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Research on the Pathways to Enhancing Digital Teaching Competence of Pre-service English Teachers Based on the TPACK Model

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Abstract

Against the dual backdrop of digital transformation in education and the focus on core literacy in the English subject, digital teaching competence has become one of the core competencies in the professional development of English teachers, directly impacting the improvement of English teaching quality in basic education and the advancement of educational modernization. The TPACK model (Technology Pedagogical Content Knowledge), as a core theoretical framework linking technology, pedagogy and subject content, provides scientific theoretical guidance for the development of digital teaching competence among pre-service English teachers. This paper uses the TPACK model as a guide. It combines two research methods. One is empirical research. The other is interview surveys. The goal is to look at digital teaching competencies in pre-service English teachers. The paper also looks at technological pedagogical beliefs. They help shape how these competencies grow. Then the study suggests three ways to make things better. First, optimize the curriculum system. Second, strengthen practical training. Third, foster technological pedagogical beliefs. Teacher training institutions can use these ideas to improve their talent development programs for English teacher education. They can also help pre-service English teachers build digital literacy.

Keywords

TPACK, pre-service English teacher, digital teaching competence, technological pedagogical beliefs

1. Introduction

1.1 Research Background

On April 8, 2026, the Ministry of Education and four other departments released a notice. The notice is about the “Artificial Intelligence + Education” Action Plan. This plan adds artificial intelligence to teacher qualification exams and certification.

Education is going through a digital transformation. AI is also becoming a big part of foreign language teaching. Pre-service English teachers will be the future teachers for K-12 schools. They need to have digital teaching competencies. These competencies are now a core requirement for their professional development.

UNESCO has a program called Digital Action for Higher Education. It says teachers' digital literacy matters. It also says the ability to use technology matters. Both are key to the digital transformation of education. This shows why digital competencies are so important right now (Song Yuanyuan, 2026) [1].

This study uses the TPACK model as its base. It looks at the current digital teaching competencies of pre-service English teachers. We want to find the real problems. Then we want to build a pathway for improvement. This pathway should work well in local settings. The study hopes to add new ideas to foreign language teacher education research. It also hopes to give practical help to teacher training institutions.

1.2 Research Significance

1.2.1 Theoretical Significance

The TPACK model is used a lot right now. Researchers use it to study teachers' digital teaching capabilities. But most of these studies focus on general academic fields. They do not dig deep into the English subject. English has its own special features. This creates big gaps. One gap is about the subject itself. Another gap is about the specific group of people being studied.

This study focuses on pre-service English teachers. We take the TPACK model and connect it closely with the core characteristics of English language teaching. This gives the TPACK model more application scenarios. It also brings new research outcomes. All of this happens inside the field of EFL teacher education.

1.2.2 Practical Significance

Based on the actual situation and core issues of the digital teaching ability of English pre-service teachers, this study explores the path of improving the digital teaching ability that can be operated, implemented and promoted, which can provide a specific and clear practical basis for normal colleges and universities to optimize the training plan of English normal students, so that English pre-service teachers can quickly adapt to the job needs of basic English digital teaching in basic education and promote the high-quality development of English education in the future.

1.3 Research Innovation Points

The innovation points of this research are mainly reflected in two aspects: first, the innovation of the research perspective, breaking through the limitations of "focus on in-service teachers, light pre-service training" in the existing TPACK model application research. Based on the growth law and group characteristics of English pre-service teachers, the TPACK model It is deeply combined with the core literacy training requirements of English pre-service teachers, and get rid of the dilemma of disconnecting theoretical research and subject teaching practice. The second is the innovation of the research content, abandoning the single and fragmented strategic suggestions in the existing research, combining the seven elements of the TPACK model, systematically analyzing the current situation and causes of the digital teaching ability of English pre-service teachers, building a scientific improvement path, and ensuring that practical guidance can be directly provided for pre-service teachers.

2. Literature Review

2.1 Theoretical Development of the TPACK Model

There is a famous framework called TPACK. That stands for Technological Pedagogical Content Knowledge. This framework is very important in educational technology. It helps us understand what teachers need to know. Mishra and Koehler (2006) [2] created this framework. They built it on an earlier idea from Shulman (1986) [3]. Shulman talked about Pedagogical Content Knowledge (PCK). TPACK asks one big question. In the information age, what knowledge should teachers have? The TPACK framework has three core parts. First is Content Knowledge (CK). Second is Pedagogical Knowledge (PK). Third is Technological Knowledge (TK). These three parts overlap. The overlaps create four more parts. They are PCK, TCK, TPK, and TPACK. TPACK is the highest level. It means teachers can use technology to show subject content. They can also pick good teaching strategies when they design lessons. Many researchers say TPACK is the heart of digital teaching competence (Koehler et al., 2013) [4].

As digital technology advances, the theoretical scope of the TPACK framework continues to grow, leading to more targeted extension models. Some scholars have tried to adapt the framework to specific disciplinary contexts. Guo Fengying and her colleagues (2024) [5], for example, built a framework for pre-service teachers' digital teaching competencies around three dimensions: cognitive thinking, instructional implementation, and innovative development. Meanwhile, other researchers have put forward new frameworks like AI-TPACK and VR-TPACK, which bring artificial intelligence literacy into the teacher knowledge system (Wu Huanqing & Wu Chuanzhen, 2025 [6]; Liu Qian et al., 2025 [7]). All of this shows that TPACK is not static—it keeps evolving. And its real value lies in offering a way of thinking about how to integrate technology with subject content and pedagogy.

2.2 Research Progress on Teachers' Digital Teaching Competence

The TPACK framework has been pretty widely used. And as it spread, a lot of empirical studies popped up—both in China and elsewhere—looking at teachers' digital teaching competence. Most of these studies focus on three things: understanding TPACK, measuring it, and figuring out how it develops. The methods? Mostly quantitative.

Take English teachers as an example. Wang Anqi and Zhang Qinghua (2023) [8] looked back at 65 SSCI studies published between 2011 and 2023. They found that more and more research is coming out. Topics cover things like where teachers' TPACK currently stands, how it changes over time, how the different parts relate to each other, developing measurement tools, and real-world classroom use. That said, they also pointed out some problems. For one, there's not enough qualitative work. For another, too many studies rely on what teachers say about themselves (self-reported data), which isn't always reliable.

Then there's the case of secondary school English teachers. Studies on this group show they have the lowest TPACK scores. And if you rank the different dimensions, the order goes like this: PCK comes first, then CK, then PK, then TCK, then TP(A)CK, then TPK, and finally TK at the bottom (Jiao Xiaohan, 2024) [9].

2.3 Research on Pathways for TPACK Competence

Concerning the specific pathways for competence development, Yi-ju Ariel Wu(2026) [10] proposed an 18-week model—CATERR—grounded in the TPACK framework. The model consists of six stages: understanding, analysis, teaching, assessment, reflection, and refinement. Through repeated peer coaching and cyclical reflection, this model was found to effectively enhance pre-service teachers' integrative competence. A key point made by the study is this: even with strong technical skills, teachers cannot turn technical knowledge into genuine TPACK competence unless they receive pedagogical guidance and engage in repeated practice within authentic teaching contexts. That conclusion echoes an earlier proposition: 'technical knowledge ≠ TPACK' (Bostancıoğlu & Handley, 2018) [11].

2.4 Summary and Outlook

In summary, the TPACK framework offers a solid theoretical foundation for understanding and enhancing teachers' digital teaching capabilities. Numerous scholars have conducted extensive research on the current status of teachers' TPACK, its influencing factors, and its development pathways, yielding rich findings. Nevertheless, significant shortcomings remain in the existing literature.

First, empirical research on TPACK specifically targeting pre-service English teachers in China is relatively scarce. Most studies draw on broad, cross-disciplinary samples and fail to adequately address the unique characteristics of the foreign language discipline. Second, research on development pathways largely stays at the level of general advocacy, lacking a systematic framework grounded in the current situation and its underlying causes. For the specific group of pre-service English teachers, a key issue remains: how can we design development pathways that are both actionable and evaluable, while directly addressing their actual competence gaps and constraints?

In light of these research gaps, this study focuses on pre-service English teachers and poses the following two research questions:

① Based on the TPACK model, what is the current status of pre-service English teachers' digital teaching competencies, and what are the core factors contributing to this status?

② Based on the TPACK model, and taking into account the current status and underlying causes of pre-service English teachers' competencies, how can a pathway for enhancing digital teaching competencies be constructed?

3. Research Design

3.1 Research Participants

This study selects students majoring in English in a university in the north as the subjects of the survey. In terms of gender distribution, women account for 83.33% (50 people) and men account for 16.67% (10), which is in line with the reality that women account for the majority in the current English teacher majors. In terms of the learning stage, undergraduate freshmen accounted for the highest proportion (61.67%), followed by undergraduate juniors (23.33%), and master's students accounted for only 1.67%. The sample consisted primarily of lower-year students, who possess a certain foundation in pedagogy but have relatively limited practical teaching experience.

3.2 Research Instruments

3.2.1 Questionnaire Design

The questionnaire used in this study comprises four sections: basic information; self-assessment scales for TPACK and digital teaching competence; the current status and development needs. The scale section is adapted from the TPACK framework (Schmidt et al., 2009) [12] and employs a five-point Likert scale.

3.2.2 Interview Outline

Based on the questionnaire results, three respondents with different levels of TPACK proficiency were selected for semi-structured interviews to supplement and triangulate the quantitative findings.

3.2.3 Data Collection and Reliability and Validity Testing

Following data collection, SPSS 26.0 was used to conduct internal consistency reliability analyses on the scales. The results showed that the Cronbach's α coefficient for the total TPACK scale was 0.94, whilst the α coefficients for the individual sub-scales were as follows: TK (0.82), CK (0.88), PK (0.84), PCK (0.85), TCK (0.80), TPK (0.86) and TPACK (0.92). The reliability coefficients for all dimensions were above 0.80, indicating that the questionnaire possesses good internal consistency in the sample Table 1, consistent with the reliability range (0.75–0.92) reported by Schmidt et al. (2009).

Table 1: Reliability of the TPACK Dimensions.

Dimension	**Cronbach's α**
Technological Knowledge: TK	0.82
Pedagogical Knowledge: PK	0.84
Content Knowledge: CK	0.88
Pedagogical Content Knowledge: PCK	0.85
Technological Content Knowledge: TCK	0.80
Technological Pedagogical Knowledge: TPK	0.86
TPACK	0.92
Total Scale	0.94

To test the construct validity of the survey design, this study employed exploratory factor analysis to examine the construct validity of the questionnaire. First, the KMO statistic was 0.87, exceeding the recommended threshold of 0.70; the approximate chi-square value for Bartlett's sphericity test was 1847.32 ($df = 595$, $p < 0.001$), indicating that the data were suitable for factor analysis. Principal component analysis was used to extract factors with eigenvalues greater than 1. The rotated factor loading matrix showed that the loadings of all items on their respective factors were greater than 0.50, and there were no significant instances of dual loading. The seven factors explained 68.7% of the cumulative variance, indicating that the questionnaire possesses good construct validity, as shown in Table 2.

Table 2: Results of the Structural Validity Test for the Questionnaire.

Testing Criteria	Test Results	Passing Criteria
KMO value	0.87	>0.7
Bartlett's sphericity test approximate chi-square value	1847.32	-
df	595	-
p	<0.001	<0.05
Cumulative variance explained (%)	68.7%	>60%

4. Analysis of Results

4.1 Overall TPACK Levels and Structural Imbalances

Statistical results show that the mean scores for the various dimensions of TPACK among pre-service English teachers, from highest to lowest, are as shown in the Table 3, following TK > TPK > PK > CK = TCK > TPACK > PCK, differing from Jiao's (2024) findings, and there are three possible reasons: First, the study in this paper is based on self-assessment questionnaires from English pre-service teachers at different undergraduate levels, while Jiao's study targets a specific group of high school English teachers and uses classroom observation, which is more likely to expose technical shortcomings; Second, teachers' self-evaluations often overestimate technical ability, resulting in a relatively high TK; Finally, differences in the information environment in which samples exist, such as regional development differences or recent training intensification, can also raise the TK mean.

In terms of standard deviation(*SD*), the standard deviations for technology-related dimensions (TK = 0.85, TPK = 0.82) were slightly higher than those for content knowledge (CK = 0.76), indicating significant variation in technological competence among pre-service teachers and a polarized distribution. Some students may have been exposed to a wide range of digital tools through self-study or coursework, while the majority remain at the basic application level. In terms of data distribution, scores across all dimensions range from 3.25 to 3.48, placing the overall performance at an intermediate level between "average" and "adequate," and not yet reaching the "good" level. See Table 3 for details.

Table 3: Descriptive Statistics of TPACK Dimensions.

Dimension	Items	*M*	*SD*
TK	3	3.48	0.85
PK	3	3.30	0.81
CK	3	3.28	0.76
PCK	3	3.25	0.78
TCK	3	3.28	0.79
TPK	3	3.33	0.82
TPACK	4	3.27	0.80
Total Scale	22	-	-

It is worth noting that the technical knowledge (TK) score is relatively high (3.48), indicating that pre-service teachers are proficient in the operation of basic digital tools and have a certain confidence and foundation. However, the specific categories of tool use, as shown in Table 4, it is not difficult to see that multimedia and network resources dominate, indicating that the current use of digital tools is only in the shallow stage.

Table 4: Survey Results on the Use of Technological Tools.

Technological Tools	Selection Frequency	Proportion
Multimedia (PPT/video/audio, etc.)	46	27.54%
Corpus（AntConc/BNC/COCA）	18	10.78%
Online Platform(Learning Pass/ Rain Classroom/Dingding)	39	19.76%
Network Resources (B station/Baidu library/online dictionary, etc.)	33	23.35%
Generative AI tool (ChatGPT / AI Course Preparation)	29	17.36%
AR/VR	0	0.60%
Almost No Need	1	0.60%
□ Other______	1	0.00%

In summary, the TPACK framework of pre-service English teachers shows the characteristics of sufficient technical foundation but weak integration ability. The score of all dimensions does not exceed 3.5 points, indicating that its overall digital teaching ability still has a lot of room for improvement. This finding is consistent with the conclusion of relevant studies at home and abroad (for example, Tondeur et al., 2017 [13]), indicating that weak technical integration skills are a common structural challenge in pre-service teacher training.

4.2 Four Dimensions of Digital Teaching Competence

Looking at Table 5, the scores across the four dimensions of digital teaching competence all fall into the slightly below-average range—between 3.23 and 3.50. Among them, instructional design competence ranks lowest (3.23). What does this tell us? Most pre-service teachers do mention technology in their lesson plans, but they tend to treat it as nothing more than a "teaching aid." They don't really adjust their teaching methods to fit the integration of technology.

Beneath this rather shallow awareness, there are deeper psychological factors at play. Yuan Peili and colleagues (2025) [14] found that technology application behavior is closely tied to pre-service teachers' technological self-efficacy and their trust in AI. In fact, only when they develop a high-expectation mindset about technology can their TPACK levels see a real improvement. On the flip side, if their technological awareness and self-efficacy stay low for too long, they'll have a hard time actively reflecting on more fundamental questions—like how technology might support language acquisition or enable personalized learning.

Table 5: Descriptive statistical results of all dimensions of digital teaching competence.

Dimensions	***M***	***SD***
Instructional Design Competence	3.23	0.78
Instructional Implementation Competence	3.29	0.80
Instructional Evaluation Competence	3.34	0.75
Instructional Innovation Competence	3.50	0.81

4.3 The Influence of Beliefs in Technology Education

To verify the mediating role of technological pedagogical beliefs between the total TPACK score and teachers' digital teaching competence, this study employed hierarchical regression analysis. Strictly adhering to the three-step mediation analysis logic proposed by Baron & Kenny(1986) [15], the regression analysis was systematically designed and implemented. The specific principles, design, implementation process, and results are as follows:

① Principles of Regression Analysis Design

The core principle of mediating effect testing is to investigate whether the influence of the independent variable on the dependent variable is achieved indirectly through a mediating variable, that is, to verify whether the transmission path "independent variable (X) → mediating variable (M) → dependent variable (Y)" holds true. In this study, the independent variable is the total score of TPACK (X), the dependent variable is the digital teaching competence (Y), and the intermediary variable is the technological pedagogical belief (M). The hierarchical regression analysis judges whether the type of intermediary effect is a complete intermediary or a partial intermediary by gradually introducing variables and observing the changes in the regression coefficient.

② Design of Regression Analysis

Combining the research hypothesis and variable characteristics, this study designs a three-level regression model. The specific design is as follows:

Model 1 (main effect test model): Take digital teaching competence (Y) as the dependent variable and demographic variable as the control variable, and include the total score (X) of TPACK to test its direct predictive role on digital teaching ability, verify whether the main effect is true, and lay the foundation for the intermediary effect test.

Model 2 (Intermediary Effect Test Model): On the basis of Model 1, add the intermediary variable technological pedagogical belief (M), and at the same time include the control variable and TPACK total score (X) to test the change of the regression coefficient of the total TPACK score on digital teaching competence, and the technological pedagogical belief (M) for digital teaching The predictive role of learning ability (Y) is to judge whether there is an intermediary effect and the type of effect.

Test criteria: Take the standardized regression coefficient (*β*), *t*-value, significance level (*p*) and adjusted R^2 as the core judgment indicators, of which $p < 0.05$ is a significant difference, and $p < 0.001$ is a significant difference; after adjustment, R^2 is used to measure the explanatory power of the model. The larger the value, the higher the degree of explanation of the model for dependent variables.

③ Procedure of Regression Analysis

This study uses SPSS 26.0 statistical software to implement hierarchical regression analysis, which is strictly operated step by step according to the preset model. The specific implementation process is as follows:

First of all, sort out the collected valid sample data, eliminate missing values and abnormal values, and ensure the integrity and validity of the data; standardize all research variables (TPACK total score, technological pedagogical belief, digital teaching competence) and control variables to avoid the regression results caused by different variables' interference.

Then there is the hierarchical regression operation; the first step is to incorporate the control variables into the regression equation, and then include them into the total score of TPACK (X). Model 1 was run, and the standardized regression coefficient (*β*), *t*-value, *p*-value, and adjusted R^2 of the TPACK total score were recorded; Second, building on Model 1, include the mediating variable(*M*)—and run Model 2, recording the standardized regression coefficients (*β*), *t*-values, *p*-values, and adjusted R^2 for both the TPACK total score and technological pedagogical beliefs .

④ Results of Regression Analysis

The results of the hierarchical regression analysis are shown in Table 6 as follows:

Table 6: Results of a Regression Analysis on the Mediating Effects of Technological Pedagogical Beliefs.

Model	**Dependent Variable**	**Independent Variable**	**Standardized *β***	***T*-Values**	***P*-Values**	**Adjusted R^2**
Model 1	Digital Teaching Competence	TPACK Total Score	0.58	12.36	<0.001	0.38
Model 2	Digital Teaching Competence	TPACK Total Score	0.37	8.92	<0.001	0.52
		Technological Pedagogical Belief	0.42	10.15	<0.001	

The results of Model 1 (main effects test) show that, after controlling for demographic variables, the total TPACK score has a highly significant positive predictive effect on digital teaching competence ($\beta = 0.58$, $t = 12.36$, $p < 0.001$). After model adjustment, $R^2 = 0.38$ shows that the total score of TPACK can explain the variation of 38% of digital teaching ability. The main effect is established, indicating that the higher the TPACK level of teachers, the stronger their digital teaching ability, which provides a necessary prerequisite for the subsequent intermediate effect test.

The results of model 2 (intermediary effect test) show that after incorporating the belief of intermediary variable technology teaching, the R^2 after adjustment of the model increased to 0.52, indicating that after adding intermediary variables, the model's explanatory power of digital teaching ability has been significantly improved, increasing by 14% compared with model 1, and the model fitting effect is better. At the same time, the standardized regression coefficient of the total score of TPACK for digital teaching ability decreased from 0.58 of model 1 to 0.37 ($t = 8.92$, $p < 0.001$), which still maintains a very significant level; the belief in teaching of intermediary variable technology has a very significant positive predictive effect on digital teaching ability ($\beta = 0.42$, $t = 10.15$, $p < 0.001$).

The results above suggest something interesting: technological pedagogical beliefs play a partial mediating role between the TPACK total score and digital teaching competence. What this means is that the TPACK total score doesn't just affect digital teaching competence directly—it also has an indirect effect. It works by strengthening teachers' technological pedagogical beliefs, which in turn helps improve their digital teaching competence. This finding is consistent with Xie et al. (2024) [16].

The interview data provides rich qualitative evidence for this quantitative result. Many respondents expressed their hesitation and concern about technology integration. One interviewee frankly said, "It's not that I don't know how to use technology, but that I don't think it's necessarily better than the traditional method." "I'm worried that technology will make students distracted and dare not try it easily." "I don't have successful experience and don't know where to start." Another interviewee said that the feedback from teachers and classmates said, "If everyone says that my skills are used naturally and helpful in teaching, I will be particularly encouraged; but if the feedback says that technology and teaching are disconnected, I will be a little frustrated and even doubt my ability." These expressions together show that the weak belief in technical teaching does not simply stem from the absolute lack of technical ability, but from the lack of successful integration experience, the lack of positive feedback, and the concern that technology may bring negative classroom effects. The problem of belief has become a key internal factor that restricts the transformation of digital teaching ability from "knowledge" to "action".

5. Digital Teaching Ability Improvement Path Construction

5.1 Path Construction Principle

5.1.1 Adaptability of Disciplines

The path design must fit the subject characteristics of English teaching and ensure that the application of technology serves the essence of language teaching, rather than blindly using it regardless of the adaptability of teaching. Because language itself carries profound cultural significance, the core goal is to use language for real communication, and English teaching must emphasize its deep understanding and practicality. The introduction of any technical tool should first answer the fundamental question of "how this technology promotes students' language acquisition, communication ability or cross-cultural understanding", rather than simply pursuing the novelty or visual impact of the technology.

5.1.2 Pre-Service Stage

Following the growth law of college students from "learners" to "teachers" as pre-service teachers, ability cultivation should be gradual. Junior students are in the foundation period of subject knowledge and educational theory. At this time, they should focus on technical cognition and basic operation, and establish a preliminary perception and positive belief in educational technology through experiential learning. Senior students should focus on integrated application and innovative practice when entering the teaching design and practical training period. Exercise the teaching ability of technology integration in real situations.

5.1.3 Practice-Oriented

Based on the real classroom scene, learn in practical exercises. Technical integration ability is essentially a kind of practical knowledge, which cannot be acquired only through listening or reading. It must be practiced, reflected and iterated repeatedly in real or simulated teaching tasks. Path design should provide sufficient integration practice opportunities for pre-service teachers through project-based learning, course research, micro-grid practice, educational internship, etc., and embed feedback and improvement mechanisms in practice to promote the effective transformation of knowledge into ability.

5.2 Developing a Pathway for Improvement

5.2.1 Optimize the Curriculum System

In order to solve the dilemma of the separation of subject knowledge, teaching method knowledge and technical knowledge, it is necessary to reconstruct the integrated system from the curriculum structure level and build a digitally empowered curriculum system (Guo Fengying et al., 2025) to break down the barriers of technology and teaching. Based on the above reference, this study believes that it is necessary to optimize the curriculum system, and puts forward two path construction suggestions. One is to open a special course for English normal students designed entirely around English teaching scenarios to strengthen the synchronous acquisition of technical knowledge and subject content. The second is to hold a special seminar on cutting-edge technology, focusing on artificial intelligence-assisted language teaching, virtual reality immersive learning, learning analysis-driven precision teaching and other topics, and adopting the combination of theoretical explanation and group discussion to expand students' cognitive boundaries of the potential of technical teaching.

5.2.2 Strengthen Practical Training

In view of the lack of technical integration training in practical links and the lack of a closed-loop mechanism, a stepped practical training system from micro-teaching to internship, from simulation to real should be built to improve teachers' digital application ability (Xu Mengxia et al., 2025) [17]. First, build a community to improve the teaching ability of pre-service teachers under the framework of digital literacy (Xu Jin, 2025) [18]. Pre-service teachers can focus on the effectiveness of technology application through self-video analysis and peer mutual evaluation, and conduct in-depth analysis of excellent digital teaching examples based on technology, teaching methods and subject content in multiple dimensions. And imitate learning to identify the integrated strategy that can be migrated; Second, reform microgrid teaching, establish a closed-loop mechanism of "design-test lecture-reflection-improvement", refer to Yi-ju Ariel Wu (2026) to put forward an 18-week CATERR model, and improve through three rounds of "understanding -analysis -teaching -evaluation -reflection -refining" training system Teachers' digital ability. Take technical integration as a necessary component of each trial lecture, and conduct a second trial lecture based on feedback to form a complete iterative training process.

5.2.3 Cultivate the Belief of Technical Teaching

Yuan Peili et al. (2025) found six types of consciousness in his research, and proposed that "the higher the level of technical self-efficacy and AI trust, the easier it is to form a 'high-expectation' AI consciousness", that is to say, the teaching belief similar to "high threat awareness" will hinder the integration and application of technology. This study believes that the systematic cultivation of positive technological pedagogical beliefs can start from the four levels of successful experience, role model motivation, belief curriculum and identity, so as to reverse the current situation of weakness in teaching beliefs and insufficient intrinsic motivation. First, improve the sense of self-efficacy through low-threshold and high-feedback task design, help students quickly get positive feedback in moderate challenges, and eliminate the psychological fear of technical difficulties. The second is to introduce excellent front-line teachers as role models, stimulate the inner motivation of pre-service teachers with their real growth experience and integrated cases, and enhance their professional identity and willingness to actively explore. The third is to open a special course on belief, organize literature reading and dialectical discussion on topics such as the educational value of technology, applicable boundaries, potential risks and teachers' professional judgment, and promote students to build a rational technical concept that is cautious, open and serves students' development. Fourth, link digital ability with the identity of "good teachers", strengthen the growth mentality of "technology empowerment competitiveness" and the crisis consciousness of "lack of technology is elimination" in professional introductory education, and transform external requirements into internal pursuits.

6. Conclusion

The survey results show that the mean scores for the seven TPACK dimensions among pre-service English teachers range from 3.25 to 3.48, with the ranking TK > TPK > PK > CK = TCK > TPACK > PCK—a clear sign of structural imbalance. Technology application stays largely at a surface level, making it hard to genuinely integrate technology with subject content and pedagogy. Overall, digital teaching application competence sits at a slightly below-average level. Further regression analysis confirms that technological pedagogical beliefs play a key mediating role between TPACK and digital teaching competence. What this means is, even if teachers have a decent grasp of TPACK knowledge, without positive technological pedagogical beliefs the efficiency of turning that knowledge into real action drops significantly. On the flip side, teachers who hold positive beliefs tend to learn actively and experiment without fear, growing quickly through practice even when their initial technical skills are weak. To tackle the issues and their root causes, this study constructs a systematic improvement pathway across three dimensions: curriculum optimization, enhanced practical training, and cultivation of intrinsic motivation. The hope is that these findings can offer useful guidance for developing digital competencies among pre-service English teachers in higher education.

That said, this study only looked at English education majors from a single institution, so the sample is relatively limited. Whether the findings hold more broadly needs checking with samples from a wider range of institutions. Future research should expand the sample scope and run comparative studies across different regions and types of institutions to further test and generalize what we've found here.

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Conflicts of Interest

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