A Study on the Cultivation Strategies for Pre-Service Teachers' Intelligent Educational Literacy in Blended Learning

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Abstract. In the context of the digital transformation of education, pre-service teachers, as the first practitioners of future education, shoulder the important mission of leading educational reform and promoting the intelligent upgrading of education. Therefore, the cultivation of pre-service teachers' intelligent educational literacy is not only an urgent task but also a crucial factor related to the development of future education. Pre-service teachers with intelligent educational literacy can fully utilize intelligent technologies to optimize the process of education and teaching, becoming the main driving force for promoting the transformation of future education. Hence, this study focuses on the cultivation of pre-service teachers' intelligent educational literacy, constructs a training strategy for them in a blended learning environment, and optimizes and evaluates the strategy through design-based research. The aim is to provide theoretical support and practical references for the future development of pre-service teachers.

Keywords: Blended learning; AI-TPACK; strategy

1 Introduction

As AI increasingly merges with education, intelligent teaching has gained prominence. Despite government efforts to promote teachers' adaptation to new technologies and enhancement of their intelligent educational literacy, challenges persist[1]. Notably, a lack of clear and systematic teacher training frameworks has led to significant disparities in IT application and intelligent teaching skills.Currently, pre-service teachers' intelligent educational literacy is inadequate, particularly in mixed learning environments. Existing research mainly focuses on in-service teachers, overlooking the important group of pre-service teachers. Given their critical role as future educators, their literacy impacts not only their teaching capabilities but also the development of future talent.The study aims to explore strategies to enhance pre-service teachers' intelligent educational literacy in mixed learning settings, offering new directions for their professional growth.

2 Literature Review

2.1 Blended learning

Blended learning combines online and face-to-face learning, aiming to optimize traditional classrooms, enrich learning resources, and improve learning outcomes. It has received widespread attention in the education community. HeKekang first proposed "blended learning", emphasizing the combination of traditional learning and E-learning advantages[2]. Li Kedong[3] emphasized that blended learning is the organic combination of face-to-face and online learning. The blended learning environment utilizes a variety of educational technologies and resources to achieve teaching goals.

2.2 Intelligent education literacy

Intelligent education literacy was first proposed in the "Notice of the General Office of the Ministry of Education on Conducting Pilot Work on Artificial Intelligence-Assisted Teacher Development Action". Different scholars have different definitions. Hu et al. believe that it is a teaching process based on the collaborative development of knowledge, ability, and thinking[4]. Li sees it as an upgrade of teachers' information technology literacy[5]. Guo et al. define it as teachers' ability to carry out human-computer collaborative teaching[6]. Liu defines it as a collection of knowledge, ability, attitude, and ethics[7]. AI-TPACK theory is a new framework based on TPACK integrating artificial intelligence technology, which is more suitable for the educational needs in the intelligent era and has guiding significance for teachers' professional development. Based on this theory, this study constructs intelligent education literacy strategies.

2.3 AI-TPACK

This study integrates Yan Zhiming's research to introduce AI-TPACK theory, a novel framework extending TPACK theory with artificial intelligence technology[8]. This framework encompasses seven knowledge domains, emphasizing the interplay between AI-TK, CK, and PK. Reflecting AI's transformative impact on education, AI-TPACK offers guidance for teacher growth, teaching environment design, and application development in the intelligent era. However, further exploration is needed to address limitations in research duration, participant diversity, and literacy evaluation methods.

The integration of blended learning, intelligent educational literacy, and the AI-TPACK theory significantly impacts pre-service teacher training. Blended learning enhances learning outcomes and teaching skills with diverse resources and modes. Cultivating intelligent educational literacy prepares teachers for the intelligent era and innovative AI-driven teaching methods. AI-TPACK theory offers a framework for integrating technology in teaching, fostering interdisciplinary thinking and innovation. This trio offers a comprehensive training system, laying a solid foundation for teachers' future development and enhancing the overall quality of the teaching workforce.

3 the Cultivation Strategies for Pre-Service Teachers' Intelligent Educational Literacy in Blended Learning

3.1 Constructing Training Strategies Grounded in the AI-TPACK Theory

Strategy construction in the study is guided by policies and supported by the AI-TPACK theory. It involves analyzing relevant key points based on student characteristics, course content, and learning environments, and integrating these with the current situation of pre-service teachers' intelligent educational literacy as revealed in previous studies[9]. The principles of educational and scientific nature, autonomy, experiential learning, and practicality serve as guidelines.

3.2 Designing Elements of Training Strategies Based on the AI-TPACK Theory

This study defines the training strategy for intelligent educational literacy as a teaching strategy aimed at cultivating pre-service teachers' intelligent educational literacy. It primarily encompasses four key elements: guiding principles, training objectives, training activities, and media support. These elements are designed to foster pre-service teachers' intelligent educational literacy. Grounded in the AI-TPACK theory, this study delves into the guiding value of its theoretical implications and proposes a series of specific suggestions from the perspectives of intelligent knowledge and intelligent ability[10]. These suggestions aim to guide the design and implementation of each element within this strategy, as outlined in the specific design approach presented in **Table 1**.

Table 1.Analysis of Design Ideas for Strategy Elements

Elements of Instructional Strategies	Theoretical content	Specific design ideas
guiding principle	AI-TPACK	Guide the development of instructional strategies
Media Support	AI-TK	Intelligent tools instead of non-intelligent multimedia tools
	AI-TPK	The design of the content of the guidance activities should add knowledge content related to AI-TK, AI-TPK, and AI-TCK, based on the layers of intelligent knowledge specified in the AI-TPACK theory
	AI-PCK	
incubation activity	AI-TPACK	Guiding the design of activity tasks, according to the intelligent competence layers specified in the AI-TPACK theory, the training process focuses on the development of teacher trainees' AI-TPK and AI-TCK related competences
training goal	AI-TPACK	Combining the intelligent knowledge layer and intelligent competence layer clarified in the AI-TPACK theory, further explain the specific contents of the three dimensions of intelligent learning literacy, intelligent teaching literacy, and professional ethics literacy for teacher educators

3.3 Designing Elements of Training Strategies Based on the AI-TPACK Theory

By meticulously sorting through a diverse range of relevant literature, theories, policies, learner characteristics, and course models, a comprehensive understanding of the subject matter was achieved. Based on this thorough analysis, a preliminary strategic chart was constructed, which is depicted in Fig. 1 below. This chart serves as a framework for guiding further development and implementation of educational strategies, ensuring alignment with best practices and the unique needs of the learners.
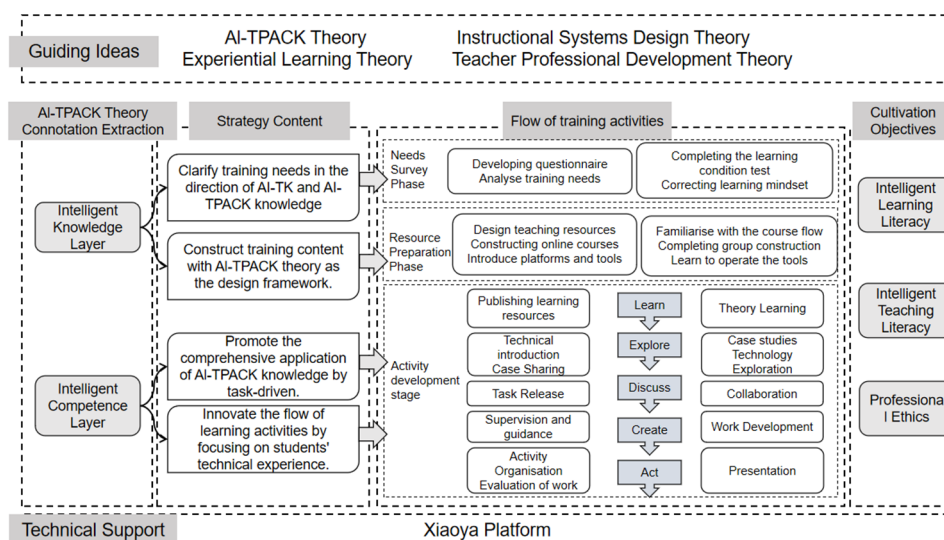

Fig. 1. Strategies for Intelligent Educational Literacy Special Provision for Teacher Trainees Based on AI-TPACK Theory (Preliminary Draft)

4 Strategy Implementation

4.1 Courses and Participants

This study employs the Xiaoya platform for blended learning, integrating online self-study with offline classroom instruction. The offline classrooms feature multimedia facilities to support diverse teaching activities, while the online courses are accessible on mobile and tablets. The experiment centers on the "Modern Educational Technology" course for sophomore math education majors at University G, aiming to foster pre-service teachers' intelligent educational literacy through effective technology application. Two classes, totaling 100 students, participate in the experiment.

4.2 Experimental Procedures

This study used a design-based research approach with two iterative experiments to refine the training strategy for pre-service teachers' intelligent educational literacy based on AI-TPACK. The first round focused on assessing strategy effectiveness, while the second round detailed the strategy for better feasibility and effectiveness.

The first round started in September 2021, and the second in October, following the first round's initial stages. The second round was informed by reflections from the first, and the research plans are summarized in Table 2.

Table 2. Plan for Design-Based Research

point	timing	Stages of the mandate	goal
preliminary stage	2023.09.06-2023.09.13	Collecting resources for smart teaching cases Conducting learning tests Instructional design in conjunction with developmental strategies	Understand the current situation and training needs of teacher educators' literacy, and develop a good plan for experiment implementation
first round (of match, or election)	2023.09.20-2023.11.22	Mathematics Class1 conducts literacy development practices	Checking the validity of the model
second round (of match, or election)	2023.10.18-2023.12.20	Mathematics Class2 conducts literacy development practices	Refinement of details to improve model operability
Forming a Strategy for Developing Intelligent Educational Literacy in Teacher Trainees Based on AI-TPACK Theory			

4.3 Strategy Optimization

After two design-based research rounds, the strategic chart has been revised to include a technical experience component in conjunction with analytical cases. This allows teachers to guide students in exploring AI technology before case analysis, deepening their understanding of tech-teaching integration. Additionally, student interaction has been enhanced through optimized communication mechanisms and the introduction of peer evaluation. Teachers can use online platforms to share mid-term work progress and issues, enabling focused guidance and brainstorming for optimization. Inter-group peer evaluation adds objectivity and fairness to work evaluations, encouraging students to reflect on their intelligent educational literacy.

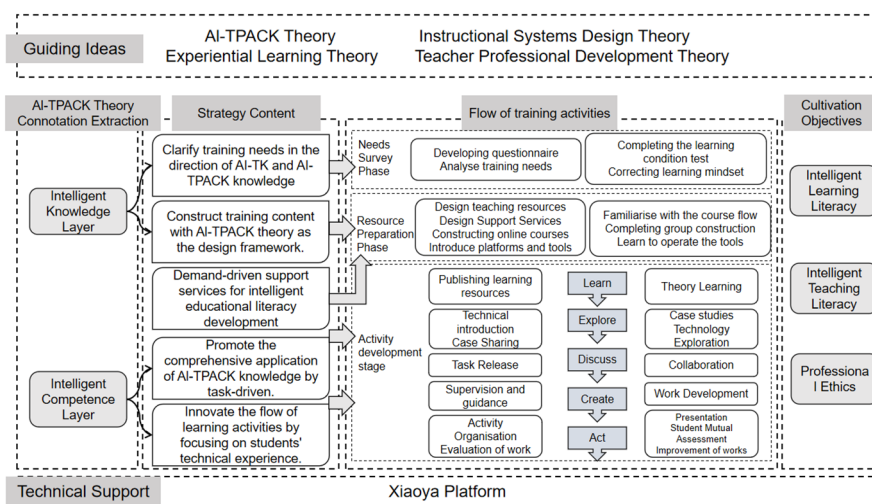The optimized strategy graph after two rounds of experiments as Fig. 2 shows:

Fig. 2 Strategies for Developing Intelligent Educational Literacy in Teacher Trainees Based on AI-TPACK Theory

5 Results

After implementing the strategies, the final results of intelligent educational literacy development were analyzed. Data was collected using a literacy self-assessment questionnaire before and after applying the strategies, assessing the effects of the implemented strategies through in-depth data analysis.The Teacher Trainees' Intelligent Educational Literacy Present Questionnaire was employed as an evaluation tool, exhibiting high internal consistency coefficients across all dimensions (0.893 for Intelligent Learning Literacy, 0.888 for Intelligent Teaching Literacy, 0.933 for Professional Ethics Literacy, and 0.949 overall), indicating reliability.To evaluate the improvement in teacher trainees' intelligent educational literacy, a pre- and post-test was conducted on the intervention subjects. Paired samples t-test was used to compare the overall level and each dimension between the pre- and post-test. Results indicated that post-test means were higher than pre-test means across all dimensions.(Table 3)

Table 3. Comparative Analysis of Intelligent Educational Literacy of Teacher Trainees

	variable name	variable value	sample size	average value	(statistics) standard deviation	t-value	p-value (two-tailed)
first round (of match, or election)	Intelligent Educational Literacy	pre-testing	55	63.80	13.74	3.275	0.002**
		post-test	57	72.05	13.76		
	Smart Learning Literacy	pre-testing	55	20.67	5.226	3.516	0.001**
		post-test	57	24.00	4.646		
	Smart Teaching Literacy	pre-testing	55	20.03	5.260	2.602	0.012*
		post-test	57	22.52	5.037		
	Professional Ethics	pre-testing	55	23.08	4.301	3.030	0.004**
		post-test	57	25.53	4.925		
second round (of match, or election)	Intelligent Educational Literacy	pre-testing	52	66.55	12.12	1.889	0.048*
		post-test	54	72.91	13.59		
	Smart Learning Literacy	pre-testing	52	20.60	4.160	2.836	0.007**
		post-test	54	23.48	5.166		
	Smart Teaching Literacy	pre-testing	52	20.33	4.805	3.066	0.003**
		post-test	54	22.83	3.491		
	Professional Ethics	pre-testing	52	25.62	4.843	0.888	0.379
		post-test	54	26.54	5.035		

*p<0.05 **p<0.01 ***p<0.001

After the first round of experiments, the p-value of the pre- and post-test T-test results of the overall level of intelligent educational literacy was <0.05, and there was a significant difference between the pre- and post-tests of the overall level of intelligent educational literacy of the teacher trainees. In the three dimensions of intelligent learning literacy, intelligent teaching literacy, and professional ethics literacy pre- and post-test T-test results p-value <0.05, statistically significant, indicating that the pre- and post-tests in the three dimensions have a significant difference, of which in the intelligent learning literacy dimensions of the

difference in the magnitude of the largest change. After the second round of experiments, the p-value of the pre- and post-test T-test results of the overall level of intelligent educational literacy was <0.05, indicating that there was a significant difference between the pre- and post-tests in the overall level of intelligent educational literacy of the teacher trainees after the cultivation of this literacy. The p-value of the T-test results of the pre- and post-tests in the dimensions of intelligent learning literacy and intelligent teaching literacy is <0.05, which is statistically significant, while the p-value of the T-test results in the dimension of professional ethical literacy is >0.05, which indicates that there is no significant difference between the pre- and post-tests in this dimension, and that the magnitude of the difference in the dimension of intelligent teaching literacy has changed the most in the current round of experiments. After two rounds of experiments, the overall level of teacher trainees' Intelligent Education Literacy has been significantly improved, which proves the effectiveness of the strategy of cultivating teacher trainees' Intelligent Education Literacy based on the AI-TPACK theory.

6 Conclusion

In conclusion, this study aims to develop a blended learning strategy for pre-service teachers' intelligent educational literacy, drawing upon the AI-TPACK theory. We have created and tested this strategy, discovering its effectiveness in enhancing teachers' capabilities in leveraging intelligent technologies for educational reform. Nevertheless, our research is not without limitations. A shorter research period restricts our ability to verify the long-term sustainability of our findings. Additionally, our focus on a specific grade and major limits the generalizability of our results. Furthermore, the evaluation methods for literacy may require further refinement. Future research should address these issues, seeking to expand the scope of our investigation and improve the evaluation frameworks, thereby contributing to the continued development and enhancement of pre-service teachers' intelligent educational literacy.

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