Content Knowledge) is a knowledge framework to integrate technology to subject teaching for teachers, which is a framework based on technology for teacher knowledge (Koehler et al., 2009; Fahrurozi et al., 2019) in the 21st century. TPACK framework (Koehler, 2008) is a theoretical framework to support teachers' information teaching ability in the information age.

According to Mishra and Koehler (2006), TPACK framework consists of seven types of knowledge components associated with the integration of technology in instruction: technological knowledge (TK), pedagogical knowledge (PK), content knowledge (CK), pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and technological pedagogical and content knowledge (TPACK). Among the seven components, TK, PK, and CK are core elements; PCK, TCK, TPK and TPACK are compound elements. The seven elements of TPACK framework are complementary each other. TPACK framework is now recognized as an essential knowledge for teachers to cultivate their information teaching ability. TPACK framework refers to Figure 1.

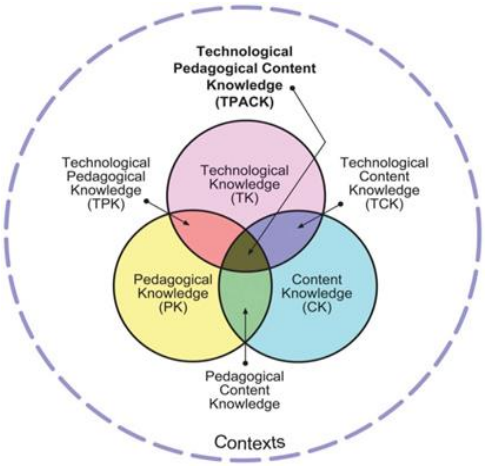

Figure 1. TPACK framework

TPACK is the abbreviation of Technological Pedagogical Content Knowledge which is the knowledge requirement of teachers' informatization teaching ability. TPACK framework incorporates technology into subject content and specific pedagogical approaches, describing how teachers' understandings of these three basic knowledge bases can interact with one another so as to produce effective discipline-based teaching with educational technologies (Ronau et al., 2012). As a theory framework integrating technology into teaching, TPACK is developed on the basis of PCK teaching theory framework, which explains the traditional teaching. The theoretical framework of PCK was proposed by Shuman in 1986 (Shulman, 1986). PCK is made up of the capital letters of the words "pedagogical, content, and knowledge". "P" stands for pedagogical knowledge, "C" stands for content knowledge and "K" stands for knowledge.

Koehler et al. (2009) proposed TPACK theory, recognizing the importance of technology in teaching and learning. And Mishra and Koehler (2006) put forward TPCK (Technological Pedagogical Content Knowledge) by integrating technological element into PCK framework. Then the spelling of "TPCK" was changed into "TPACK", pronounced Tee-pack (Schmidt et al., 2009). The reason why they improved the spelling is that: One is easier for spelling and memory; Second, the improved spelling makes it have deeper meaning, and emphasize that subject knowledge, teaching method knowledge and technical knowledge are essential; Third, it emphasizes the interaction of the three kinds of knowledge, including subject content knowledge, teaching approach knowledge and technical knowledge. It is in 2008 that the structure diagram of TPACK framework is presented (Mishra and Koehler, 2008). TPACK has already emerged in pre-service teacher education as a useful frame for describing and understanding the goals for technology use (Schmidt et al., 2009). The technology, pedagogy, and content knowledge (TPACK) framework is recommended to be used as a way to think about effective technology integration (Harris et al., 2009) so as to cultivate more excellent teachers to meet the development of information technology.

In the present study, the researcher uses Kohler et al.'s (2009) theory of TPACK based on the breadth of theory and the depth of factors being studied. Three research questions are answered:

☐ What's the level of pre-service English teachers' TPACK in H University?

- ☐ Are there any differences of pre-service English teachers' TPACK under different background factors, such as Gender, Internship experience, and Educational Technological Course?
- ☐ What's the relationships between the subfactors inside TPACK framework, i.e. TK, PK, CK, PCK, TCK, TPK, and TPACK for pre-service English teachers?

3. Materials and Methods

3.1 Research Design

Quantitative method was adopted in the research. The questionnaire was used to collect data. Then the collected data was analyzed and the TPACK level of pre-service English teachers, the influencing factors of TPACK, and the correlation between the inside subfactors of TPACK were studied. Finally, linear multiple regression was employed to test the significant predictor among variables to support sustainable development of TPACK for pre-service English teachers.

3. 2 Research Population and Samples

A population is all the individuals or units of interest, whereas a sample is a subset of the individuals in a population (Jackson, 2008). The population of the study is all pre-service English teachers throughout Inner Mongolia of China. Purposive sampling technique involves selecting a similar subset of the population, emphasizing a homogeneous subset of the population related to research questions. Based on purposive sampling technique and convenience sampling principle in which participants are obtained typically wherever is convenient for the researcher (Jackson, 2008), the researchers selected pre-service English teachers of freshmen, sophomores, juniors and seniors in H University of Inner Mongolia in China as research samples. The basic personal information, gender and grade status of 215 samples who participated in the questionnaire survey is as shown in Table 1.

Table 1. Basic Information of Respondents on Gender and Grade

Characteristic	Category	Frequency	Percentage
Gender	Male	24	11.2%
	Female	191	88.8%
	Total	215	100.0%
Grade	Grade 1	47	21.9%
	Grade 2	42	19.5%
	Grade 3	68	31.6%
	Grade 4	58	27%
	Total	215	100%

Table 1 shows that the gender of the respondents is mainly female, with a few males. Among them, 191were female, accounting for 88.8%; There are 24 male pre-service English teachers, accounting for 11.2%. It reflects from the data result that the survey respondents are in line with the actual situation, because the actual number of male pre-service English teachers applying for English majors is indeed very small, and most of pre-service English teachers are females.

3.3 Research Instruments

Questionnaire is used as research instrument. The questionnaire is designed based on Wang's (2020) Maturity scale. The questionnaire as research instrument in the study is divided into three parts. The first part is to explain the basic information and notes for filling of the questionnaire to the respondents, so that the respondents can have a certain understanding of the purpose, significance, anonymity and voluntary principle of the questionnaire. The second part is about personal basic information. The third part is the TPACK scale for pre-service English teachers, with a total of 42 items, measuring TK, CK, PK, PCK, TCK, TPK and TPACK of TPACK framework.

3.4 Research Analysis of Reliability and Validity

227 questionnaires were actually collected, and researchers checked the data and missing values of data, 12 invalid data is deleted. Finally, 215 questionnaires were used to be analyzed in the study. Normality distribution of data was tested by Skewness and Kurtosis, and the results show that the distribution of the data is normal. Cronbach Alpha coefficient was used to check reliability in this study as shown in Table 2.

Table 2. Results of Reliability Analysis

Items	N of Items	Cronbach Alpha coefficient	Strength
TK	6	0.917	excellent
CK	5	0.907	excellent
PK	5	0.930	excellent
PCK	6	0.931	excellent
TCK	7	0.933	excellent
TPK	6	0.933	excellent
TPCK	7	0.938	excellent
Total	42	0.984	excellent

It can be seen from Table 2 that the Cronbach Alpha coefficients of the 7 components of the scale are all greater than 0.9. And the overall Cronbach Alpha coefficient of the questionnaire is 0.984. Therefore, the results shows that the reliability of this scale is relatively high, and the scale has excellent consistency.
The Kaiser-Meyer-Olkin measure (KMO) and Bartlett's test of Sphericity were used to verify the feasibility of factor analysis. KMO and Bartlett sphericity test results are shown in Table 3 below.

Table 3. KMO Value and Bartlett Sphericity Test of TPACK Scale

KMO Measure of Sampling Adequacy		0.967
Bartlett's sphericity test	Approx. Chi-Square	9403.531
	df	861
	Sig.	0.00

Table 3 shows that the KMO value of TPACK scale is 0.967, greater than 0.9. the Bartlett's sphericity test is 0.00 ($p<0.001$), showing that the TPACK scale is suitable for factor analysis, indicating that the collected data is suitable for factor analysis.

4. Research Findings

Based on three research questions, this part gives the results of research analysis.

4.1 Findings Related to Research Question One

To answer Research Question one, this study analyzed the overall status quo of the seven subfactors of pre-service English teachers' TPACK framework as a whole. Since seven subfactors TK, PK, CK, TPK, PCK, TCK, TPACK are continuous numerical variables, descriptive statistical analysis is chosen. And T-test is used to verify whether the difference between the mean scores of each subfactor is significant. The criteria for judging the results of the 5-Point data is given in Table 4.

Table 4. The criteria for judging the results of the 5-Point data

No.	Mean Score	Level
1	1-1.99	low
2	2-2.99	moderate
3	3-3.99	moderate to high
4	4-5	high

Table 5. Mean scores of TPACK Subfactors

Items	Account	Means (SD)	Test Value	T	P
TK	215	3.93（0.61）	3.00	22.31	0.000
CK	215	3.84（0.63）	3.00	19.45	0.000
PK	215	4.03（0.59）	3.00	25.71	0.000
PCK	215	4.03（0.57）	3.00	26.48	0.000
TCK	215	4.04（0.55）	3.00	27.88	0.000
TPK	215	4.08（0.53）	3.00	29.41	0.000
TPACK	215	4.05（0.55）	3.00	27.95	0.000

Note: Because the study used Likert-5 scale, 3 is classified as neutral and the test value is 3.

Table 5 shows that the mean scores of TK, CK, PK, PCK, TCK, TPK and TPACK are 3.93, 3.84, 4.03, 4.03, 4.04, 4.08, 4.05 respectively. The mean score range was 3.84-4.08, and the mean score was TPK > TPACK > TCK>PK(PCK) >TK>CK from high to low. Moreover, the P-values of T-test are all less than 0.05, so all seven subfactors of TPACK were significantly higher than 3 points. It means that according to this survey, the levels of seven TPACK subfactors of pre-service English teachers are above the average level. Furthermore, the mean scores of PK, PCK, TCK, TPK and TPACK are all greater than 4 (P<0.05). The mean scores of TK and CK are all greater than 3 (P<0.05). Therefore, TK and CK are at a moderate to high level for pre-service English teachers.

4.2 Findings Related to Research Question Two

To answer Research Question two, the researchers used independent sample T-test to understand the influence of various factors on TPACK, such as gender, Internship experience and Educational Technology course.

4.2.1 Differences of TPACK Subfactors Based on Gender.

Independent sample-T test was selected to analyze the difference between TPACK seven subfactors for male and female pre-service English teachers, as shown in Table 6.

Table 6. Mean Scores of TPACK Subfactors Based on Gender

	Mean (SD)	
	Male (N=24)	**Female（N=191）**
TK	4.00（0.44）	3.93（0.63）
CK	3.75（0.51）	3.85（0.64）
PK	4.03（0.49）	4.03（0.60）
PCK	4.00（0.47）	4.04（0.58）
TCK	4.00（0.47）	4.05（0.56）
TPK	4.01（0.54）	4.09（0.53）
TPACK	3.97（0.42）	4.06（0.56）

As can be seen from the above Table 6, except for TK and PK subfactors, the mean scores of males in the five subfactors of CK, PCK, TPK, TCK and TPACK are lower than those of females. In order to more accurately test whether there is a significant difference between the female and male on TPACK subfactors, the independent sample T-test is applied.

Table 7. Independent sample T-test analysis of TPACK Subfactors Based on Gender

		Levene's Test for Equality of Variances		**t-test for Equality of Means**					**95% Confidence Interval of the Difference**	
		F	**Sig.**	**t**	**Df**	**Sig.（2-tailed）**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
TK	EVA	2.921	0.089	0.567	213	0.572	0.075	0.133	-0.188	0.339
	EVNA				0.74	35.769	0.464	0.075	0.102	-0.132
CK	EVA	1.653	0.2	-0.67	213	0.504	-0.091	0.137	-0.362	0.178
	EVNA				-0.8	32.907	0.429	-0.091	0.114	-0.325
PK	EVA	0.697	0.405	-0.026	213	0.979	-0.003	0.128	-0.256	0.249
	EVNA				-0.03	32.36	0.976	-0.003	0.109	-0.226
PCK	EVA	0.978	0.324	-0.323	213	0.747	-0.040	0.124	-0.285	0.205
	EVNA				-0.38	32.522	0.706	-0.040	0.105	-0.255
TCK	EVA	1.613	0.205	-0.456	213	0.649	-0.054	0.119	-0.290	0.181
	EVNA				-0.52	31.665	0.607	-0.054	0.105	-0.268
TPK	EVA	0.079	0.778	-0.664	213	0.507	-0.077	0.117	-0.308	0.153
	EVNA				-0.657	28.919	0.516	-0.077	0.118	-0.319
TPACK	EVA	1.242	0.266	-0.706	213	0.481	-0.084	0.119	-0.320	0.151
	EVNA				-0.884	34.306	0.383	-0.084	0.095	-0.278

Note: EVA=Equal Variances Assumed; EVNA=Equal Variances Not Assumed

Table 7 shows the differences between TPACK seven subfactors for pre-service English teachers based on gender, which shows that the sig. values of Levene's Test for Equality of Variances on the seven subfactors of TPACK are higher than 0.05. Thus, the values of sig. (2-tailed) on Equal Variances Assumed line should be read for further analysis. It is obvious that the seven subfactors of sig. (2-tailed) are larger than 0.05 (p>0.05), which explains that gender has no significant differences on the seven subfactors of TPACK for pre-service English teachers.

4.2.2 Differences of TPACK Subfactors Based on Internship Experience

The independent sample T-test is employed to analyze whether pre-service English teachers' internship experience has an impact on TPACK subfactors. The mean and standard deviation of each subfactor of TPACK framework are shown in the following Table 8.

Table 8. Mean Scores of TPACK Subfactors Based on Internship Experience

Items	**Mean (SD)**	
	Yes（N=146)	**No（N=69）**
TK	4.02（0.55）	3.76（0.70）
CK	3.94（0.59）	3.62（0.65）
PK	4.07（0.55）	3.94（0.66）
PCK	4.07（0.55）	3.96（0.60）
TCK	4.07（0.52）	3.99（0.59）
TPK	4.11（0.51）	4.00（0.59）
TPACK	4.07（0.50）	4.01（0.63）

Note**:** "Yes" indicates having internship experience; "No" means no internship experience.

As can be seen from the above Table 8, the mean scores of pre-service English teachers who have internship experience in all seven subfactors are higher than those who have not. In order to more accurately test whether there is a significant difference on TPACK subfactors based on internship experience, the independent sample T-test was applied.

Table 9. Independent Sample T-test of TPACK Subfactors Based on Internship Experience

		Levene's Test for Equality of Variances		**t-test for Equality of Means**						
									95% Confidence Interval of the Difference	
		F	**Sig.**	**t**	**Df**	**Sig.(2-tailed)**	**Mean Difference**	**Std. Error Difference**	**Lower**	**Upper**
TK	EVA	11.907	0.001	2.929	213	0.004	0.259	0.088	0.08	0.43
	EVNA			2.685	108.729	0.008	0.259	0.096	0.06	0.45
CK	1.551	0.214		3.494	213	0.001	0.315	0.090	0.137	0.49	1.55
	EVNA			3.377	122.759	0.001	0.315	0.093	0.13	0.49
PK	EVA	3.535	0.061	1.564	213	0.119	0.134	0.086	-0.03	0.30

	EVNA			1.466	114.256	0.145	0.134	0.091	-0.04	0.31
PCK	EVA	1.005	0.317	1.309	213	0.192	0.109	0.083	-0.05	0.27
	EVNA			1.264	122.631	0.209	0.109	0.086	-0.06	0.28
TCK	EVA	0.912	0.341	0.924	213	0.356	0.074	0.080	-0.08	0.232
	EVNA			0.886	120.377	0.377	0.074	0.084	-0.09	0.24
TPK	EVA	1.08	0.3	1.371	213	0.172	0.107	0.078	-0.04	0.26
	EVNA			1.3	117.319	0.196	0.107	0.083	-0.05	0.27
TPACK	EVA	5.921	0.016	0.745	213	0.457	0.060	0.080	-0.09	0.21
	EVNA			0.689	110.817	0.492	0.060	0.087	-0.11	0.23

Note: EVA=Equal Variances Assumed; EVNA=Equal Variances Not Assumed;

TPACK=Technological Pedagogical And Content Knowledge

Table 9 shows the differences of pre-service English teachers' TPACK based on internship experience, which shows that the sig. values of Levene's Test for Equality of Variances on four subfactors CK, PK, PCK, TCK, TPK are higher than 0.05. Thus, the values of sig. (2-tailed) on Equal Variances Assumed line should be read for further analysis. It is obvious that all five subfactors CK, PK, PCK, TCK, TPK of sig. (2-tailed) are larger than 0.05 ($p>0.05$), which explains that internship experience has no significant differences on the CK, PK, PCK, TCK, TPK subfactors.

On the other hand, the sig. values of Levene's Test for Equality of Variances on two subfactors TK, TPACK are lower than 0.05. Thus, the values of sig. (2-tailed) on Equal Variances Not Assumed line should be read for further analysis. It is obvious that the TPACK of sig. (2-tailed) is 0.492, higher than 0.05 ($p>0.05$), which explains that internship experience has no significant differences on the TPACK. However, the sig. (2-tailed) value of TK subfactor is 0.008 ($p<0.05$), showing that there exist significant differences between pre-service English teachers based on internship experience.

Hence, we can conclude that there are no significant differences on subfactors CK, PK PCK, TCK, TPK and TPACK, while there exists significant differences on subfactor TK based on internship experience. Therefore, the level of pre-service English teachers who have internship experience is higher than those who have not on TK.

4.2.3 Differences of TPACK Subfactors Based on Educational Technology Course.

The independent sample T-test was employed to analyze whether educational technology course has an impact on TPACK seven subfactors for pre-service English teachers. The mean and standard deviation of each subfactor of TPACK are shown in the following Table 10.

Table 10. Mean Scores of TPACK Subfactors Based on Educational Technology Course

	Yes（N=183）		**No (N=32)**	
	Mean	**S. D.**	**Mean**	**S. D.**
TK	3.99	0.58	3.59	0.67
CK	3.89	0.60	3.52	0.71
PK	4.06	0.57	3.90	0.69
PCK	4.07	0.55	3.81	0.64
TCK	4.07	0.53	3.87	0.62
TPK	4.10	0.52	3.94	0.58
TPACK	4.07	0.53	3.89	0.63

Note, "Yes" means " Learning Educational Technology Course ";

"No" means " No Learning Educational Technology Course "

As can be seen from the above Table 10, the mean scores of pre-service English teachers who have learnt Educational Technology Course in all the seven subfactors are higher than those who have not. In order to more accurately test whether there is a significant difference on TPACK subfactors based on educational technology course, the independent sample T-test is applied.

Table 11. Independent Sample T-test of TPACK subfactors for Pre-service English Teachers Based on Educational Technology Course

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
TK	EVA	2.807	0.095	3.469	213	0.001	0.400	0.1	0.17	0.62
	EVNA			3.22	3.137	39.56	0.003	0.40	0.12	0.14
CK	EVA	1.667	0.198	3.112	213	0.002	0.370	0.11	0.1	0.60
	EVNA			2.71	2.763	39.109	0.009	0.37	0.13	0.09
PK	EVA	2.608	0.108	1.417	213	0.158	0.160	0.1	-0.0	0.38
	EVNA			1.46	1.236	38.681	0.224	0.16	0.12	-0.10
PCK	EVA	1.324	0.251	2.356	213	0.019	0.256	0.10	0.04	0.47
	EVNA			2.49	2.117	39.407	0.041	0.25	0.12	0.01
TCK	EVA	1.779	0.184	1.891	213	0.06	0.198	0.10	-0.00	0.40
	EVNA			1.87	1.687	39.221	0.1	0.19	0.11	-0.03
TPK	EVA	0.502	0.479	1.538	213	0.125	0.15	0.10	-0.04	0.36
	EVNA			1.85	1.43	40.297	0.16	0.15	0.11	-0.06
TPACK	EVA	2.599	0.108	1.769	213	0.078	0.185	0.10	-0.02	0.39
	EVNA			2.12	1.553	38.834	0.129	0.18	0.11	-0.05

Note: EVA=Equal Variances Assumed; EVNA=Equal Variances Not Assumed

Table 11 shows the differences of pre-service English teachers' TPACK subfactors based on educational technology course, which shows that the sig. values of Levene's Test for Equality of Variances on all seven subfactors are higher than 0.05. Thus, the values of sig. (2-tailed) on Equal Variances Assumed line should be read for further analysis. It is obvious that the three subfactors TK, CK, PCK of sig. (2-tailed) are lower than 0.05 ($p<0.05$), which explains that learning of educational technological course has significant differences on the TK, CK, PCK subfactors. However, the sig. (2-tailed) value of PK, TCK, TPK and TPACK subfactors are higher than 0.05, showing that there are no significant differences between preservice English teachers Learning Educational Technology Course and ones who not on PK, TCK, TPK and TPCK subfactors.
Hence, the level of pre-service English teachers who have learnt Educational Technology Course is higher than those who have not on TK, CK, PCK subfactors.

4.3 Findings Related to Research Question Three

To answer research question three, the researchers used "Pearson correlation analysis" to analyze the correlation between the various seven subfactors of TPACK first.

Table 12. Correlation Analysis of Seven Subfactors of TPACK（N=215）

	TK	CK	PK	PCK	TCK	TPK	TPCK
TK	1						
CK	.749**	1					
PK	.742**	.807**	1				
PCK	.734**	.790**	.865**	1			
TCK	.716**	.740**	.811**	.877**	1		
TPK	.720**	.734**	.811**	.861**	.886**	1	
TPCK	.705**	.711**	.780**	.811**	.859**	.854**	1

Note: ** means P< 0.01, significant correlation.

Table 12 shows that according to the results of the analysis conducted to determine the significant correlation between seven subfactors of TPACK, there is a pairwise significant positive correlation between all seven subfactors of TPACK according to Pearson correlation analysis. And the range of correlation coefficient is from 0.705 to 0.886. Among them, the correlation between TPK and TCK is the highest ($P < 0.01$), and the correlation coefficient is 0.886.

According to the correlation analysis above, it can be concluded that all seven subfactors of TPACK are pairwise highly positive correlated. Next, it is necessary to further investigate the influence relationship among variables, especially the influence relationship on TPACK.

Table 13. Results of Linear Stepwise Multiple Regression for TK, CK, PK, PCK, TCK, TPK to TPACK

Model	Predictor Variables	B	Standard Error	β	t	p	Tolerance	VIF
1	Fixed	0.576	0.144		4.012	0.000		
	TCK	0.858	0.035	0.859	24.437	0.000	1.000	1.000
2	Fixed	0.324	0.138		2.337	0.020		
	TCK	0.474	0.070	0.474	6.776	0.000	0.214	4.664
	TPK	0.443	0.071	0.434	6.197	0.000	0.214	4.664
3	Fixed	0.278	0.138		2.012	0.046		
	TCK	0.431	0.071	0.431	6.054	0.000	0.202	4.954
	TPK	0.395	0.073	0.387	5.397	0.000	0.199	5.013
	TK	0.105	0.042	0.118	2.474	0.014	0.454	2.203

Note: a. Dependent Variable：TPCK. *p <.05 (1st Model: R2 =.0737, 2nd=0.777, 3rd=0.784); D-W=2.154
Regression was employed to verify significant predictors to TPACK. The dependent variables in this study are continuous numerical variables (Likert scale), therefore, linear regression analysis is chosen in this study.
Linear stepwise regression analysis was applied to examine the predictive status of TK, CK, PK, PCK, TCK, TPK subfactors as independent variables on TPACK subfactor as dependent variable. The results are as follows:
When Table 13 is examined, it is observed that only TCK, TPK and TK significantly predicted the TPACK for preservice English teachers. According to the results of this analysis, it can be said that TCK explained 43.1% of TPACK, and TPK explained 39.5% of TPACK, TK explained 10.5% of TPACK. TPK contributes the most to TPACK, then TCK, and TK contributes to TPACK weakly.
Linear regression equation: TPACK=0.278+0.431*TCK+0.395*TPK+0.105*TK

5. Discussion and Conclusion

Results of the survey on the seven subfactors of TPACK of pre-service English teachers shows that the mean scores of TPACK seven subfactors ranges from 3.84 to 4.08(P<0.05). And the mean score was TPK > TPACK > TCK >PK(PCK) >TK＞CK from high to low. Therefore, all subfactors of TPACK of pre-service English teachers are moderate to high or high level. The results show that the three compound subfactors, TPK, TPCK and TCK, are relatively high, while the two core subfactors, TK and CK, are relatively low. It shows that pre-service English teachers have a strong ability to integrate technology into subject teaching. However, pre-service English teachers have relatively weak abilities on the subfactors CK and TK, which is consistent with Wu's (2022) study, that is, CK and TK subfactors have the lowest scores. After analysis, the reason of high composite technology dimensional ability is that during the epidemic all the preservice English teachers experienced online courses, and familiar with the process of online courses. As a result, most of them have more confidence in online-related learning or teaching ability. Due to the coronavirus pandemic, almost all of the students have experienced online teaching for a long period of time, and although they are not real educators, their role as students of online courses has greatly enhanced the confidence of pre-service English teachers in their ability to organize teaching using online technology. CK has the lowest mean score. On the one hand, it indicates that pre-service English teachers do not have a comprehensive grasp of English content knowledge, and the input English knowledge should be further expanded and improved. On the other hand, it shows that pre-service English teachers should dig deeper into the connotation of English knowledge combined with practical teaching. The mean score of TK is low. After analyzing this result, it is because most of the research samples in this study are female students, whose thinking is inherent liberal arts and most of them lack interest in purely technical knowledge and skills.
The results show that gender has no significant effect on the TPACK of pre-service English teachers. This finding supports Liu's (2019) research results that gender has no effect on pre-service teachers' TPACK. However, the results are different from those of Ma (2017). Ma (2017) 'findings show that gender affects the PK of TPACK of normal college students, and the TK level of males is significantly higher than that of females, and the PK level of females is significantly higher than that of males. Analysis of the reasons, this is related to the high degree of information in social life and learning in recent years, whether male or female, whether living or learning, has been in a high information environment. Thus both male and female pre-service teachers are more familiar with the technology into learning or teaching, and have a relatively high confidence in technology.
The results show that internship experience has a significant impact on the PK subfactor and CK subfactor of TPACK for pre-service English teachers, that is, pre-service English teachers with internship experience have higher PK ability and CK ability than those without internship experience. By analyzing the reasons, the

internship experience can enable pre-service English teachers to really experience the classroom, and combine the basic subject knowledge and teaching method with practice, improving PK (Xu, 2022) and CK ability. Pre-service English teachers without internship experience lack the cognition and experience to connect subject knowledge and teaching methods with actual teaching, so they are weak in the input degree of relevant knowledge or skills, and need to be further improved. Hence, preservice English teachers should be provided various internship chances as early as possible and as much as possible.

The results show that educational technology courses have significant effects on the TK, CK, PCK subfactors of TPACK for pre-service English teachers. That is, the pre-service English teachers who have taken Education Technology courses have higher level in TK, CK, PCK subfactors than those who have not taken. This is similar to the results of some studies, such as Educational Technology courses have a significant impact on the TPACK subfactor of normal college students (Ma, 2017). As an informatization course integrating education and technology, Educational Technology course can play an important role in improving the knowledge and ability of integrating technology and education and teaching, and play a role in cultivating TPACK for pre-service English teachers. The course of educational technology aims to cultivate pre-service teachers' ability to apply technology to teaching, and the study of the course improves pre-service teachers ' ability to integrate subject knowledge, subject teaching methods and technology, thus bringing influences on TK, CK, PCK. It shows that educational technology courses have a direct and positive impact on the improvement of TPCK subfactors.

The results of correlation coefficients of seven subfactors of TPACK framework shows that there is a significant correlation between each subfactor. In order to better analyze the influencing factors of TPACK's sustainable development and set up teacher education courses for pre-service English teachers, the researchers conducted linear multiple regression analysis. The result of the regression equation based on this is as follows： Linear regression equation 1: TPACK=0.278+0.431*TCK+0.395*TPK+0.105*TK. It shows that in linear regression equation, in order to improve TPACK, pre-service English teachers should emphasize the cultivation of TCK, TPK and TK. According to the results of the regression equation, the researchers put forward some effective suggestions for the curriculum setting of teacher education. Since TPK, TCK and TK can predict TPACK, pre-service English teachers' TPK, TCK and TK abilities should be cultivated effectively. For TPK, Educational Technology Course is set to cultivate students' TPK ability. Based on the results of the research, the Educational Technology Course is effective to improve preservice English teachers TPACK. For TCK, TCK courses are designed to develop pre-service English teachers' knowledge to integrate technology and English knowledge. Whereas, there is no related course for TCK cultivation in many curriculum Settings. The re-searchers suggest that the way to cultivate TCK can be combined with the integration of modern teaching facilities and English knowledge to improve the TCK of pre-service English teachers, such as carrying out oral English courses, English reading courses and English writing courses in smart classrooms. It is also possible to encourage and guide instructors to integrate technical elements into traditional English courses to cultivate TCK. For TK, results of preservice English teachers show that TK is relatively low.

Besides suggestions above, all in all, some strategies are put forward on Instructor Training, Class Teaching and Assessment Requirements and Internship Experience for improving pre-service English teachers' TPACK sustainable development in the process of talent training. First, instructor training, educational institution (colleges or universities) should give more policy support and personnel training arrangements to improve the technical level of instructors in teaching. Second, class teaching is the most direct means to improve preservice teachers ' TPACK, the teaching content and teaching methods in classroom teaching need to be reformed by integrating science and technology. The content integrated information technology should be consciously increased in the teaching content, and the instructors should strive to integrate technology into teaching content of pre-service English teachers. From teaching to learning, information technology should be target-oriented. And assignment of homework should also be considered to integrate technology. Classroom teaching is the most direct factor in improving preservice teachers ' relevant ability. Teachers had better fully integrate the relevant factors of information technology into the classroom teaching. Third, assessment requirement is the way to test the teaching effect and teaching quality. The proportion of technology in the study should be fully considered in the setting of assessment objectives, and the indicators in the assessment should involve the application of technology teaching. The assessment objective should be considered to promote focus on the technical teaching ability to promote the enthusiasm of preservice teachers and the pertinence of teachers' teaching. Finally, more internship opportunities should be arranged for pre-service English teachers to enter the teaching scene earlier and experience real TPACK teaching. Different forms of internship can be used to improve practical ability. For example, in lower grade education internship, preservice teachers can view and emulate teaching in real classroom. In middle and upper grade, education study and microsimulation teaching in micro-classrooms could be set up in teacher education curriculum. In higher grade, post internship could be arranged in order to improve their TPACK experience of real teaching. Focus is not only on the number of internship forms but also on the quality. According to the form of thesis guidance teacher, corresponding teaching practice guidance teachers can be arranged for pre-service English teachers, and measures can be taken to ensure that the guidance teachers really play the role of one-to-one follow-up guidance on internship.

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