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Bridging the AI Gap: A Needs Analysis of Chinese Pre-Service EFL Teachers in Developing Intelligent-Technological Pedagogical Content Knowledge

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Abstract
This study explores the readiness and learning needs of Chinese pre-service English as a Foreign Language teachers in developing Intelligent-Technological Pedagogical Content Knowledge for the effective integration of AI in English Language Teaching. Using a mixed-methods approach, quantitative data were collected from 253 pre-service English teachers, while qualitative insights were obtained from semi-structured interviews with eight participants. The findings show strong levels of Intelligent-Technological Knowledge and Intelligent-Technological Pedagogical Knowledge, but moderate levels in Intelligent-Technological Content Knowledge, Intelligent-Pedagogical Content Knowledge, and ethics. Key learning needs include increasing familiarity with AI tools, designing personalized instruction, incorporating AI into English speaking and listening tasks, and developing cohesive AI-supported pedagogy. Ethical concerns, such as fairness, transparency, and data security, were also highlighted. The study underscores the importance of tailored training programs that integrate AI technologies, pedagogical methods, and ethical considerations to prepare teachers for AI-driven educational environments. While contributing to the growing discourse on AI in teacher education, the study is limited by a small qualitative sample and its focus on Chinese pre-service teachers, which may limit broader applicability. Future research should expand sample sizes, incorporate cross-cultural comparisons, and examine the long-term impact of AI training on teacher competencies and practices.

Keywords: AI readiness, English language teaching, ethics, Intelligent-Technological Pedagogical Content Knowledge, needs analysis, pre-service EFL teachers, teacher education

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Introduction

The rapid advancements in Artificial Intelligence (AI) have significantly reshaped global education, particularly English language teaching (ELT) (Koraishi, 2023). AI offers transformative potential by enabling personalized learning, adaptive systems, streamlined assessments, and efficient classroom management (Muñoz & Chimbo, 2023). In China, the New Generation AI Development Plan (NGAIDP) launched in 2017 has positioned the country as a global leader in AI innovation, resulting in extensive AI integration across various domains, including education (Wu et al., 2020). Asia, led by China, has also emerged as a hub for AI-ELT research (Edmett et al., 2023).

Despite its potential, integrating AI into ELT presents challenges such as data privacy, ethical concerns, unequal access, high costs, and insufficient teacher training (Albeihi & Rice, 2025; Minnillo et al., 2024). Teachers' limited familiarity with AI tools further underscores the need for targeted professional development (Edmett et al., 2023). In response, Celik (2023) proposed the Intelligent-Technological Pedagogical Content Knowledge (I-TPACK) framework, an extension of Mishra and Koehler's (2006) TPACK model, to assess teachers' competencies in ethically integrating AI while maintaining pedagogical effectiveness. For pre-service teachers (PSTs), foundational AI knowledge, ethical awareness, and domain-specific application skills are critical to developing I-TPACK competence (Hava & Babayiğit, 2024).

Pre-service English as a Foreign Language (EFL) teachers' readiness to adopt AI tools is crucial in maximizing its benefits for ELT. Needs analysis, as an essential step in curriculum design, helps identify PSTs' readiness and learning gaps to inform targeted training programs (Syafitri et al., 2023). Studies highlight varying perceptions of PSTs regarding AI integration. While acknowledging its advantages in enhancing teaching efficiency, PSTs express concerns about dependence on AI, reduced critical thinking, and ethical challenges (Chung & Jeong, 2024). However, research on Chinese pre-service EFL teachers' readiness and specific needs for AI integration remains scarce, despite China's prominence in ELT and AI education (Chan & Tang, 2024).

Thus, this study aims to investigate the readiness and learning needs of Chinese pre-service EFL teachers for integrating AI into ELT. This research seeks to provide a comprehensive understanding of their current AI-readiness and learning needs to inform the development of targeted training programs for enhancing their I-TPACK competence. To achieve this aim, the study addresses the following two research questions:

1. What is the current level of Chinese pre-service EFL teachers' readiness for integrating AI into ELT based on the I-TPACK framework?
2. What are the learning needs of Chinese pre-service EFL teachers in developing I-TPACK competence for effective AI integration in ELT?

Literature Review

AI in English Language Teaching

With its creative ways to improve teaching methods and learning results, AI has significantly impacted ELT. The main areas of focus for AI applications in ELT have been language skill development, personalized and data-driven learning, and administrative and pedagogical efficiency (Edmett et al., 2023; Xu & Ismail, 2024).

AI tools, such as AI chatbots, writing assessors, and adaptive platforms, enhance language skills through engaging, personalized learning. AI chatbots like TalkPal AI, Bard AI, and Dou Bao

improve students' speaking skills by "creating a stress-free and non-competitive learning environment" (Shikun et al., 2024, p.292); Grammarly and Wordtune refine writing (Fitria, 2021; Zhao, 2023); ChatGPT and Quillbot aid reading comprehension (Chea & Xiao, 2024), and Lyricstraining supports listening skills (Erazo et al., 2024). Together, these tools demonstrate AI's transformative potential in language education. AI also leverages Machine Learning and Big Data to personalize learning. Zhou and Li (2024) proposed an AI-L-TM model using analytics and IoT to recommend tailored pathways for Chinese college students. In Task-Based Language Teaching (TBLT), AI provides dynamic feedback and pre-class resources to foster independence and skill development (Huang et al., 2024). These advancements enhance ELT by promoting personalized learning and innovative teaching.

Despite the transformative potential of AI in English language education, its effective integration in classrooms depends largely on educators' AI literacy and competencies. Edmett et al. (2023, p. 21) also noted that "English language teacher education and training must include a focus on AI literacy." However, many educators, particularly pre-service English teachers, lack the AI-specific knowledge and skills to effectively implement these technologies in teaching (Shi et al., 2023). This highlights the pivotal role of teacher education programs in fostering AI literacy and developing the competencies necessary for future educators to leverage AI in ELT effectively.

I-TPACK Framework in Teacher Education

AI technology has become integral to online education, yet educators often struggle to effectively integrate AI tools or develop students' AI-related skills. As a result, AI competency has emerged as a crucial 21st-century skill, necessitating frameworks to enhance educators' AI literacy (Ng et al., 2023). Among these, the TPACK framework (Mishra & Koehler, 2006) is a widely recognized model for evaluating teachers' integration of technology, pedagogy, and content, making it adaptable for AI literacy education (Celik, 2023; Ng et al., 2021; Ning et al., 2024; Ye et al., 2024).

To meet the demands of AI education, Celik (2023) introduced the I-TPACK framework, which integrates ethical considerations into TPACK and assesses technological knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK) in an interconnected manner. Jang and Lee (2023) found that the I-TPACK framework comprehensively addresses competencies essential for AI-integrated education, making it a valuable tool for teacher training.

As depicted in Figure One, Celik's (2023) I-TPACK framework further expands TPACK by incorporating ethical dimensions, offering a nuanced understanding of the interaction between TPACK components and ethics. This model evaluates five constructs: Intelligent-TK (I-TK), Intelligent-TPK (I-TPK), Intelligent-TCK (I-TCK), Intelligent-TPACK (I-TPACK), and Ethics. It emphasizes not only effective AI tool usage but also understanding their capabilities, ethical considerations, and impacts on teaching practices, forming a theoretical foundation for teacher education programs (Aqib et al., 2025; Velander et al., 2024). Incorporating ethics into the framework is crucial in the digital age, where AI tools raise issues of fairness, privacy, and transparency, ensuring that educators are not only proficient in technology and pedagogy but also mindful of their ethical responsibilities when using AI in teaching. The framework has been widely applied to evaluate I-TPACK competence and AI readiness among both in-service and pre-service teachers (Bautista et al., 2024; Gregorio et al., 2024; Karataş & Ataç, 2024; Luaran et al., 2024; Velander et al., 2024).

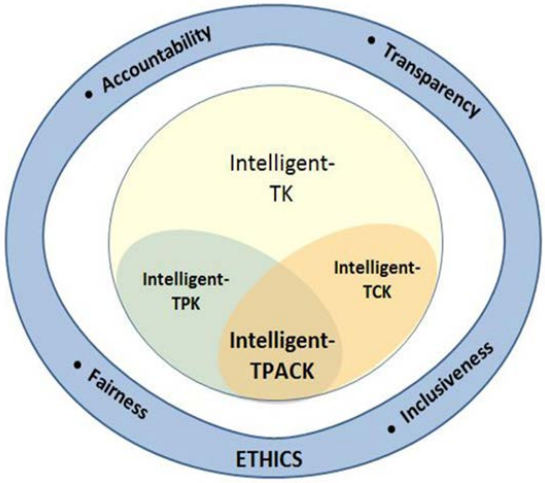


Figure 1. I-TPACK framework (Celik, 2023)

AI Readiness in Pre-Service English Teacher Education

AI readiness refers to PSTs' preparedness to incorporate AI tools into their teaching, shaped by their attitudes, behaviors, and existing competencies (Chiu & Chai, 2020). Despite the growing significance of AI in education, many pre-service English teachers are unaware of the importance of AI readiness, and some express concerns about inadequate preparation for integrating technology into their teaching practices (Bautista et al., 2024; Wang, 2023). Assessing PSTs' current AI readiness is therefore crucial to identify areas for targeted professional development.

Recent studies provide valuable insights into AI readiness among pre-service English teachers. For example, Chan and Tang (2024) found that TPK and Information Literacy (IL) are key predictors of TPACK, highlighting the need for focused AI training. Similarly, Hastomo et al. (2024) observed moderate TPACK competence among Indonesian pre-service teachers, stressing the importance of professional development and collaboration to enhance AI readiness. Luaran et al. (2024) reported stronger competencies in TK and TCK compared to TPK and TPACK among Malaysian PSTs, recommending tailored training to address gaps in classroom AI experience. These studies employed Celik's (2023) I-TPACK framework, demonstrating its effectiveness in evaluating AI readiness.

However, key gaps persist in the existing literature, such as small sample sizes, insufficient qualitative data, and a lack of longitudinal studies (Chan & Tang, 2024; Luaran et al., 2024; Hastomo et al., 2024). Moreover, there is a notable gap in research on AI readiness among Chinese pre-service English teachers, despite China's prominence in global English language education (Li et al., 2023; Ma, 2024). As Chung and Jeong (2024) highlight, addressing the unique challenges faced by Chinese pre-service teachers is essential to bridging this gap and gaining a comprehensive understanding of AI readiness across diverse educational contexts.

Needs Analysis in Pre-Service English Teacher Education

Needs analysis, or needs assessment, gathers key information to design curricula that address specific learning needs (Ibrahim, 2020; Mohd Fisal & Mohd Said, 2023). It identifies gaps between learners' current skills and professional demands, making it essential in pre-service English teacher education, particularly with evolving language teaching needs and AI integration (Farhadi & Öztürk, 2023). Similar to its use in English for Specific Purposes (ESP), it informs

targeted training programs by identifying necessities, lacks, and wants (Mustafa Ibrahim et al., 2023; Hutchinson & Waters, 1987).

Needs analysis methods include Target Situation Analysis, which focuses on required skills, and Present Situation Analysis, which evaluates current proficiency (Munby, 1981; Richterich & Chancerel, 1978). Deficiency Analysis bridges these approaches to pinpoint skill gaps, while Means Analysis considers contextual factors like resources (Dudley-Evans, 1998).

Recent studies highlight the importance of needs analysis in pre-service teacher education. Farhadi and Öztürk (2023) identified strengths in TPACK among Turkish pre-service EFL teachers, but pointed out challenges in areas such as TK, TCK, and TPK. Chan and Tang (2024) found a link between AI readiness, IL, and TPACK proficiency in Hong Kong pre-service teachers, though their study was limited by sample size and lack of qualitative data. Research on the I-TPACK development of Chinese pre-service EFL teachers remains scarce, despite its critical role in AI integration, signaling a clear gap in the literature (Huang, 2021; Ma et al., 2024).

To sum up, the literature review underscores the increasing importance of AI in English language teaching and the need for Chinese pre-service EFL teachers to develop I-TPACK competence for effective integration. Current literature offers limited insights into their readiness and specific needs for AI integration. The I-TPACK framework provides a solid foundation for evaluating TPACK in AI-driven teaching, while needs analysis identifies gaps to inform professional development. This study aims to fill these gaps by examining the readiness and needs of Chinese pre-service EFL teachers to enhance their I-TPACK competence.

Method

Research Design

This study employed a sequential explanatory mixed-methods design to examine Chinese pre-service EFL teachers' AI readiness for ELT integration and their I-TPACK developmental needs. The research consisted of two phases aligned with the study's objectives.

AI readiness was evaluated through a questionnaire developed based on the I-TPACK framework (Celik, 2023; Chan & Tang, 2024). The study employed descriptive statistics to measure readiness in five dimensions: I-TK, I-TPK, I-TCK, I-TPACK, and ethics. Present Situation Analysis (Richterich & Chancerel, 1978) evaluated participants' current competencies. Developmental needs were identified through Deficiency Analysis (Hutchinson & Waters, 1987; West, 1994) and semi-structured interviews, which provided qualitative insights via Learning Needs Analysis (Hutchinson & Waters, 1987).

The integration of quantitative and qualitative data ensured methodological triangulation, enhancing validity. The quantitative phase outlined readiness and gaps, while the qualitative phase offered detailed insights to inform targeted I-TPACK training programs (Creswell & Creswell, 2017).

Participants

Participants were selected from a university in central China, spanning all four years of a teacher education program integrating English proficiency, pedagogy, and teaching practice (Dong & Mustapha, 2019; Zheng & Borg, 2014). As regional universities supply most English teachers in rural areas, the sample reflects China's future teaching workforce (Feng, 2011).

Table One shows that 87.35% (n=221) of participants were female, consistent with the gender distribution of PSTs in China (Wang & Xie, 2023), while 12.65% (n=32) were male.

Academic grades were evenly distributed: first-year (28.06%, n=71), second-year (24.51%, n=62), third-year (22.13%, n=56), and fourth-year (25.3%, n=64). This ensures a representative sample for examining the needs of prospective English teachers.

Table 1. *Demographic distribution of the survey participants*

Items	**Options**	**Frequency**	**Percent (%)**
Gender	Male	32	12.65
	Female	221	87.35
Academic grade	First Year	71	28.06
	Second Year	62	24.51
	Third Year	56	22.13
	Fourth Year	64	25.3
Total		253	100

Eight respondents, aged 17 to 22 and spanning all academic years, were selected for semi-structured interviews to explore I-TPACK learning needs for AI integration in ELT. Anonymized as S1 to S8, the participants (six female, two male) contributed insights from diverse educational stages. Participant demographics are detailed in Table Two.

Table 2. *Demographic distribution of the semi-structured interview participants*

Participants	**Gender**	**Age**	**Academic Year**
S1	Female	17	First-year
S2	Female	18	First-year
S3	Female	19	Second-year
S4	Female	19	Second-year
S5	Female	20	Third-year
S6	Male	20	Third-year
S7	Male	22	Fourth-year
S8	Female	21	Fourth-year

Research Instruments

To evaluate Chinese pre-service EFL teachers' readiness for integrating AI into ELT, a questionnaire was adapted from two validated instruments: the I-TPACK Scale (Celik, 2023) and the AI Readiness for English Language Teachers Survey (Chan & Tang, 2024). The questionnaire included two sections: the first collected demographic data, and the second assessed AI readiness through 27 five-point Likert scale items (1 = "strongly disagree" to 5 = "strongly agree") across five dimensions: I-TK, I-TPK, I-TCK, I-TPACK, and Ethics. The dimensions were primarily drawn from Chan and Tang (2024), designed specifically for English language teachers, while the Ethics dimension was adopted from Celik's (2023) scale, ensuring relevance and reliability.

Semi-structured interviews further explored participants' learning needs and preferences for I-TPACK development in AI-integrated ELT. Guided by Hutchinson and Waters' (1987) Learning Needs Analysis Framework, the interview protocol aligned with the five constructs of Celik's (2023) I-TPACK framework. Questions addressed familiarity with AI tools, their application in teaching, integration with pedagogy and content, ethical concerns like data privacy, and learning preferences. This approach provided actionable insights for designing tailored AI-integrated ELT training programs.

Validity and Reliability

To ensure the validity and reliability of the research instruments, rigorous procedures were implemented for the questionnaire and interview protocol. A pilot test with 30 pre-service English teachers from a central China university assessed the questionnaire's reliability. Cronbach's alpha values for I-TK (.941), I-TPK (.928), I-TCK (.777), I-TPACK (.944), and Ethics (.886) indicated strong internal consistency (Cronbach, 1951; George & Mallery, 2003).

Reliability was reassessed after the full-scale survey, yielding Cronbach's alpha values of .882, .892, .795, .938, and .901 for the respective dimensions (Table Three), confirming consistency. Content validity was established through expert review involving four specialists in English education, AI, and translation (Polit & Beck, 2006): two experts evaluated pedagogical alignment, one assessed AI-related constructs, and one verified linguistic and cultural accuracy. Their feedback refined the questionnaire's clarity, relevance, and precision.

Table 3. *Reliability statistics of the questionnaire*

Constructs	Total items	Cronbach's alpha
I- TK	5	.882
I- TPK	7	.892
I- TCK	4	.795
I- TPACK	7	.938
Ethics	4	.901

The interview protocol, rooted in Hutchinson and Waters' (1987) Learning Needs Analysis Framework and Celik's (2023) I-TPACK, ensured alignment with the study's objectives. Content validity was ensured through expert reviews by two specialists in English education and AI technology, whose feedback improved question clarity and relevance. A pilot test with three pre-service English teachers confirmed the questions' effectiveness in eliciting meaningful responses (Turner, 2014).

Data Collection and Analysis

The three-week data collection included quantitative and qualitative phases. In the quantitative phase, a survey of 302 pre-service English teachers from a central China university yielded 253 valid responses (83.8% response rate) after excluding incomplete entries. The questionnaire, distributed via Tencent QQ and completed on Wenjuanxing (https://www.wjx.cn), ensured equal representation across academic years through random sampling (Lohr, 2021). Valid responses met the criteria for completeness and logical consistency (Krosnick, 1991). In the qualitative phase, eight volunteers were purposefully selected to ensure diversity in academic grade, English proficiency, and teaching experience, guided by the principle of data saturation (Guest et al., 2006).

Data analysis combined quantitative and qualitative methods. SPSS Version 29 was used for descriptive statistics (frequencies, percentages, means, standard deviations) to assess AI readiness across five dimensions: I-TK, I-TPK, I-TCK, I-TPACK, and Ethics. NVivo 12 facilitated thematic analysis of interview data (Braun & Clarke, 2006), with initial coding in Chinese to retain contextual nuances. Themes were refined, translated into English, and validated by bilingual experts. These rigorous methods ensured the reliability and validity of the findings, providing a detailed understanding of Chinese pre-service EFL teachers' AI readiness and specific I-TPACK development needs.

Findings

The Current Level of AI Readiness Among Chinese Pre-Service EFL Teachers

Evaluating participants' existing levels of readiness across the specified dimensions is Present Situation Analysis in needs analysis (Richterich & Chancerel, 1978). The results of the questionnaire, summarized in Table Four, provide a detailed account of Chinese pre-service EFL teachers' readiness to integrate AI into ELT based on the I-TPACK framework. The descriptive statistics, including mean (M) and standard deviation (SD), were used to interpret participants' readiness levels across five dimensions: I-TK, I-TPK, I-TCK, I-TPACK, and Ethics. The interpretation of mean scores follows Wiersma's (2000) categorization, where scores are classified as low (1.00–2.33), moderate (2.34–3.67), or high (3.68–5.00).

Table 4. *Descriptive statistics of the questionnaire*

Construct	**M**	**SD**	**Interpretation**
I-TK	3.7162	0.64582	High
I-TPK	3.7261	0.57688	High
I-TCK	3.6344	0.61053	Moderate
I-TPACK	3.5624	0.67948	Moderate
Ethics	3.5642	0.69620	Moderate

The findings reveal varying levels of readiness across the five dimensions. I-TK had a mean score of 3.7162 (SD = 0.64582), which falls within the high range, indicating that participants demonstrated a strong understanding of general technological knowledge related to AI tools. Similarly, I-TPK recorded a mean of 3.7261 (SD = 0.57688), also in the high range, suggesting that pre-service EFL teachers are confident in integrating AI tools with pedagogical approaches to support ELT effectively.

In contrast, the other three dimensions, I-TCK (M = 3.6344, SD = 0.61053), I-TPACK (M = 3.5624, SD = 0.67948), and Ethics (M = 3.5642, SD = 0.69620), scored within the moderate range. The results for I-TCK suggest that participants have a reasonable, though not advanced, understanding of how AI tools can be applied to specific language content. The moderate score for I-TPACK reflects participants' partial ability to integrate technology, pedagogy, and content holistically in AI-enhanced teaching. Additionally, the Ethics dimension highlights a moderate awareness of ethical considerations, such as fairness and privacy, in the use of AI tools in education.

Taken together, the above findings reveal that Chinese pre-service EFL teachers exhibit a solid level of AI readiness, with notable strengths in I-TK and I-TPK, showcasing their foundational technical expertise and pedagogical skills in utilizing AI tools. However, the moderate performance in I-TCK, I-TPACK, and Ethics reveals areas requiring further development, particularly in effectively merging technology with content knowledge, integrating pedagogy and technology, and posing ethical challenges associated with AI use.

The Deficiencies of I-TPACK Competence Among Chinese Pre-Service EFL Teachers

Deficiency Analysis combines Target and Present Situation Analyses to pinpoint gaps between current abilities and future needs, providing a foundation for tailored curriculum design (Hutchinson & Waters, 1987; West, 1994). It was used to identify areas of insufficient readiness among participants. To better understand the specific areas where Chinese pre-service EFL teachers require further development in I-TPACK competence, Table Five identifies questionnaire items with an average score below 3.6 across the five constructs. The threshold of 3.6 was determined based on the data distribution in this study, where items with mean scores below 3.6 highlight areas of relative weakness. This threshold ensures a focused analysis of constructs requiring further development in participants' I-TPACK competencies.

Table 5. *Items with a mean score lower than 3.6 by construct*

Construct	Item	M	SD
I-TK	4. I have adequate knowledge to effectively utilize AI tools.	3.48	0.805
	5. I am well-acquainted with the technical features and functions of AI tools.	3.36	0.793
I-TPK	9. I can use AI tools to track and assess students' progress in English language learning.	3.56	0.767
I-TCK	14. I am familiar with a range of AI tools commonly employed by English language teaching professionals.	3.42	0.815
	16. I know how to apply AI tools, such as e-rater, Duolingo, or ChatGPT, in English language learning.	3.43	0.845
I-TPACK	17. I can utilize various AI tools to provide adaptive feedback in English language instruction.	3.55	0.773
	18. I am capable of leveraging AI tools to support personalized learning in English language education.	3.56	0.777
	19. I can implement AI tools to deliver real-time feedback during English teaching and learning activities.	3.59	0.800
	22. I am able to lead my colleagues in adopting AI tools for English classroom integration.	3.43	0.846
	23. I can choose appropriate AI tools to monitor students' learning effectively.	3.55	0.823
Ethics	25. I can assess whether AI tools operate fairly for all students in my teaching.	3.47	0.824
	26. I can interpret the rationale behind decisions made by AI tools.	3.59	0.774

In the I-TK construct, participants demonstrated moderate confidence in their knowledge and familiarity with AI tools. Item 4 (M = 3.48, SD = 0.805) and Item 5 (M = 3.36, SD = 0.793) reveal limitations in understanding and applying the technical capacities of AI tools, suggesting a need for foundational training to build their technical proficiency and confidence. For I-TPK, Item 9 (M = 3.56, SD = 0.767) indicates moderate proficiency in using AI tools to monitor students' learning progress. While this score approaches the higher end of the moderate range, it underscores the need for enhanced training in integrating AI tools with pedagogical practices to better track and assess student learning outcomes. Within the I-TCK construct, several items highlight significant gaps in participants' readiness. Item 14 (M = 3.42, SD = 0.815) and Item 16 (M = 3.43, SD = 0.845) reflect limited awareness and application of AI tools commonly used in English language teaching, such as Duolingo, ChatGPT, etc. Additionally, Items 17 (M = 3.55, SD = 0.773) and 18 (M = 3.56, SD = 0.777) indicate challenges in leveraging AI for adaptive and personalized feedback, further emphasizing the need for targeted training on advanced AI functionalities. The I-TPACK construct also reveals areas of improvement. Item 19 (M = 3.59, SD = 0.800) and Item

23 (M = 3.55, SD = 0.823) highlight moderate confidence in using AI tools for real-time feedback and monitoring student progress. Meanwhile, Item 22 (M = 3.43, SD = 0.846) points to a lack of leadership skills in promoting the integration of AI tools within teaching environments, indicating a need for training programs that focus on leadership and collaborative practices in AI integration. Finally, in the Ethics construct, Items 25 (M = 3.47, SD = 0.824) and 26 (M = 3.59, SD = 0.774) reveal moderate awareness of ethical considerations in AI use, such as ensuring fairness and understanding the decision-making processes of AI tools. These findings highlight the importance of embedding ethics-related content in training programs to prepare teachers for the responsible use of AI technologies in their classrooms.

Overall, the findings reveal several deficiencies in the I-TPACK competence of Chinese pre-service EFL teachers. Regarding I-TK, participants demonstrated limited knowledge of effectively utilizing AI tools and understanding their technical features. For I-TCK, they lacked familiarity with a range of AI tools commonly used in language learning and faced difficulties applying these tools, such as ChatGPT and Duolingo, in instructional contexts. Similarly, I-TPK revealed gaps in using AI tools to track students' progress in ELT and I-TPACK conveyed gaps in using AI tools to provide feedback, and integrate them effectively into classroom practices, including supporting colleagues in adoption. Additionally, ethical considerations posed challenges as participants struggled to assess the fairness of AI tools and interpret the rationale behind AI-driven decisions.

The Learning Needs of Chinese Pre-Service EFL Teachers in Developing I-TPACK

This section presents findings from semi-structured interviews on the learning needs of Chinese pre-service EFL teachers in developing I-TPACK competence for AI integration into ELT. Guided by Hutchinson and Waters' (1987) Learning Needs Analysis and Celik's (2023) I-TPACK framework, thematic analysis (Braun & Clarke, 2006) identified six sub-themes: I-TK, I-TPK, I-TCK, I-TPACK, Ethics needs, and learning mode preferences. These sub-themes outline teachers' requirements for AI integration, ethical awareness, and preferred learning formats. Fourteen codes under these sub-themes (see Appendix A) link the I-TPACK framework to the identified needs. The following sections detail these findings.

I-TK Needs

The analysis of I-TK needs identifies two key areas where Chinese pre-service EFL teachers require support: familiarity with AI tools and utilization of advanced AI functions. These findings highlight significant gaps in their knowledge and application of AI.

Participants demonstrated limited engagement with AI tools, with their usage restricted to basic functions. While all eight participants reported some familiarity with Chinese AI tools, such as Kimi (37.5%), Doubao (37.5%), Wenxin Yiyan (12.5%), Squirrel AI (12.5%), and Lanxin Xiaowei (12.5%), their usage remained confined to basic functionalities like translation, vocabulary learning, information retrieval, speaking practice, etc.

For instance, one participant noted that *I usually use Kimi and Doubao to some extent for English learning, like practicing speaking* (S1), while another added that *Doubao can help with learning English. It allows for direct conversations, speaking practice, and even dictation correction* (S2). Tools like Kimi and Doubao were frequently mentioned, as they provide convenience in everyday tasks. *Kimi is convenient because it directly provides links to relevant sources*, as shared by another participant (S6).

However, this familiarity often lacked depth. As one participant admitted, *I've used AI tools in English teaching only sparingly. My understanding of the technology is not deep since I haven't undergone systematic training* (S7). This highlights a pressing need for foundational training to help pre-service teachers develop confidence and competence in integrating AI tools effectively.

Beyond basic familiarity, participants recognized the potential of advanced AI functionalities but admitted limited engagement with these features. One participant shared their positive experience, stating that *Wenxin Yiyan provided detailed information, including word distinctions and usage contexts, which I couldn't easily find elsewhere* (S3).

Similarly, another noted the creative possibilities: *During my internship, we used Xiwa Interactive Whiteboard and PPT enhancement AI like Squirrel AI to refine presentations* (S8). Despite these promising applications, challenges persisted in utilizing advanced features. For example, a participant remarked that *AI struggles with promoting teacher-student interaction but works well for lesson design* (S6), while another observed that *AI lacks flexibility for personalized tasks like tailoring lessons to individual students*(S3). These limitations underscore the untapped potential of advanced AI functionalities, revealing Chinese EFL teachers' needs for advanced application of AI tools.

I-TPK Needs

The analysis of I-TPK needs outlines four critical areas where Chinese pre-service EFL teachers need assistance: AI used in instructional design, interactive activities, adaptive assignments, and personalized learning. These aspects reflect the diverse ways in which AI can support pedagogical approaches, as well as the existing challenges faced by pre-service EFL teachers in fully utilizing AI's potential.

Participants highlighted the utility of AI tools in simplifying lesson planning and material preparation. One participant explained that *During lesson preparation for simulated teaching, AI helps create an outline of the topics to cover and provides background materials. It simplifies the process, especially for supplementary content beyond the classroom* (S6). Another added that *AI tools can systematize subject knowledge, making lesson design more direct and diverse* (S4). These insights underscore AI's potential to enhance efficiency in instructional design, though its limitations in creativity and adaptability were also noted.

AI's role in fostering classroom interaction was another key area. For example, one participant used AI to facilitate student engagement: *During my teaching internship, I used AI for interactive games within PowerPoint presentations. AI facilitated mini-games to enhance student engagement* (S7). Similarly, AI's ability to create scenarios for speaking practice was valued: *AI could engage in real-time dialogue and personalized interaction, which would greatly benefit speaking activities* (S2). However, participants also emphasized the need for teacher intervention to ensure meaningful interactions.

AI's potential for adaptive assignments to individual needs was frequently mentioned. One participant shared that *Activities like encouraging students to explore topics after class. For example, assigning homework with background research using AI could work well* (S6). Another highlighted how AI could assist in identifying student progress and adapting resources accordingly: *AI could provide personalized learning based on individual progress and abilities* (S5).

Personalized learning was a recurring topic, with participants expressing interest in AI tools that cater to individual student needs. One participant remarked that *AI helps with creative*

elements and design, which I couldn't achieve on my own, allowing me to tailor lessons more specifically to my students' learning styles and preferences (S8). Another suggested, For English teaching, *For English teaching, AI could assist teachers in lesson preparation by offering videos, images, or cases related to specific topics, which would allow me to customize content to better meet the diverse needs of my students* (S5). These responses reflect how AI tools could not only support teachers in their preparation but also enhance their ability to deliver personalized learning experiences for their students.

I-TCK Needs

The analysis of I-TCK needs reveals that among various English language skills, the interviewees expressed the greatest demand for AI tools to enhance their speaking and listening abilities.

Participants recognized the value of AI in enhancing their spoken English but identified gaps in current applications. One participant noted, *AI can understand and transform my speech no matter how poorly I pronounce* (S1), emphasizing the accessibility of basic pronunciation support. Another shared, *Doubao allows for direct conversations and speaking practice, which is helpful for building fluency* (S2). Similarly, tools like Doubao and Kimi were praised for providing opportunities to simulate speaking scenarios. However, participants also pointed out that current tools lack real-time feedback on fluency and pronunciation nuances, which are critical for further improvement. One participant stated that *AI needs to enhance its support for speaking by offering more interactive and realistic conversation scenarios* (S7). So, they want to improve their English-speaking skill. One even expressed that *I hope to improve my oral English through such a course* (S1).

AI tools were also viewed as valuable resources for improving listening skills. Participants highlighted the use of podcasts and interactive dialogues to develop listening comprehension. *Resources like podcasts on Himalaya are very useful for listening practice*, said one participant (S4). Others pointed out that AI tools could assist by providing tailored audio content that aligns with individual learning needs. For instance, *AI could offer personalized listening exercises to help students improve specific aspects of their listening skills* (S5). Despite these benefits, several participants expressed concerns about the adaptability of AI tools. *AI struggles to handle regional accents and lacks the flexibility to replicate real-world conversations*, observed one participant (S3).

I-TPACK Needs

Analyzing I-TPACK needs highlights two key areas where AI integration is most desired by Chinese pre-service EFL teachers: scenario-based language learning and developing integrated teaching competence. These needs reflect the importance of combining AI technology with teaching methods and content to support innovative and effective language instruction.

Participants expressed a strong interest in learning how to effectively integrate AI with teaching methods and English content. One participant stated that *I want to know how to connect AI with teaching methods and English content effectively* (S5). This reflects a broader need for professional development in using AI as a teaching tool. Another participant highlighted the challenge of balancing technology with pedagogy, noting that *AI can support lesson planning and material creation, but teachers still need to know how to guide classroom interaction and ensure learning outcomes* (S8).

Moreover, participants recognized the importance of understanding AI's strengths and limitations to create a cohesive and integrated teaching approach. As one participant noted that *AI can support lesson planning and material creation, but teachers still need to know how to guide classroom interaction and ensure learning outcomes* (S8). Another participant emphasized that *It's essential to learn how to use AI flexibly, combining its capabilities with effective teaching methods to maximize its impact* (S6).

Ethics Needs

The analysis of ethics needs highlights two critical areas of concern among Chinese pre-service EFL teachers: awareness of ethics and bias and privacy management and data security. These aspects emphasize the necessity of fostering ethical practices to ensure the effective and responsible integration of AI into teaching.

Participants frequently emphasized the importance of addressing ethical issues, particularly fairness and transparency, in AI applications for education. One participant remarked that *Fairness and transparency are crucial for building trust between students and AI, ensuring effective integration into teaching* (S4). This sentiment was echoed by another participant who stated that *Teachers must address ethical concerns to ensure responsible and fair use of AI while fostering students' understanding of these issues* (S8). Such perspectives underscore the critical need for pre-service teachers to develop ethical awareness when integrating AI into their practices, ensuring that AI applications promote equitable outcomes.

Concerns about data privacy and security also emerged as a significant theme. One participant highlighted the need for stronger measures, stating that *Advanced identity verification and privacy management systems should be implemented to regulate data usage* (S2). Another participant shared concerns about the potential misuse of sensitive information, noting that *AI privacy policies make me reconsider the implications of using such tools in teaching* (S6). These insights reflect the need for pre-service teachers to understand and implement robust data protection measures to safeguard students' privacy and ensure compliance with ethical standards.

Learning Mode Preferences

The thematic analysis of Learning Mode Preferences reveals two distinct preferences among Chinese pre-service EFL teachers: blended learning and hands-on learning. These preferences reflect their desire for a learning approach that balances theoretical knowledge with practical application, ensuring adequate training for integrating AI into teaching. Among the eight participants, five favored blended learning, while three preferred a more practice-oriented, hands-on approach.

Blended learning, combining online and offline instruction, emerged as the preferred mode for the majority of participants (n=5). One participant explained that *Blended learning, with online sessions for theoretical knowledge and offline practice for hands-on experience, is the best approach* (S6). This preference reflects the flexibility of online resources for acquiring foundational knowledge and the effectiveness of offline sessions for engaging directly with new techniques. Another participant emphasized that *Online learning allows flexibility, but offline promotes discussion and interaction, which is essential for grasping new concepts* (S1).

Three participants favored hands-on learning through practical workshops. One noted that *Practical workshops provide hands-on experience, which is crucial for understanding how to apply AI tools in real teaching scenarios* (S3). Another added that *Workshops conducted in small*

groups or natural class settings enable better interaction and immediate feedback (S4). This approach was essential for bridging the gap between theoretical understanding and practical implementation, ensuring pre-service teachers feel confident using AI tools in the classroom.

In summary, the thematic analysis of semi-structured interviews with eight Chinese pre-service EFL teachers from four academic years revealed their learning needs in developing I-TPACK competence for AI integration into ELT, aligned with the I-TPACK framework across six key areas. I-TK needs focus on building familiarity with AI tools and understanding their advanced features. I-TPK needs emphasize the use of AI to enhance instructional design, create interactive activities, support adaptive assignments, and enable personalized learning. I-TCK needs highlight the demand for AI tools to improve speaking and listening skills through scenario-based applications. I-TPACK needs stress the integration of AI with teaching methods and English content to foster cohesive and effective teaching practices. Ethics needs center on the importance of addressing fairness, transparency, and data security concerns. Lastly, participants preferred the learning modes that combine blended learning, which balances theoretical knowledge with practical application, and hands-on workshops for experiential learning. These findings underscore the interconnected nature of their needs within the I-TPACK framework, calling for tailored training programs to help pre-service teachers effectively incorporate AI into their teaching practices.

Discussion

AI Readiness: Strengths and Deficiencies Across I-TPACK Dimensions

The quantitative results reveal that Chinese pre-service EFL teachers demonstrate a solid overall level of AI readiness with high mean scores in I-TK and I-TPK and moderate scores in I-TCK, I-TPACK, and Ethics. The high readiness in I-TK and I-TPK is consistent with Gregorio et al. (2024) and Karataş and Ataç (2024), who found strong foundational competence in these areas among pre-service teachers. However, moderate performance in I-TCK, I-TPACK, and Ethics aligns with Karataş and Ataç's (2024) observation of challenges in integrating technology with content and pedagogy. In contrast, Gregorio et al. (2024) reported higher ethical competence, suggesting regional differences in teacher training emphases. Chan and Tang (2024) similarly highlighted gaps in I-TCK and I-TPACK, attributing them to insufficient scenario-based training, which this study also identifies as a critical need. These comparisons emphasize the importance of addressing integrated competencies and ethical considerations in teacher education programs to strengthen AI readiness.

An in-depth examination of the low-scoring items across the I-TPACK dimensions highlights key deficiencies that impede the effective integration of AI into ELT, offering valuable insights into needs requiring further development. In I-TK, limited knowledge of advanced AI tools and technical features aligns with Celik (2023) and Velander et al. (2024), who emphasized the need for structured training to build foundational technical skills for AI integration. Similarly, gaps in I-TPK, particularly in using AI for adaptive assessments and personalized feedback, resonate with Gregorio et al. (2024) and Karataş and Ataç (2024), who noted the underutilization of AI's potential in designing responsive learning environments. For I-TCK, participants' lack of familiarity with tools like ChatGPT and Duolingo mirrors findings by Jang and Lee (2023) and Chan and Tang (2024), who highlighted the importance of context-specific training to bridge the gap between general AI knowledge and subject-specific applications. Deficiencies in I-TPACK, particularly in integrating AI for personalized learning and feedback delivery, reflect Celik's

(2023) call for cohesive professional development frameworks and emphasis on clear curricular guidance by Velander et al. (2024). Finally, ethical considerations, including fairness and transparency, are underdeveloped, consistent with Karataş & Ataç (2024) and Celik (2023), who stress the need for embedding ethical literacy into teacher training programs. These findings underscore the importance of tailored, scenario-based training, ethical education, and collaborative learning approaches to address the interconnected gaps in pre-service EFL teachers' I-TPACK competence.

Needs Analysis: Insights for Chinese Pre-Service EFL Teacher Education

The integration of quantitative and qualitative findings provides a comprehensive understanding of the learning needs of Chinese pre-service EFL teachers in developing I-TPACK competence for AI integration. While the quantitative analysis highlights moderate scores in I-TCK, I-TPACK, and Ethics, alongside low-scoring items across all dimensions, the qualitative thematic analysis complements these insights by uncovering specific areas requiring intervention. Together, these results reveal interconnected challenges and opportunities for targeted teacher training.

Quantitative findings reveal gaps in I-TK, particularly in knowledge of advanced AI tools and technical features, corroborated by qualitative findings emphasizing the need for familiarity with AI tools and their functionalities (Celik, 2023; Velander et al., 2024). For I-TPK, participants struggle with using AI to track and assess student progress. Qualitative insights highlight needs for enhancing instructional design, creating interactive activities, supporting adaptive assignments, and enabling personalized learning. These align with Chan and Tang (2024), who emphasize training in adaptive learning and engagement, and Hava and Babayiğit (2024), who highlight the role of I-TPACK competencies in personalized instruction. Deficiencies in I-TCK include limited familiarity with tools like ChatGPT and Duolingo. Qualitative findings further emphasize the need for AI tools to improve speaking and listening through scenario-based applications, consistent with Jang and Lee's (2023) call for contextualized training connecting general AI knowledge to subject-specific teaching. Low scores in I-TPACK, particularly in adaptive feedback, personalized learning, and collaboration, underline the need for comprehensive training. Qualitative data emphasize integrating scenario-based learning and cohesive AI-supported pedagogy, echoing Celik's (2023) and Chan and Tang's (2024) advocacy for bridging theoretical and practical AI applications. Regarding Ethics, participants expressed concerns about equity, transparency, and ethical dilemmas in AI-driven teaching. Arani (2024) highlights similar risks, including data privacy breaches and bias, emphasizing the need for guidance to ensure fairness in educational applications.

The qualitative interview also identified the learning mode preference of Chinese pre-service EFL teachers. Participants' preference for blended learning and hands-on workshops aligns with findings in prior studies. Pardede (2019) highlighted the effectiveness of blended learning in combining flexibility with enhanced technical skill development, while Yildiz Durak (2021) emphasized the importance of hands-on tasks in boosting pre-service teachers' confidence and practical application abilities. These findings echo the need for teacher training programs to integrate blended learning with experiential workshops, providing both theoretical flexibility and practical engagement. This approach can bridge gaps in EFL teacher preparation, equipping educators to implement AI tools in diverse and dynamic learning contexts effectively.

Conclusion

This study examined the current level of AI readiness and learning needs of Chinese pre-service EFL teachers in developing I-TPACK competence, integrating quantitative and qualitative findings for a comprehensive analysis. The results indicate a high level of proficiency in I-TK and I-TPK, yet reveal moderate levels in I-TCK, I-TPACK, and ethics, particularly in the integration of AI tools for adaptive learning, scenario-based applications, and addressing fairness and transparency concerns.

The needs analysis employed three complementary approaches: Present Situation Analysis, Deficiency Analysis, and Learning Needs Analysis to identify areas requiring intervention comprehensively. The findings have important implications for teacher education. They highlight the need for tailored teacher education programs to address the specific learning needs of Chinese pre-service EFL teachers. Training should enhance I-TK by building familiarity with advanced AI tools and their applications. It should also strengthen I-TPK through scenario-based modules focused on instructional design, interactive activities and personalized learning. For I-TCK, practical training in using tools like ChatGPT and Duolingo for language-specific tasks is essential. Collaborative workshops can help develop I-TPACK, supporting the integration of AI with teaching methods and English content. Moreover, the tailored teacher education program integrating ethics should address fairness, transparency, and data security concerns, fostering responsible AI use. Finally, adopting blended learning models that combine theoretical instruction with hands-on workshops can ensure a balance between conceptual knowledge and practical application, preparing teachers to effectively and ethically leverage AI in education.

This study's findings are directly relevant to the ongoing discourse on the challenges of integrating AI in ELT. As AI tools such as ChatGPT and Grammarly gain widespread adoption, educators must critically evaluate and integrate these technologies not only to enhance linguistic proficiency but also to cultivate critical thinking, uphold academic integrity, and prioritize originality amidst the proliferation of AI-generated content. The ethical use of AI in education must be a central focus, particularly in addressing issues related to plagiarism detection, academic dishonesty, and the preservation of authentic student work.

While the study contributes valuable insights into the I-TPACK development needs of Chinese pre-service EFL teachers, it also has limitations. The sample size was relatively small, consisting of only eight participants in the qualitative interviews, which may not fully capture the diversity of experiences across the broader population of pre-service teachers. Furthermore, the focus on Chinese pre-service EFL teachers may limit the generalizability of the findings to other educational contexts. Future research should expand the sample size and include cross-cultural comparisons to better understand I-TPACK development in different educational settings. Longitudinal studies could also assess the long-term impact of targeted AI training interventions on teachers' competencies and their classroom practices, especially as AI tools continue to evolve.

In conclusion, as we enter the era of AI in education, it is imperative that teacher training programs evolve to equip educators with the necessary skills and ethical frameworks to navigate the complexities of AI integration. By addressing the specific needs of pre-service teachers, particularly in the areas of I-TCK, I-TPACK, and ethics, we can ensure that AI technologies are used to enhance both teaching practices and learning outcomes in the 21st century.

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Appendix A: Coding Scheme

Theme	Sub-theme	Code
Learning needs	I-TK needs	Familiarity with AI tools
		Advanced functions of AI tools
	I-TPK needs	AI used in instructional design
		AI used to create interactive activities
		AI used in adaptive assignments
		AI used in personalized learning
	I-TCK needs	AI used to improve English speaking
		AI used to improve English listening
	I-TPACK needs	AI used in scenario-based language learning
		AI used in integrated teaching competence
	Ethics needs	Awareness of ethics and bias
		Privacy management and data security
	Learning preferences mode	Blended-learning
		Hands-on learning