

# Exploring Pre-service EFL Teachers' Technological Pedagogical and Content Knowledge (TPACK) in Smart Learning Environment

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**Abstract:** The extensive use of information and communications technology in the field of education has put forward higher requirements for teachers' knowledge and ability in teaching. The present study examined pre-service EFL teachers' technological pedagogical and content knowledge. A total of 191 pre-service EFL teachers in a provincial normal university were selected as research subjects, and the questionnaire method was used to investigate their technological pedagogical content knowledge. The results indicated that pre-service EFL teachers' technological pedagogical and content knowledge is at a medium level. In addition, under the influence of smart learning environment, technological content knowledge had the greatest predictive effect on the improvement of technological pedagogical content knowledge, while pedagogical content knowledge had a negative predictive effect on TPACK. Based on the above results, two suggestions were proposed to improve pre-service EFL teachers' technological pedagogical and content knowledge, namely, constructing the TPACK curriculum system and strengthening the systematic learning of technological pedagogical content knowledge.

**Keywords:** Pre-service EFL teachers, Smart learning, Technological pedagogical content knowledge, Technological content knowledge, Pedagogical content knowledge

## 1. Research background

Nowadays, information technology has been widely used in the field of education, injecting new vitality into educational reform. With the popularization of smart learning and the continuous advancement of information and communications technology in education, Smart learning environment provides learners with personalized learning resources and convenient interactive tools through artificial intelligence, big data, the Internet and other technologies, and promotes the transformation of teaching and learning methods, therefore, it is believed that the integration of technology in the teaching process can improve students' enthusiasm and classroom participation<sup>0</sup>, enhance the learning experience, and improve their learning efficiency. Teachers are expected not only to have a good knowledge of a certain subject or pedagogical knowledge related to classroom management, organizational principles, teaching strategies, but also master the knowledge of integrating technology into teaching effectively.

In China, the *Ten-Year Development Plan for Information and Communications Technology in Education* (2011-2020) has made it clear that "information and communications technology in education drives the modernization of education, emphasizing the integration of information technology and teaching". Therefore, digital literacy has become one of the core skills necessary for teachers, which has become an important element as well as indicator of teachers' professional quality in the new era. Pre-service teacher education also pays more and more attention to the cultivation of digital teaching ability, and has taken a variety of measures to promote pre-service teachers' digital literacy so that they can meet the requirements of the times as well as the reform of compulsory education. However, English teaching has always followed the traditional teaching model, where teachers are accustomed to imparting language knowledge in the textbook and students practicing four basic skills. This way of teaching is no longer suitable for learning in the new context, since TPACK stresses preparing pre-service teachers to integrate technology with content knowledge and pedagogy. In this context, pre-service teachers' TPACK has gained more and more attention since the TPACK level of pre-service teachers directly affects the professional development of EFL teachers as well as

the overall quality of English teaching in primary and secondary schools. How to improve the level of pre-service teachers' TPACK has become an important subject matter in EFL teacher education.

## 2. Literature Review

Since the development of technological pedagogical content knowledge (TPACK) framework by Mishra and Koehler in 2005, TPACK has become a hot topic in teacher education and education technology. It has been recognized that TPACK plays an essential role in enabling teachers to utilize technology and tools in pedagogically appropriate ways for subject matter instruction<sup>[2]</sup>. Also, studies have found that contextual factors, such as the availability of technology and school policies, exert influences on teachers when they apply TPACK to classroom instruction<sup>[3]</sup>. Some other scholars have tried to devise reliable measures of TPACK, which have resulted in a seven-factor model<sup>[4]</sup> and a six-factor model<sup>[5]</sup>. Researchers have evaluated these models some even argued that trying to define and describe different types of knowledge or elements is inherently a difficult and pointless task 错误;未找到引用源。. However, gradually there was a consensus that teachers should integrate technological knowledge, pedagogical and content knowledge to form their own TPACK. The TPACK framework by Mishra and Koehler has received the most traction in research and in professional development approaches. In addition, quantitative studies proved that applying technology based instruction affected pre-service teachers' TPACK self-efficacy positively<sup>[6]</sup>, and epistemic beliefs held by pre-service teachers differentiate their perceived TPACK<sup>[7]</sup>.

In China, research concerning TPACK covers the following seven aspects: the improvement and expansion of TPACK construct, the investigation of TPACK status and development strategy, comparative research of TPACK, influencing factors of TPACK, teacher education programs to promote TPACK, teaching practice based on TPACK, measurement and evaluation of TPACK. As far as the research subjects are concerned, most researches focus on in-service teachers in primary and secondary schools, and relatively few studies take pre-service teachers as the research subjects. In terms of the research on pre-service teachers, both qualitative and quantitative methods have been adopted to investigate pre-service teachers' TPACK in different disciplines, and there have been abundant research on the integration and development of TPACK and different disciplines, such as preschool education, mathematics education, chemistry education, etc., focusing on the differences of various disciplines and exploring the professional teacher training model; integrated design and experimental research of TPACK and different professional courses in teacher education, which drew conclusions alike that pre-service teachers' TPACK can be improved through different courses and curriculum activities<sup>[8]</sup>.

Based on the previous literature, it can be found that the research focusing on pre-service teachers' TPACK mainly focuses on the TPACK training mode and reform of curriculum system, and there are fewer studies on TPACK-related studies for pre-service EFL teachers, and less research on the factors influencing the development of TPACK level of pre-service EFL teachers in different learning environments. Therefore, studying the current situation of TPACK of pre-service EFL teachers in smart learning environment is of benefit to figure out the influence of the learning mode and experience in smart learning environment on pre-service EFL teachers' TPACK, so as to further explore the strategies and methods to improve digital literacy and teaching ability of pre-service EFL teachers.

In smart learning environment, English teaching manifests new features, which are reflected in the dramatic shift in English teaching method with modern information technology broadening the teaching content and enriching the teaching activities, the role of teachers being transferred from a lecturer to a scaffold for students' learning and resource sharing being realized, which provides favorable conditions for teaching as well as for learning. Under such a context, the purpose of this study was to explore the current situation of pre-service EFL teachers' TPACK, and investigate the influence of different types of knowledge on the general level of pre-service EFL teachers' TPACK. Specifically, the current study addressed the following research questions:

- (1) What is the overall situation of pre-service EFL teachers' TPACK in the provincial normal university?
- (2) How are the factors correlated with pre-service EFL teachers' TPACK?

### 3. Framework of technological, pedagogical content knowledge (TPACK)

Shulman proposed at an earlier time that effective teaching requires a special type of knowledge, pedagogical content knowledge which is the blending of content and pedagogy<sup>[9]</sup>. In 2005, American scholars Mishra and Koehler proposed a teacher knowledge framework for integrated technology, namely the technological pedagogical content knowledge (TPACK)<sup>[10]</sup>. TPACK is a set of professional knowledge system that meets the needs of teachers' professional development in the era of information technology<sup>[11]</sup>. Based on Shulman's pedagogical content knowledge (PCK) model, the TPACK framework includes three fundamental elements, pedagogical knowledge (PK), content knowledge (CK), and technological knowledge (TK). These three types of knowledge are combined to form the other four types of knowledge, pedagogical content knowledge (PCK), technological pedagogical knowledge (TPK), technological content knowledge (TCK), and as a whole technological pedagogical content knowledge (TPACK).

Among the three core elements of TPACK, pedagogical knowledge (PK) refers to knowledge related to the practice and theory of the teaching process, such as teaching objectives, teaching management and evaluation, teaching strategies, etc.; content knowledge (CK) includes both the specific subject knowledge of a particular field that teachers have accepted and will teach, as well as the teacher's knowledge and understanding of the structure of the subject matter and the relationship between disciplines; technological knowledge (TK) refers to knowledge of traditional and modern digital technologies. The four composite elements formed by the combination of these three core elements are PCK, TCK, TPK, TPACK, which address how the three types of knowledge interact with each other. Pedagogical content knowledge (PCK), following Shulman's notion, refers to the concept and knowledge of teachers reconstructing teaching materials to adapt to different students' knowledge interests and abilities; technological content knowledge (TCK) refers to the teacher's understanding of the ways in which technology and subject content affect and limit each other, such as what technology is suitable for interpreting content knowledge; technological pedagogical knowledge (TPK) is a teacher's understanding of how technology is used in the teaching and learning process. Compared to other elements of knowledge, technological, pedagogical content knowledge (TPACK) is a more diverse and comprehensive level of knowledge about the complex relations among technology, pedagogy and content that enable teachers to adopt appropriate teaching strategies to conduct effective teaching. The framework of pre-service teachers' TPACK is shown in Figure 1.

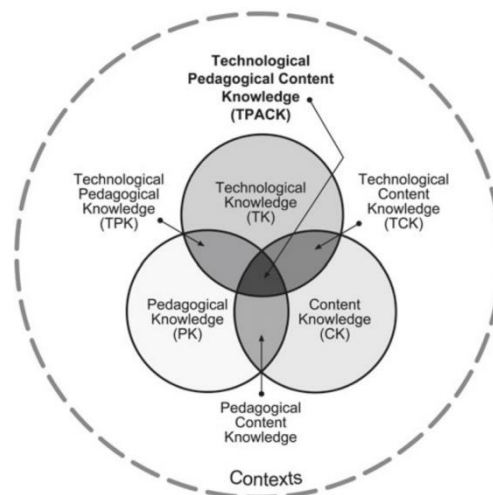


Figure 1: The technological pedagogical content knowledge framework<sup>[12]</sup>

As Koehler puts it, “the original intention of the TPACK model is to hope that teachers can understand the functions and limitations of technology in terms of influencing their teaching content and teaching methods, and to help teachers form a certain way of thinking and know how to analyze the advantages and disadvantages of technology.”<sup>[13]</sup>

## 4. Materials and methods

### 4.1 Participants

A total of 191 third-year students majoring in English education in a provincial normal university were selected as the research subjects. The participants aged between 20 and 23 years old, including 15 boys, accounting for 7.9%, and 176 girls, accounting for 92.1%.

### 4.2 Measures

The questionnaire used in this study was the Chinese Pre-service Teachers' Technological Pedagogical Content Knowledge (CTPCK) Scale, which was validated by Sang et al. to investigate the TPACK level of students in normal universities in Beijing<sup>[14]</sup>. The scale was translated by Chai et al. from the English version developed by Schmidt et al. when they investigated teachers' pedagogical and technological knowledge<sup>[15]</sup>. The reliability test of the CTPCK scale has been carried out on pre-service teachers in Shanghai, Hong Kong and other cities in China, etc. After validation, the questionnaire has good reliability and validity, which proves that it can be an ideal assessment instrument for the evaluation of Chinese pre-service teachers' TPACK.

The questionnaire consists of two parts: the first part is the basic information of the research subjects, which consists of gender, age, teaching experience, learning experience and other information; and the second part includes self-assessment questions on knowledge corresponding to the seven factors. The questionnaire has a total of 42 questions, divided into seven dimensions, CK(4), PK(6), TK(9), PCK(8), TCK(4), TPK(5), TPACK(6), using 7-point Likert scale, from 1 (fully disagree) to 7 (fully agree). The higher the average score of all items, the higher the TPACK level. In this study, the Cronbach's alpha coefficient of the overall scale was 0.90, the seven dimensions are respectively 0.86(CK), 0.92(PK), 0.89(TK), 0.96(PCK), 0.86(TCK), 0.92(TPK), 0.93(TPACK), which were all between 0.86 and 0.93. The results indicated that the questionnaire had a high internal reliability and it could accurately reflect the TPACK level of the research subjects.

What more, this study interviewed 10 pre-service EFL teachers randomly selected to explore the factors affecting the development of pre-service EFL teachers' TPACK level.

### 4.3 Data collection and analysis

This present study is mainly a quantitative research based on survey method. Online questionnaires were adopted to collect data. Before filling out the questionnaire, there is a special and detailed survey description, including purpose and significance of the survey, privacy protection, informed consent, filling directions and data feedback channels, etc.

SPSS24.0 was used for data analysis, including descriptive statistics, correlation analysis, and multiple regression analysis.

## 5. Results and discussion

### 5.1 Descriptive analysis of pre-service EFL teachers' TPACK

The descriptive statistics of TPACK and each factor were presented (Table 1). As can be seen, the average scores of pre-service EFL teachers' TPACK factors are ranked from high to low as follows: TPK>TCK>TPACK>PK>TK>CK>PCK. The average score of TPK ranks the highest (M=5.04), which indicated that pre-service EFL teachers already had a relatively good mastery of technological pedagogical knowledge. Because of the impact of scientific and technological development, pre-service EFL teachers, members of "the Internet Generation", use network information technology frequently in life and study, and they also have an understanding of technology-assisted teaching. Moreover, after the online learning experience during the epidemic in smart learning environment, they believe that they are accustomed to intelligent learning platforms, intelligent classrooms and other facilities, and they know well how technologies have been used and integrated in teaching and learning. However, the average scores of CK (M=3.98) and PCK (M=3.35) were much lower than those of other factors, which suggested that pre-service EFL teachers still paid more attention to the acquisition of language knowledge and skills in smart learning environment, but neglected the learning of pedagogical content knowledge and the training of teaching skills, and lacked confidence in how to use appropriate teaching

methods to teach content knowledge. Part of the reason for this result may be that the university under investigation is located in an underdeveloped area, and the students have relatively poorer basis in English. What's more, constrained by local economy, culture and other factors, pre-service EFL teachers in the study have relatively fewer resources and opportunities for language learning and communication. Although they can obtain content knowledge through various ways, their own professional knowledge is not solid enough. Therefore, pre-service EFL teachers lack sufficient content knowledge and confidence in English classroom teaching.

In addition, the average scores of TK, PK, TPACK, TCK are at the medium level ( $M_{TK}=4.60$ ,  $M_{PK}=4.73$ ,  $M_{TPACK}=4.77$ ,  $M_{TCK}=4.86$ ). Generally, it can be seen that with the development of educational technology, smart learning is becoming more and more popular, and the application of these technologies in education and teaching has promoted the overall improvement of the TPACK level of pre-service EFL teachers, but the results indicated that although pre-service EFL teachers could use technologies in their learning, they didn't think they have grasped enough technological knowledge and they were not sure whether they have integrated technological knowledge in English subject teaching appropriately and effectively. Moreover, it can be inferred that pre-service EFL teachers were not confident in their pedagogical knowledge and content knowledge. The reason could be that the use of MOOCs, micro-courses, and intelligent teaching platforms have greatly promoted pre-service EFL teachers' mastery and use of technology, however, these pre-service teachers still felt that they may only master basic hardware and software knowledge and operational skills, but had no idea about how to integrate subject teaching and technology effectively.

Table 1: Description statistics of TPACK factors

Factor	N	Mean	SD
Content knowledge (CK)	191	3.98	1.13
Pedagogical knowledge (PK)	191	4.73	0.96
Technological knowledge (TK)	191	4.60	0.96
Pedagogical content knowledge (PCK)	191	3.35	1.03
Technological content knowledge (TCK)	191	4.86	1.07
Technological pedagogical knowledge (TPK)	191	5.04	0.98
Technological pedagogical content knowledge (TPACK)	191	4.77	1.05

## 5.2 Correlation analysis

In order to explore the relationship among the seven dimensions of TPACK, the correlation among the seven dimensions of TPACK was explored (see Table 2). The results showed that there was a significant correlation between TPACK and the other six dimensions. Among them, TPACK was positively correlated with TCK, TPK, TK, PK, and CK, and the correlation coefficients were between 0.51~0.79. However, pedagogical content knowledge (PCK) was negatively correlated with TPACK.

Table 2: Correlation among different factors of TPACK

	CK	PK	PCK	TK	TPK	TCK	TPACK
CK	1						
PK	.702**	1					
PCK	-.587**	-.793**	1				
TK	.547**	.578**	-.570**	1			
TPK	.456**	.678**	-.628**	.759**	1		
TCK	.497**	.506**	-.577**	.692**	.677**	1	
TPACK	.513**	.548**	-.627**	.707**	.692**	.787**	1

Note: \* $p < 0.05$ ; \*\* $< 0.01$ ; \*\*\* $< 0.001$

## 5.3 Multiple regression analysis

In this study, TPACK was further taken as the dependent variable, and the other six factors CK, TK, PK, TCK, TPK and PCK were regarded as independent variables. The stepwise regression analysis method was adopted to explore the predictive effect of the variables CK, TK, PK, TCK, TPK, PCK on TPACK, and the results are shown in Table 3. According to the result, the regression equation was formulated:

$$TPACK = 1.809 + 0.450TCK + 0.172TPK + 0.065CK + 0.190TK - 0.207PCK - 0.113PK$$

The model was tested for variance,  $F=72.008$ ,  $P<0.001$ ,  $R^2=0.701$ , indicating that the independent variables CK, TK, PK, TCK, TPK, PCK introduced by the model can explain 70.1% of TPACK. Further analysis of the regression results revealed that the improvement of CK, TK, TCK, and TPK will promote pre-service EFL teachers' TPACK.

Table 3: Multiple regression analysis of TPACK among pre-service EFL teachers

Variable	R <sup>2</sup>	F	β	T
TPACK	.701	72.008**		
TCK			.450	7.382***
TPK			.172	2.128*
CK			.065	1.150
TK			.190	2.505*
PCK			-.207	-2.896**
PK			-.113	-1.248

Note: \* $p<0.05$ ; \*\* $<0.01$ ; \*\*\* $<0.001$

According to the regression results in Table 3, TCK had the strongest predictive effect on TPACK, which indicated that to facilitate pre-service EFL teachers' TPACK, improving their TCK has a most significant positive effect on TPACK level. Therefore, in smart learning environment, more emphasis could be put on the increase of TCK so as to enhance pre-service EFL teachers' digital teaching ability. This also reflected that modern education technology has had an important impact on pre-service teachers' acquisition of content knowledge, and the influence of TCK on TPACK is much strengthened in English subject teaching.

It is worth noting that the regression results also indicated that PCK and PK had a negative predictive effect on TPACK. That is, pre-service EFL teachers who have had a good grasp of pedagogy knowledge, whether general pedagogy or pedagogical knowledge of the English subject, lacked confidence in their own TPACK level or they think that TPACK was not so important. This can be attributed to the fact that pre-service EFL teachers with better English teaching ability pay more attention to the learning of English pedagogical knowledge but less attention to the improvement of digital literacy, which reflected their belief that digital teaching is not so important to improve English teaching level. In contrast, pre-service EFL teachers with weak English teaching ability will attach importance to the use of IT-based teaching methods to improve the effectiveness of their English teaching.

#### 5.4 Factors influencing pre-service EFL teachers' TPACK development

To further explore the factors influencing the development of pre-service EFL teachers' TPACK, 10 pre-service EFL teachers were randomly selected as the research subjects for interviews to explore the factors influencing the development of pre-service EFL teachers' TPACK. From the results of the interviews, it was found that pre-service EFL teachers in local colleges and universities were affected by a variety of factors in the process of developing TPACK, including education policy, information technology, school culture, and personal factors.

Firstly, all the participants were from a provincial normal university in a multi-ethnic area, and the special "educational context" of ethnic areas has become an important influencing factor. Due to the limited educational infrastructure, lack of teaching funds and equipment investments, teaching quality, and teachers' professional ability in local colleges and universities in ethnic minority areas, students have been receiving English subject education in traditional teaching methods for a long time, and paid more attention to the acquisition and practice of content knowledge and pedagogical content knowledge, so their TPACK level is still relatively low.

Secondly, pre-service EFL teachers in ethnic minority areas have much less technological resources. Due to the influence of economic backgrounds, pre-service EFL teachers had much later and limited access to modern education technology, which led to weaker digital literacy and awareness of integrating information technology in teaching. For a long time, teachers, mainly those in rural areas, are used to the traditional grammar translation method in English classroom, only attaching importance to vocabulary and sentence patterns drills, and they don't have the basic knowledge of digital teaching, let alone integration of information technology and smart learning.

Thirdly, pre-service EFL teachers have a biased sense of their English proficiency and teaching ability. Influenced by traditional epistemic belief, although most pre-service EFL teachers believe that English proficiency is necessary for becoming an English teacher, they don't fully recognize the

important effect of content knowledge on teaching. Therefore, some pre-service EFL teachers will spend more time practicing and working hard to improve pedagogical knowledge and English teaching skills but do not attach great importance to the effective integration of information technology to carry out English teaching. Some pre-service EFL teachers even believe that the development of modern computers and networks has provided them with more resources and ways to learn English, so there is no necessary connection between content knowledge and teaching effectiveness.

## **6. Suggestions for improving the TPACK level of pre-service EFL teachers**

Based on the above quantitative analysis as well as interviews, two suggestions are proposed to improve pre-service EFL teachers' TPACK in provincial normal universities.

### ***6.1 Constructing TPACK curriculum system for pre-service EFL teachers***

To enhance pre-service EFL teachers' TPACK, a well-designed complete TPACK curriculum system must be constructed. At the basic level, pre-service EFL teachers should be provided with courses focusing on one single dimension of knowledge, including TK, PK, CK, which are the basis of TPACK. Only by laying a solid foundation in these types of knowledge can pre-service EFL teachers be able to integrate different types of knowledge in later teaching practice. Then, the curriculum should put its emphasis on the cultivation of TCK, TPK, PCK by imparting related theories and more importantly, by offering opportunities for pre-service teacher to apply knowledge into practice. Also, during this stage, pre-service EFL teachers should be required to integrate appropriate and effective technological knowledge in the presentation of subject content. And the last stage stresses a comprehensive integration of the knowledge in teaching practice to make sure pre-service EFL teachers understand the importance of developing TPACK and are able to apply their knowledge into real teaching. In addition, curriculum setting should adhere to the principles of interest, creativity, and innovative perspectives, integrating the three main themes of "knowledge and ability progress", "creative enhancement", and "identity recognition".

Meanwhile, to facilitate pre-service EFL teachers' TPACK in teaching practice, following the design approach, a curriculum based on the "three-stage project design", which is composed of "micro-design project—large-design project—TPACK overall reflection project" can be developed. In the design-oriented teacher education curriculum, teachers' understanding of "design" and their identity as "designer" are emphasized, so teachers are required to select, design and use technology according to the specific teaching context. Pre-service EFL teachers will first be able to understand and accept the concept of "design" through micro-design projects, such as photography, short video production and other learning activities, so as to promote students to form a new perspective on technology. Then, the curriculum system enters the stage of large-scale design projects, and the corresponding courses provide pre-service teachers with the opportunity to contact teaching website development or make micro-lessons, digital stories, etc., and can explain their own design and explain the reason for this creation. In the design activities, pre-service EFL teachers can learn to take notice of the tension and dynamic balance between "content knowledge-pedagogy-technology" in real teaching situations, and learn to judge and choose in the design process, thereby deepening their identity as "designers". In the third stage, English teaching majors enter into reflection, using TPACK as a thinking framework, reviewing and reflecting on the design activities of the first two in the previous stage, from which a new understanding of the application of technology to teaching mode can be generated.

### ***6.2 Strengthening the systematic learning of CK and PCK***

From the results, it is clear that pre-service EFL teachers' CK and PCK were lower compared with other 5 types of knowledge, therefore, content knowledge and pedagogical content knowledge should be stressed. In actual teaching, insufficient language "input" in the classroom has led to insufficient language "output", resulting in the general inefficiency of students' output, leading to students' inadequacy in language use and thinking ability, as well as the ability of teaching design and implementation. Despite reforms that emphasize the development of students' abilities in recent years, these problems have not been totally solved. For quite a long time, EFL teacher education has emphasized linguistic knowledge and four basic skills, while neglecting the content knowledge related to the English subject and knowledge of teachers' reconstructing teaching materials to adapt to different students' knowledge interests and abilities. As a result of such teaching method, pre-service EFL

teachers usually follow the ways they have been taught in their teaching practice. Even though these young teachers are fully aware of the effect of technology on teaching, they do not know in what way they can put their technological knowledge into actual use due to the lack of pedagogical content knowledge. To solve this, pre-service EFL teachers should pay equal attention to knowledge of the subject matter, on the other hand, they are supposed to improve the professional skills and pedagogical content knowledge.

Since PK and PCK were found to have negative predictive effect on pre-service EFL teachers' TPACK, it must be noted that pre-service teachers' attitude toward the use of technology and its relationships with content, pedagogy should be put into perspective. In smart learning environment, pedagogical knowledge and pedagogical content knowledge, together with content knowledge are the basis for teachers to conduct effective teaching by means of appropriate technology. When pre-service EFL teachers develop the right attitude toward technology, the strong awareness to apply technology into teaching, and master the knowledge of integrating technology with pedagogy and content effectively in specific teaching contexts, their TPACK may be significantly improved for successful implementation of teaching in smart learning environment.

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