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Preparing for the AI Era: AI-TPACK Levels of Pre-service English Teachers and Their Attitudes toward AI

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ABSTRACT

Background. As artificial intelligence (AI) becomes increasingly embedded in educational processes, teacher education programs must prepare future teachers to meaningfully integrate AI tools into their pedagogical practice. Despite this growing need, little is known about pre-service English teachers' AI related pedagogical competencies, or how their attitudes toward AI align with these competencies. Addressing this gap is essential for informing curriculum design and professional development. This study contributes to the emerging fields of AI integration in language teacher education. It offers timely insights into how future English language teaching (ELT) professionals perceive and use AI, an area with limited empirical evidence.

Purpose. To investigate the artificial intelligence technological pedagogical content knowledge (AI-TPACK) levels of pre-service English teachers and their attitudes toward AI and to examine whether these two constructs are meaningfully related.

Method. 244 pre-service teachers in their junior or senior year from two state universities participated in this study. The participants completed two assessment scales: the AI-TPACK and the GenAI attitude scale. The obtained data were analysed via SPSS, and additional analysis was performed in the R environment.

Results. The findings revealed that pre-service teachers in the ELT department reported relatively positive perceptions across AI-TPACK dimensions and demonstrated positive attitudes toward AI as measured by a learner-oriented GenAI attitude scale. Item-level mean scores across AI-TPACK dimensions ranged from 3.61 to 3.88, indicating relatively similar perceptions across the subdimensions. Notably, no significant relationship was identified between any of the constructs of AI-TPACK and attitudes.

Conclusion. Although pre-service English teachers demonstrated positive attitudes towards AI as a learner and relatively positive perceptions of AI-related pedagogical competence, the absence of significant relationships between these two constructs may point to a possible attitude-competence gap in AI integration. These findings suggest that favourable perceptions of AI alone may not be sufficient for the development of integrated pedagogical competence. Therefore, teacher education programs may need to provide more structured and practice-oriented opportunities for AI integration in ELT contexts.

KEYWORDS

pre-service ELT teachers; AI-TPACK; AI attitudes; teacher education programs; professional development

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INTRODUCTION

Digital technologies have developed rapidly and significantly impacted many fields, particularly education. AI integration is increasingly shaping educational processes (Miao & Holmes, 2021), enabling students to learn at their own pace, while supporting teachers in assessing student progress and designing lesson plans. With features like intelligent tutoring systems, real-time feedback, and adaptable learning pathways, AI-driven tools support personalised learning experiences.

Language instruction and learning now heavily rely on AI-driven tools and appli-

cations since they offer creative ways to improve instructional strategies. AI tools support learners to develop their language skills across reading, listening, writing, and speaking in foreign language classrooms (Hockly, 2023). For example, through customized and interesting experiences, AI-powered apps enable learners to read aloud while guiding them through accurate pronunciation, promoting reading fluency and comprehension (Hidayat, 2024). In writing, AI tools such as Grammarly provide real-time suggestions for grammar, punctuation, and style, so they increase performance (e.g., Fitria, 2021), while platforms such as Duolingo employ speech recognition technology to assess pronunciation and fluency and offer immediate, personalized feedback by providing a non-monotonous language learning environment (Fakhrurriana et al., 2024).

In addition to the positive impacts of AI observed in the four language skills, using AI in educational contexts positively influences learners' motivation and self-efficacy (Winkler & Soellner, 2018; Yıldız 2023). This positive influence transforms into positive experiences for teachers and improves the quality of their instructional practices (Chen et al., 2020). Integrating AI chatbots into instruction facilitates communication among students as they boost students' confidence and motivation in an English as a foreign language (EFL) context (Yang, 2022), while improving speaking proficiency and self-regulated learning (Wei, 2023). Moreover, teachers who found AI effective in personalizing learning and automating administrative tasks reported that AI tools led to more efficient teaching practices (Arvin et al., 2023). As ELT evolves alongside technological developments, assessing how well pre-service English teachers are equipped to integrate AI into their pedagogical practices is essential. Therefore, understanding how they perceive and engage with AI-driven tools can provide valuable insights into their readiness to embrace AI in the classroom.

A useful lens for analysing teachers' proficiency in combining technology, pedagogy, and content knowledge has been the Technological Pedagogical Content Knowledge (TPACK) framework. In order to provide a more thorough understanding of teaching in the digital age, Mishra and Koehler (2006) developed TPACK, which was built on Shulman's (1986) concept of Pedagogical Content Knowledge (PCK) by incorporating technological knowledge. Since its introduction, numerous studies have examined the use and effects of the TPACK framework in the context of ELT (e.g., Anwar et al., 2022; Taopan et al., 2020) and reported significant improvements on creating and customizing language learning materials using technology, along with an increased awareness for purposeful technology integration in language teaching (Ersanli, 2016; Kaçar, 2022).

More recently, AI has brought forth new pedagogical and epistemic issues that challenge conventional digital technologies. AI systems increasingly serve as adaptive, generative and decision-support technologies, in contrast to earlier educational technologies that were mainly concerned with communication and information delivery. These systems are capable of creating content, analysing learner data and customizing educational procedures. This shift has transformed technology from being a passive instructional tool into an active participant in the teaching-learning process. Consequently, teachers now have a bigger role to play as mediators. They have to design AI-supported learning environments, critically assess AI outputs, and deal with pedagogical and ethical concerns related to the use of AI in education (Celik, 2023). In response to these developments, the AI-TPACK framework has emerged as an extension of the TPACK framework. Rather than viewing AI simply as an additional technological tool within technological knowledge, AI-TPACK conceptualizes AI as a separate domain of knowledge. This involves understanding how AI systems operate, interpreting their outputs and effectively integrating them into teaching practices to enhance meaningful learning experiences.

It emphasizes teachers' ability to integrate AI technologies with pedagogical strategies and subject knowledge. The successful adoption of emerging technologies is influenced not only by knowledge and skills but also users' attitudes. A positive or negative attitude can significantly influence how readily people embrace AI innovations and accept emerging technologies (Iqbal et al., 2022; Venkatesh et al., 2003). Research indicates a general positive attitude toward AI regardless of learners' various backgrounds (e.g., Long & Magerko, 2020; Nyaaba et al., 2024; Zhai et al., 2021). Moreover, teachers with positive attitudes are more likely to engage with AI tools, explore their pedagogical applications, and integrate them into their lessons (Scherer et al., 2019). Studies suggest that when teachers perceive AI as practical, easy to use, and beneficial for student learning, they are likely to enhance their AI-related skills (e.g., Zawacki-Richter et al., 2019). Conversely, teachers who perceive AI as a threat are less willing to explore AI applications, which limits their technological pedagogical growth (Holmes et al., 2019).

However, recent literature reveals a gap between teachers' positive attitudes toward AI and their ability to integrate AI into their teaching in practice. While teachers are willing to use AI technologies, they often report limited pedagogical readiness or insufficient competence to apply these tools effectively in the classroom (e.g., Chounta et al., 2022; Pokrivcakova, 2023). This may suggest an attitude-competence paradox, where favourable perceptions of AI do not necessarily guarantee the pedagogical knowledge required for meaningful technology integration. Pre-service teachers, in particular, are a critical group as their beliefs, perceptions, and competencies are still developing during their teacher education programs. Investigating the relationship between AI attitudes and AI-TPACK competence may provide insights into how future language teachers conceptualize and prepare for AI-supported teaching practices. Against this background, the current study aims to examine wheth-

er learner-oriented attitudes toward AI actually correspond to higher levels of perceived AI-TPACK among pre-service English teachers.

LITERATURE REVIEW

AI in ELT and Teacher Education

AI has started to challenge conventional instructional practices in education and redefine the processes of teaching and learning in contemporary educational environments. Recent research has investigated pre-service teachers' use of Generative AI (GenAI) tools throughout their educational life. Nyaaba et al. (2024) examined how pre-service teachers used GenAI applications as a learning companion during their coursework and as a teaching assistant during their practice. Their findings revealed that these AI tools were primarily used to find academic resources, clarify complex concepts and assist with designing lessons, including identifying teaching materials, designing assessments and generating lesson objectives. A similar study by Hsu et al. (2024) investigated how pre-service primary teachers in Ireland use GenAI personally, academically, and for lesson planning. The results indicated that while personal and academic use were common, lesson planning use was limited. However, concerns about ethical issues, over-reliance on AI, potential skill loss, equity and data privacy persist. Overall, these findings suggest that while pre-service teachers are increasingly engaging with AI technologies, they hesitate to integrate these tools into pedagogy because of the concerns regarding responsible use. These patterns are not unique to international contexts; similar dynamics are observable within Turkish context.

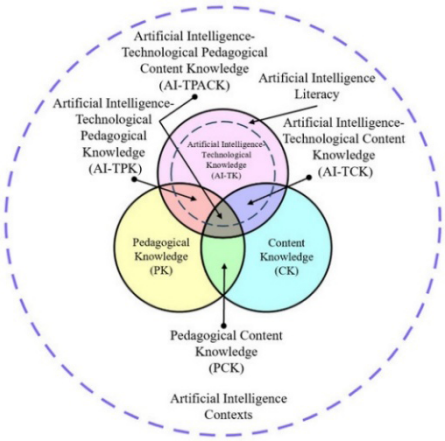
In Türkiye, the use of AI technologies in education is not a new phenomenon; efforts to integrate AI into education began around 2010 (Akdeniz & Özdinç, 2021). The Ministry of Education (MONE) and Council of Higher Education (COHE) have since launched forums and initiatives to explore the instructional benefits of AI technologies. Supported by United Nations Children's Fund (UNICEF) and funded by the European Union, MONE launched a project aimed at improving teachers' digital skills (UNICEF Türkiye, 2024). Additionally, MONE's Directorate of Innovation and Educational Technologies (YEĞİTEK) published the Policy Brief for AI in Education, emphasizing the importance of ethical AI use, personalized learning environments, and preparing students for AI-driven futures (YEĞİTEK, 2024). COHE also published the Ethics for the Use of Generative AI in Scientific Research and Publications in higher education institutions, focusing on principles such as transparency, responsibility, and academic integrity (COHE, 2024). COHE has encouraged universities to integrate AI-focused modules into existing degree programs and to create specialized undergraduate and graduate programs in AI to develop a knowledgeable workforce. However, most teacher education programs still do not offer dedicated courses on AI due to the continued use of the 2018 teacher education curriculum recommended by COHE. As a result, pre-service teachers are primarily responsible for developing their AI-TPACK competencies on their own initiative. In this context, examining pre-service teachers' AI-TPACK competence and their attitudes toward AI becomes particularly important, because they are already exposed to AI as learners through GenAI tools in their own language learning but may not yet be prepared to use AI pedagogically as future teachers responsible for instructional design and classroom practice.

AI-TPACK as a Competence Framework

As AI becomes more visible, teachers are required to possess the necessary competencies to integrate AI into their pedagogy effectively. One promising approach to developing such competencies is through the integration of TPACK with AI-literacy (Velander et al., 2024). The resulting framework, AI-TPACK, offers a structured model of the knowledge and skills that teachers can utilize to enhance classroom instruction and adapt to AI-enhanced learning environments. AI-TPACK has seven key components as shown in the Figure 1.

Figure 1

The components of AI-TPACK



Note. Adapted from Ning et al. (2024).

Content Knowledge (CK) refers to the teacher's mastery of the subjects they teach. Pedagogical Knowledge (PK) involves knowledge of pedagogical strategies, implementation, management of the classroom and assessment of students. AI-Technological Knowledge (AI-TK) is the teacher understanding and use of AI technology, specifically, awareness of AI tools and platforms, and their use in the classroom. Pedagogical Content Knowledge (PCK) means connecting pedagogy and content, essentially choosing and executing pedagogical strategies that suit the conveyance of knowledge. AI-Technological Content Knowledge (AI-TCK) refers to the use of AI to support discipline-specific learning and create more engaged, tailored educational environ-

ments. AI-Technological Pedagogical Knowledge (AI-TPK) is the understanding of how AI changes what it means to teach and learn, thereby creating new pedagogical strategies that are enhanced by AI. Finally, AI-Technological Pedagogical Content Knowledge (AI-TPACK) is the composite, accessible framework through which a teacher can blend understanding of AI with pedagogy and content knowledge to employ AI tools for discipline-specific learning effectively.

In the present study, AI-TPACK is used not simply as a descriptive model, but as the main framework for assessing how pre-service English teachers perceive their readiness to integrate AI with language content and pedagogy.

Pre-service ELT Teachers' Attitudes toward AI

Beyond teachers' practical engagement, attitudes toward technology play a crucial role in how it is integrated into instructional practices (Baylor & Ritchie, 2002) and the effectiveness of technology use in practice (Buabeng-Andoh, 2012; Kimmons & Hall, 2018; Teo et al., 2016), as teachers' beliefs significantly influence their pedagogical decisions (Pajares, 1992). In the context of AI specifically, research presents a more complex picture. For example, Cojean et al. (2023) found that teachers generally favoured traditional technologies over AI-based tools, as they had concerns about the ethical use of AI. In contrast, studies in EFL contexts have shown favourable attitudes toward AI among teachers and students. Aljohani (2021) reported that EFL teachers and students viewed AI positively in the Saudi Arabian context. Similarly, Benaicha and Semmoud (2024) found that Algerian EFL teachers acknowledged AI's benefits for personalized learning and professional development but also expressed concerns about changes in teacher roles and potential difficulties in implementing. Rapti and Panagiotidis (2024) found that Greek EFL teachers acknowledged AI's role in supporting differentiated instruction and flipped classroom models.

Studies focusing on students have revealed similar trends. For instance, Zhang et al. (2024) demonstrated that students who received explicit AI-literacy training had a better understanding of AI concepts and held more positive attitudes toward AI and its implications for their future careers. Likewise, Sebbah (2025) found that Algerian EFL students demonstrated generally positive attitudes toward the use of AI, appreciating its efficiency and the support it provides in learning processes; however, they also voiced concerns about potential over-reliance on such technologies, as well as possible adverse effects on their motivation, critical thinking abilities, and creativity. In the context of the present study, positive attitudes toward AI are theoretically relevant because they may influence willingness to engage with AI tools, but they cannot be assumed to indicate pedagogical readiness.

Attitude-Competence Gap

Positive attitudes alone may not guarantee effective pedagogical use of AI technologies. Teachers must also possess relevant content knowledge and technological skills to employ AI tools in their lessons effectively (Voogt et al., 2015). In fact, several studies have highlighted a noticeable gap between positive attitudes and actual knowledge or preparedness for AI use. Chounta et al. (2022) found that Estonian K-12 teachers recognized the educational potential of AI but had limited knowledge of AI technologies. Similarly, Alvarez-Herrero (2024) discovered that Spanish teachers lacked practical knowledge for implementing AI in their classrooms. Pokrivcakova (2023) noted that while Slovak EFL pre-service teachers held favourable attitudes toward AI in language teaching, they expressed a strong need for targeted training. These findings collectively point to the need to examine whether attitudes correspond to pedagogical competence.

Studies previously conducted to investigate the relationship between teachers' attitudes and their TPACK levels showed a general consensus pointing to a positive relationship. Overall, studies indicate that teachers with positive attitudes are more likely to provide higher ratings for their perceptions regarding TPACK (e.g., Tondeur et al., 2020; Zhang & Chen, 2022). For example, Abbitt (2011) found that pre-service teachers' development of TPACK improved their self-efficacy in technology integration after a technology-focused training course. In line with these findings, Raygan and Moradkhani (2022) identified positive correlations among teachers' TPACK, attitudes, and technology use in EFL context while Alhamid and Mohammad-Salehi (2024) reported a moderate relationship between TPACK components of Iraqi EFL teachers and their attitudes toward online teaching. Within the Turkish context, studies have also shown positive relationship between teachers' attitudes and TPACK competencies (e.g., Albayrak-Sarı et al., 2016; Ay, 2015; Kozikoğlu & Babacan, 2019).

Despite these growing insights, research on the relationship between AI-specific pedagogical competence and attitudes toward AI is still limited, especially regarding pre-service English language teachers. While earlier studies have individually explored teachers' TPACK competencies, attitudes toward technology, or AI literacy, there are few that investigate the relationship between AI-TPACK and attitudes toward AI within a unified research framework (e.g., Erol et al., 2025; Xu et al., 2025). Moreover, to date, no research has specifically examined this relationship among pre-service English teachers in the Turkish context. Taken together, the reviewed literature suggests that this relationship may be less straightforward in AI-mediated contexts than broader TPACK literature implies. Positive attitudes may not necessarily translate into the integrated pedagogical knowledge

for effective AI use in teaching. Rather than treating favourable attitudes toward AI as a direct indicator of readiness, the present study empirically examines whether positive attitudes meaningfully correspond to perceived AI-TPACK competence among pre-service English teachers through the following research questions:

RQ1: What are the AI-TPACK levels of pre-service English teachers?
RQ2: What are the pre-service English teachers' attitudes toward AI?
RQ3: Are there any relationships between pre-service English teachers' attitudes toward AI and their AI-TPACK levels?

METHOD

Participants

A total of 244 participants were recruited from third year (*N* = 117) and fourth year students (*N* = 127) studying in the ELT department in two state universities. These institutions offer four-year ELT programs designed to prepare future English teachers through a combination of linguistic, pedagogical and practicum-based courses. A convenience sampling approach was employed targeting the participants from the upper years of the program because the students have completed most of the courses specific to the field (e.g., Instructional Technologies, Approaches to English Language Learning and Teaching, English Language Curricula, Teaching English Language Skills, Syllabus Design in ELT) and have begun developing lesson plans, designing instructional materials and presenting teaching demonstrations, which makes them more capable of reflecting on technology and AI integration in language teaching. Participants were recruited through announcements made in relevant courses with the collaboration of the course instructors. Participation was voluntary and all students who were present during the data collection sessions were invited to take part. A total of 244 pre-service English teachers agreed to participate. The average age of the participants was 22, consisting of 103 males and 141 females.

Data Collection Tools

This study gathered data using the AI-TPACK scale and AI attitude scale. The AI-TPACK scale was employed to investigate the AI-TPACK levels of pre-service English teachers. This scale, developed by Ning et al. (2024) and adapted to Turkish by Canbazoğlu et al. (2024), uses a five-point Likert format (from 1-strongly disagree to 5-strongly agree) and consists of 39 items across seven subdimensions: CK, PK, AI-TK, PCK, AI-TCK, AI-TPK, and AI-TPACK. Higher scores indicate greater competence in integrating AI into teaching and learning process. The Cronbach Alpha values for each dimension (CK = 0.72, PK = 0.80, AI-TK = 0.88, PCK = 0.77, AI-TCK = 0.92, AI-TPK = 0.89, and AI-TPACK = 0.84) were above the threshold of 0.70, meaning a satisfactory level of internal reliability for the scale constructs. Sample items from each dimension are: (CK) *"I possess a strong understanding of the concepts and principles within my discipline"*. (PK) *"I am capable of using a variety of diverse teaching methods in the classroom"*. (AI-TK) *"I am familiar with commonly encountered AI technologies in the educational environment"*. (PCK) *"I am proficient at formulating curriculum plans with ease"*. (AI-TCK) *"I am capable of effortlessly using AI in specific academic domains"*. (AI-TPK) *"I am capable of using AI to enhance my pedagogical perspectives"*. (AI-TPACK) *"I am knowledgeable in integrating AI with educational content and teaching methods to improve classroom teaching efficiency and effectiveness"*. Because the AI-TPACK subscales consisted of different number of items, item-level means were calculated to enable meaningful comparisons across dimensions. Item-level means above the midpoint of the Likert scale (3.00) were interpreted as indicating relatively positive perceived competence.

The GenAI Attitudes Scale, also in a five-point Likert format (from 1-strongly disagree to 5-strongly agree), was utilized to assess participants' attitudes toward AI. It was developed by Orhan et al. (2024) and included 33 items in total. The Cronbach alpha value of the scale was 0.96, suggesting an excellent level of internal reliability. An example item from the scale is as follows: *"The activities offered by GenAI encourage me to practice English"*. Although the scale captures attitudes toward GenAI use, it primarily reflects participants' own experiences as learners in language learning contexts, rather than measuring teacher-oriented attitudes toward the pedagogical use of AI in instructional settings.

Data Collection Process

After obtaining ethical approval from university ethics boards (E-10042736-659-1354477, E-35950415-605-94624), the participants received consent forms and participated in the study voluntarily. They were informed that all information would remain confidential. The scales were administered in the participants' native language to prevent interruptions caused by language barriers. Data were collected face-to-face, and the overall process lasted approximately 30 minutes.

Data Analysis

The data collected from 244 pre-service English teachers were analysed using IBM SPSS Statistics (version 28) and R (version 4.3.1) to explore their attitudes toward AI and their perceived competence across the components of the AI-TPACK framework. The analysis process consisted of descriptive statistics, assumption checks, and Spearman's rho correlation analysis.

Ethics

This study was approved by the Social and Human Sciences Scientific Research and Publication Ethics Committees of two universities. All participants were informed about the purpose and procedures of the study, their right to withdraw from participation at any time, and their voluntary participation was ensured. Written informed consent was obtained from all participants.

RESULTS

Pre-Service English Teachers' AI-TPACK Levels and Their Attitudes toward AI

Descriptive statistics were computed to summarize the pre-service English teachers' self-reported scores across seven dimensions of the AI-TPACK framework. These dimensions represent their pedagogical knowledge and competence in integrating AI with pedagogical and content knowledge in ELT. The following table presents statistical analysis for each subscale:

The participants reported relatively positive self-perceptions across all AI-TPACK dimensions. The item-level means ranged from 3.61 to 3.88. The highest item-level mean scores were observed in PK (*M* = 3.88) and AI-TCK (*M* = 3.87), while CK demonstrated the comparatively lowest mean score (*M* = 3.61). The remaining dimensions also showed relatively similar scores, including AI-TK (*M* = 3.84), PCK (*M* = 3.81), AI-TPACK (*M* = 3.79), and AI-TPK (*M* = 3.75).

Regarding pre-service English teachers' attitudes, the mean attitude score was 128.51 (*SD* = 22.01), with values ranging from 33 to 165, indicating scores above the scale midpoint across the sample. Most skewness and kurtosis values were within an acceptable range as recommended by Tabachnick and Fidell (2007); however, some deviations from normality were observed, which further supported the use of Spearman's rho.

The Relationship between AI-TPACK Levels of Pre-Service English Teachers and Their Attitudes toward AI

The analysis began with an examination of missing data, revealing that there were no missing responses for any of the variables included. Standardized z-scores were examined to identify potential outliers, and a small number of extreme observations were identified; however, these cases were retained in the analysis due to the large sample size and the robustness of the selected statistical procedures. The assumptions of normality and linearity were then assessed. To evaluate the normality of the dataset, histogram plots with kernel density overlays were generated for all key variables, including attitudes toward AI and the seven components of AI-TPACK. Although many kurtosis and skewness values fell within acceptable ranges, some deviations from normality and the presence of extreme values in the distribution were considered a factor that undermines normality. To further examine the assumption of linearity, scatterplots were generated. The distributions did not demonstrate clear linear relationships between attitudes toward AI and the AI-TPACK components, indicating that the assumptions required for Pearson correlation were not fully met.

Given the violations of both normality and linearity assumptions and the ordinal nature of Likert scale data, Spearman's rank order correlation (Spearman's rho) was used to examine the relationship between variables. The results indicated that the relationship between attitudes toward AI and each

Table 1

Descriptive Analysis of AI-TPACK Scale and Attitude Scale

Variable	N	Mean	Item-Level Mean	SD	Min	Max	Skewness	Kurtosis
CK	244	18.06	3.61	2.74	11	25	-0.04	-0.22
PK	244	23.30	3.88	3.54	7	30	-0.64	1.59
AI-TK	244	19.22	3.84	4.11	8	25	-0.50	-0.52
PCK	244	22.83	3.81	3.45	8	30	-0.40	1.33
AI-TCK	244	23.21	3.87	4.86	8	30	-0.62	0.02
AI-TPK	244	22.52	3.75	4.64	7	30	-0.46	-0.01
AI-TPACK	244	18.95	3.79	3.74	5	25	-0.67	0.67
Attitude	244	128.51	3.89	22.01	33	165	-1.07	2.16

*Note. *SD = Standard Deviation. *Mean = summed raw score; Item-Level Mean = summed score divided by number of items in each subscale.*

of the AI-TPACK components were very small (ρ ranging from -.033 to .083) and not statistically significant ($p > .05$), suggesting negligible effect sizes as shown in Table 2.

The highest observed correlation was between attitudes and AI-TPACK ($\rho = .083$, $p = .195$); however, this relationship was weak and not statistically significant. Importantly, the magnitude of all correlation coefficients was close to zero. Given the relatively large sample size, this pattern is theoretically informative, suggesting that these findings are consistent with negligible associations between attitudes toward AI and AI-TPACK components at the level measured in this study. Furthermore, the 95% confidence intervals for all correlation coefficients included zero and were narrowly centred around zero, reinforcing the conclusion that the observed relationships are negligible in practical terms.

DISCUSSION

The current study investigated the AI-TPACK levels of pre-service English teachers at two state universities in Türkiye and their attitudes toward AI use. It aimed to explore the relationship between these two constructs. Given the non-linear relationships observed in the data, Spearman's rho correlation analysis was employed to identify potential patterns or links between them. The results indicated that participants reported relatively positive perceptions for all AI-TPACK domains. When item-level means were considered, participants reported relatively similar perceptions across all AI-TPACK dimensions. Comparatively lowest scores were observed in CK, whereas PK and AI-TCK demonstrated relatively higher item-level mean scores. However, these differences were small, suggesting that participants perceived themselves as moderately competent across multiple dimensions of AI-related pedagogical knowledge. As these findings are based on self-reported perceptions rather than objective measures of competence, and rely solely on quantitative data, potentially overlooking the deeper insights that can be obtained through qualitative approaches, they should be interpreted with caution. The relatively close item-level mean scores across dimensions may indicate that pre-service English teachers do not perceive substantial differences among the various components of AI-related pedagogical knowledge.

Another focus of the study concerned pre-service teachers' attitudes toward AI. Consistent with existing literature (e.g., Aljohani, 2021; Benaicha & Semmoud, 2024; Rapti & Panagiotidis, 2024), the results of this study revealed participants' positive attitudes toward AI use in their learning practices. However, a key finding of this study is the absence of a statistically significant correlation between any components of AI-TPACK and attitudes toward AI. Importantly, this result should not be interpreted as a simple lack of association. As mentioned in the results, the observed correlation coefficients were very small, and the confidence intervals were narrowly centred around zero. This pattern is consistent with negligible associations between the constructs at the level measured in this study and is unlikely to reflect a limitation of statistical power alone. Although literature investigating the relationship between teachers' attitudes and TPACK levels suggests that teachers with positive attitudes are likely to rate their TPACK perceptions higher (e.g., Raygan & Moradkhani, 2022; Tondeur et al., 2020; Zhang & Chen, 2022), the present findings suggest that this relationship may not be as straightforward in the context of AI integration, indicating that favourable dispositions toward AI may not necessarily transform into the complex knowledge structures required for pedagogical use. This may suggest a possible disjunction between pre-service English teachers' attitudes toward AI as a learner and their knowledge of how to integrate it pedagogically, which represents this study's central contribution.

One possible explanation for this pattern lies in a conceptual and measurement level distinction between the constructs assessed. Specifically, the AI-TPACK scale captures participants' perceived pedagogical competence in integrating AI into teaching. In contrast, the attitude scale employed in

Table 2

Spearman's rho Correlations between AI Attitudes and AI-TPACK Subscales

Variable	ρ	p	95% CI
CK	.057	.378	[-.07, .18]
PK	-.014	.831	[-.14, .11]
AI-TK	-.033	.603	[-.16, .10]
PCK	.070	.278	[-.06, .20]
AI-TCK	.027	.672	[-.10, .16]
AI-TPK	.015	.821	[-.11, .14]
AI-TPACK	.083	.195	[-.04, .21]

Note. ρ = Spearman's rho; N = 244.

this study does not directly measure attitudes toward AI as a teacher in instructional design or classroom practice; rather, it predominantly reflects learner-oriented experiences with GenAI in language learning contexts. The scale is largely grounded in a conceptualization of AI as a learning support tool, emphasizing engagement, motivation and perceived usefulness for language learning. While this distinction introduces limitations, it may also reflect a realistic separation between experiencing AI as a learner and applying it pedagogically as a teacher. In addition, this distinction suggests that although these two constructs are related at a broader conceptual level, they may operate at different levels of professional cognition. Therefore, this conceptual misalignment between variables may be a key factor contributing to the non-significant correlations observed in this study. At the same time, this interpretation does not necessarily mean that attitudes are irrelevant for technology integration. Rather, it may imply that reporting positive attitudes toward AI and feeling comfortable using it in learning contexts do not necessarily correspond to pre-service English teachers' ability to integrate it effectively into pedagogical practice. According to earlier studies (Tondeur et al., 2017; Voogt et al., 2015), positive attitudes toward technology do not always lead to successful pedagogical integration. Instead, such integration usually develops through institutional support, structured training and hands-on teaching experience. Taken together, these findings may point to a broader issue in AI integration within teacher education, a potential attitude-competence gap. In this sense, the current study may go beyond reporting non-significant correlations and suggest a possible disjunction between favourable dispositions toward AI and the more demanding, integrated knowledge base required for AI-supported teaching.

The limited range of participants' attitudes could be another explanation. Most participants expressed relatively positive attitudes toward AI, which decreased score variability and reduced the likelihood of finding statistically significant correlations. Even when there is a conceptual relationship, correlation coefficients may appear weaker when responses cluster within a small range (Cohen et al., 2013). Similar findings have been noted in studies on teachers' technology acceptance as generally positive attitudes toward digital technologies have been shown to reduce response variability and weaken correlations with competence-related constructs (Scherer et al., 2019).

The reliance on self-reported data for both AI-TPACK and attitudes toward AI could also be a contributing factor. Self-assessments by participants may not accurately reflect their true attitudes or competencies. The prevalence of social desirability bias in self-reported data could explain the lack of significant correlations observed in this study (Nederhof, 1985). Researchers could also expand the analysis of AI-TPACK by examining how elements like teaching experience or access to AI resources affect the interaction between attitudes and competence. In addition, as the sample was limited to pre-service English teachers from two state universities in Türkiye, the generalizability of the findings to broader populations may be limited. Future studies could include more objective criteria, such as task-based assessments or classroom observations alongside the views of pre-service English teachers from various institutions, to better clarify the relationship between these two constructs.

For teacher education programs in Türkiye, the current study may provide some preliminary insights. Türkiye started implementing a new educational model in 2024 (MONE, 2024). The goal of this approach is to raise students who are holistically developed. It prioritizes the elements such as well-being, sustainability, and digital competence. In a similar vein, a recent ELT program emphasizes the significance of deliberate technology integration, particularly in light of quickly developing digital tools like AI. Although current findings cannot directly assess the effectiveness of specific training practices, they may suggest the need for structured opportunities for pre-service teachers to engage with AI tools in meaningful pedagogical contexts (Čipková et al., 2024). Previous studies indicate that teacher education programs can enhance technological knowledge through strategies such as modelling technology use, reflective practice, and collaborative learning environments (Baran et al., 2019), which have been associated with reduced anxiety and greater readiness for classroom practice. However, additional empirical research is necessary to better understand how these experiences contribute to the development of AI-related teaching competencies.

CONCLUSION

This study adds to the growing body of research on AI-related teacher competency, by analysing the relationship between the AI-TPACK levels of pre-service English teachers and their attitudes toward AI in Türkiye. The findings, based on self-reported data, point to a possible discrepancy between pre-service ELT teachers' positive attitudes toward AI, as captured by a learner-oriented GenAI attitude scale, and their perceived readiness to integrate it into their teaching. This outcome may suggest that the integration of AI into teacher education may be influenced by factors beyond self-reported data, such as institutional support, practical experience, or contextual variables within educational settings. This study offers preliminary insights into this relationship within a relatively underexplored area of ELT. The findings point to the need for further research employing longitudinal designs, performance-based measures and more closely aligned constructs to better understand how AI-TPACK and attitudes toward AI interact and evolve over time.

DATA AVAILABILITY STATEMENT

Supplementary materials and the data that support the findings of this study are available from the corresponding author upon request.

DECLARATION OF COMPETING INTEREST

None declared.

AUTHORS' CONTRIBUTIONS

Gülsah Külekci: conceptualization; writing- review and editing; methodology; formal analysis; writing-review and editing.

Ebru Kiziltas: conceptualization; writing – original draft; methodology; formal analysis; writing- original draft.

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