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An exploration of Turkish EFL pre-service Teachers' perceptions on the integration of generative AI in English language Teacher Education: benefits, challenges, and future directions

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Abstract

This study explores the perceptions of pre-service English as a Foreign Language (EFL) teachers in Türkiye regarding the integration of generative artificial intelligence (GenAI) into English language teacher education. Employing a quantitative research design, data were collected from 150 pre-service teachers (PSTs) to examine their awareness of AI technologies, perceived impacts on language learning, and acceptance of AI as a pedagogical tool. The findings provide a nuanced understanding of how pre-service teachers engage with AI in educational contexts and emphasise the need for thoughtful pedagogical integration of GenAI tools in teacher education programs. The study highlights the importance of structured, reflective initial teacher education that addresses both the technological affordances and ethical implications of AI use in the classroom. The study also underlines the gender equity in AI adoption, reinforcing that both male and female PSTs share similar levels of engagement with AI technologies. Additionally, results indicate gender parity in AI engagement, suggesting equitable adoption across male and female participants. This research contributes to the growing body of literature advocating for inclusive and responsible technology integration in education.

Keywords: English pre-service teachers, Generative AI, Artificial intelligence in education (AIEd), English language teacher education

Introduction

The rapid emergence of GenAI tools, such as ChatGPT and Gemini, has transformed multiple sectors, with education being among the most significantly affected. In the field of English language teaching (ELT), GenAI technologies have demonstrated considerable potential to support a range of instructional and learning-related tasks, including grammar correction, lesson planning, and feedback generation (Chung & Jeong, 2024; Liu et al., 2024). As a result, the integration of GenAI into initial teacher education (ITE) programs, particularly in English language teacher preparation, has

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become an increasingly pressing concern for curriculum designers, teacher educators, and policymakers (Moorhouse & Kohnke, 2024).

Despite growing scholarly and institutional interest, important gaps remain in understanding how PSTs perceive, experience, and engage with GenAI in pedagogically meaningful ways. Although PSTs often express positive attitudes towards the affordances of GenAI (Guan et al., 2025; Özer-Altınkaya & Yetkin, 2025), empirical evidence suggests that their actual preparedness to use these tools effectively in classroom settings remains limited. Research across diverse settings, including Portugal, Spain, and Hong Kong, indicates that PSTs often engage with GenAI in instrumental and task-oriented ways, with limited opportunities for critical reflection or ethical understanding (Guan et al., 2025; Lucas et al., 2025). Moreover, teacher education programs have been often criticized for insufficiently addressing the pedagogical, ethical, and reflective dimensions of AI integration, resulting in fragmented and uneven preparation of AI-rich teaching environments (Dimas et al., 2025; Moorhouse & Kohnke, 2024).

Beyond pedagogical preparedness, studies also highlight the role of psychological and behavioural factors in shaping PSTs' engagement with GenAI. Variables such as perceived usefulness, self-efficacy, trust, and innovation consciousness have been shown to influence teachers' willingness to adopt emerging technologies (Nissim & Simon, 2025; Sun et al., 2025). At the same time, the influence of demographic characteristics, particularly gender, on GenAI engagement remains underexplored and inconsistently reported, pointing to the need for more systematic investigation using robust measurement approaches.

Against this backdrop, the present study aims to address these gaps by investigating pre-service English language teachers' engagement with GenAI tools in the Turkish ITE context. Specifically, it seeks to (1) assess PSTs' levels of familiarity with GenAI, perceptions of language learning through AI, and acceptance of AI as an instructional resource; (2) evaluate the validity of a proposed three-factor model comprising familiarity, language acquisition, and acceptance; and (3) examine the model's measurement invariance across gender groups. By employing a multidimensional questionnaire and applying both descriptive and inferential statistical analyses, this study offers a comprehensive and contextually grounded account of how PSTs engage with GenAI technologies in Türkiye. By providing empirical evidence from an underrepresented educational context and adopting a multidimensional analytical lens, this research contributes to the growing literature on responsible and pedagogically informed AI integration in teacher education. In doing so, it highlights the importance of moving beyond purely instrumental uses of GenAI toward a more holistic approach that balances technological competence with critical awareness and ethical consideration in English language teacher education.

Literature review

Generative artificial intelligence and initial teacher education

The rapid integration of GenAI tools into educational contexts has intensified scholarly interest in their implications in ITE, particularly within ELT contexts. Tools such as ChatGPT and Gemini have been widely discussed for their potential to support instructional tasks including grammar correction, feedback generation, and lesson planning. Despite this growing interest, the literature consistently points to a disconnect between

the accelerating development of GenAI tools and the pedagogical and ethical preparedness of teacher education programs.

A prominent strand of research highlights the uneven readiness and largely superficial engagement of pre-service teachers (PSTs) with GenAI tools. Lucas et al. (2025) found that PSTs in Portugal and Spain reported limited exposure to GenAI during their training and tend to engage with these tools in instrumental, task-oriented ways rather than through reflective or pedagogically grounded practices. Guan et al. (2025) identified a superficial level of interaction with AI tools among PSTs in Hong Kong, suggesting that their use was often task-oriented and instrumental, lacking reflective or critical engagement. Similar patterns have been reported in the Turkish context where PSTs express generally positive attitudes toward GenAI but lack opportunities to develop practical competence and critical awareness (Özer-Altınkaya & Yetkin, 2025). Collectively, these findings suggest that access to AI technologies alone is insufficient; meaningful integration requires structured pedagogical support within ITE curricula.

Closely related to issues of preparedness are concerns about curriculum design and pedagogical scaffolding in GenAI-rich teacher education. Moorhouse and Kohnke (2024) contend that current ITE programs seldom offer systematic or critical approaches to AI integration, limiting PSTs' ability to make informed decisions about its use. Their call for redesigning teacher education, including course content, assessment methods, and reflective practice, is echoed by Dimas et al. (2025) and Kalenda et al. (2025), who show that PSTs often struggle to align AI-generated outputs with curricular goals and learner needs. This suggests a lack of scaffolding in developing AI pedagogical literacy, which encompasses not only technical skills but also the ability to evaluate, adapt, and ethically implement AI tools in real classrooms.

Alongside pedagogical concerns, the literature documents perceived benefits and constraints of GenAI for language learning. Studies from contexts such as China and the United States indicate that PSTs value GenAI tools for supporting writing, vocabulary development, and lesson design (Butler & Jiang, 2025; Liu et al., 2024). Abbasi et al. (2024) emphasize GenAI's capacity to personalize learning and reduce performance anxiety, particularly in low-stakes environments. However, these benefits appear unevenly distributed across language skills. While receptive and written language skills are frequently reported as well supported, productive skills such as speaking and critical thinking receive less consistent support from current GenAI applications (Chung & Jeong, 2024). This raises critical questions about the extent to which GenAI promotes a holistic language development or reinforces a narrow focus on easily automatable tasks.

A further body of research examines psychosocial and behavioural factors affecting PSTs' GenAI adoption. Drawing on models such as the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT2), studies identify variables including AI self-efficacy, perceived usefulness, trust, and innovation consciousness as significant predictors of intention to use GenAI in educational contexts (Hu et al., 2025; Nissim & Simon, 2025; Sun et al., 2025). These findings highlight the importance of addressing not only technical competence but also affective and ethical dimensions of AI-focused teacher education. Informed by these models, the present study conceptualises acceptance of GenAI not merely as tool usage, but as a multidimensional construct shaped by perceived usefulness, confidence, and willingness

to integrate AI into pedagogical practice. This conceptualisation directly informed the interpretation of results.

Overall, the literature portrays a fragmented landscape in which GenAI is widely recognised for its potential yet insufficiently embedded within coherent pedagogical and ethical frameworks in ITE. Most existing studies focus on isolated dimensions of GenAI engagement such as technical skills, attitudes or specific applications, without offering an integrated view of how PSTs negotiate GenAI across cognitive, affective, and institutional domains. This fermentation highlights the need for more comprehensive, context-sensitive research that can inform responsible and pedagogically grounded integration of GenAI in English language teacher education.

The present study

While the expanding literature on GenAI in ITE has enhanced understanding of PSTs' readiness, perceptions, and usage patterns, several critical gaps remain. First, existing studies adopt a fragmented analytical approach, focusing on isolated variables such as self-efficacy, lesson planning, or ethical awareness, without sufficiently capturing the complex, multi-dimensional nature of GenAI engagement that spans cognitive, pedagogical, and affective domains. Second, the geographical concentration of existing research in contexts such as China, Hong Kong, and the United States has resulted in a regionally skewed evidence base, leaving underrepresented contexts such as Türkiye, comparatively unexplored despite the global diffusion of AI technologies. Third, methodological limitations persist, with many studies relying on small-scale qualitative inquiries or narrowly framed quantitative designs, thereby constraining the generalizability and integrative potential of findings.

This present study addresses these gaps by offering a large-scale, multi-dimensional exploration of pre-service English language teachers' engagement with GenAI tools in the Turkish ITE context. Data were collected using a multi-dimensional questionnaire designed to capture three interrelated dimensions of GenAI engagement: (1) participants' self-reported familiarity and understanding of GenAI, (2) their perceived benefits and limitations of GenAI for language acquisition (e.g., vocabulary, writing, grammar, speaking), and (3) their acceptance of GenAI integration in language teaching. By integrating both cognitive and affective dimensions, this study seeks to present a more holistic and contextually grounded portrait of future English language teachers' engagement with emerging AI technologies.

In line with recent calls for more critical and ethically informed engagement with AI in education, this research moves beyond instrumentalist perspectives that frame GenAI solely as a technological aid. Instead, it considers the broader implications of GenAI for teacher identity, instructional design, and learner-centred pedagogy. By providing empirical evidence from a relatively underexplored educational context and examining the validity of a three-factor measurement model, the study contributes to a more realistic understanding of GenAI integration in English language teacher education. The findings aim to inform curriculum designers, teacher educators, and policymakers seeking to develop responsive and future-ready ITE programs in the age of AI. Accordingly, the study addresses the following research questions:

Table 1 Genders of the participants

Gender	Frequency (n = 150)	Percentage (%)
Male	54	36
Female	96	64

Table 2 Ages of the participants

Age	Frequency (n = 150)	Percentage (%)
Under 18	1	1
18–25	147	98
26–35	–	
35-above	2	1

1. What are the levels of familiarity with AI, language acquisition through AI, and acceptance of AI among the participants?
2. Does the proposed three-factor model (familiarity, language acquisition, and acceptance of AI) demonstrate a good fit to the data?
3. Is the measurement model invariant across gender groups at the configural, metric, and scalar levels?

Methodology

Participants and context

This research used a quantitative approach to examine how English PSTs in a Turkish university view the use of GenAI tools in their classes. The questionnaire was adopted by the previous study by Chung and Jeong (2024), containing 18 Likert statements focused on three main themes: familiarity with GenAI tools in the academic context, GenAI tools and their relation to language acquisition and acceptance of GenAI tools in an academic context.

Participation relied on voluntary convenience sampling, with an online questionnaire distributed to all students enrolled in the English Language Teaching department. Although the study did not use probabilistic random sampling, this approach enabled broad participation across gender and year of study. The online version of the questionnaire was created using Google Forms and distributed to all students majoring in the English Language Teaching department at a state university in Türkiye, resulting in 150 English PSTs completing the survey. The demographic information of the participants is presented below:

As shown in Table 1, the sample consisted of 54 (36%) males and 96 (64%) females.

Regarding the age profile of the participants, Table 2 demonstrates that out of the 150 EFL pre-service teachers who responded to the online questionnaire, 1 participant was 17 years old, 147 were between 18 and 25 years old, 1 was 38 years old, and 1 was 48 years old.

Table 3 Years of study of the participants

Year of study	Frequency (n = 150)	Percentage (%)
1st year	50	33
2nd year	44	29
3rd year	41	27
4th year	15	10

Table 4 Familiarity with GenAI tools

Have you used GenAI tools (such as ChatGPT, Gemini, Perplexity AI, Otter.ai, and others) for your studies before?	Frequency (n = 150)	Percentage (%)
Yes	147	98
No	3	2

Regarding the participants' year of study, Table 3 shows that of the 150 EFL pre-service teachers who completed the online questionnaire, 36 were first-year students, 44 were second-year students, 41 were third-year students, and 29 were fourth-year students.

As shown in Table 4, regarding familiarity with GenAI tools, 147 participants (98%) reported being familiar with them, whereas only 3 participants (2%) indicated a lack of familiarity.

This study was conducted in the ELT department of a state university located in western Türkiye. Undergraduate ELT programs in Türkiye are four-year degrees, typically offered through faculties of education, and are structured according to a nationally standardized curriculum determined by the Council of Higher Education. These programs integrate theoretical coursework with practical experience, covering areas such as linguistics, second language acquisition, teaching methodology, instructional technologies, assessment, and classroom management. Although there is an increasing emphasis on technology integration, the incorporation of digital and AI literacy remains inconsistent across institutions. The centralized nature of the curriculum often constrains its responsiveness and adaptability to rapidly emerging innovations such as GenAI. As GenAI begins to reshape educational practices globally, examining the perceptions of pre-service ELT teachers in Türkiye has become both timely and essential. The ELT PSTs are in the formative stages of their professional development and are poised to enter classrooms increasingly shaped by AI-driven tools and pedagogies. However, existing research in the Turkish context has largely overlooked this cohort, with a predominant focus on in-service teachers or broader trends in educational technology use. In response to evolving digital demands, the university where this study was conducted has recently launched initiatives, including professional development workshops and institutional policies, to support the integration of AI into teaching and learning practices. These efforts target not only students but also academic and administrative personnel, reflecting growing institutional awareness of the transformative potential of AI. Within this shifting landscape, gaining insight into

how pre-service teachers engage with GenAI is critical for evaluating their preparedness and for informing the future direction of ELT teacher education in Türkiye.

Data collection process

The instrument used in this study was adopted from Chung and Jeong (2024) after obtaining the researchers' approval. The decision to adopt and adapt an existing questionnaire was driven by two main reasons. First, as noted by Punch and Oancea (2014), creating an instrument from scratch demands significant time, effort, and resources; therefore, utilizing existing materials relevant to the study's aims and context is both efficient and practical. Second, employing the same instrument for a central variable enables researchers to compare, integrate, and synthesize results across different studies, which, while not the primary goal of this research, may benefit future investigations.

The questionnaire was originally developed and administered in English in the source study; therefore, no translation was required for the present research. Given that English is the language of instruction in the ELT programme, the instrument was considered linguistically appropriate for the target population. Prior to full administration, the questionnaire was reviewed for clarity and contextual relevance, and it was tested on a small scale with two pre-service English language teachers. This preliminary testing led to minor typographical corrections but did not result in substantive changes to item content. During the data collection period, participants were also able to seek clarification regarding item wording, ensuring accurate interpretation of the statements.

The study explores three key dimensions: familiarity with GenAI tools in academic settings, the impact of these tools on language acquisition, and the acceptance of GenAI as a legitimate educational resource. These aspects are crucial for understanding pre-service teachers' (PSTs) confidence and willingness to engage with technology, which shapes their overall perception of its utility in the classroom. The questionnaire consists of 18 Likert-scale statements, evaluating these dimensions on a 5-point scale, where higher scores reflect a more positive perception of GenAI tools, such as ChatGPT, for academic use.

Administered via Google Forms, the self-administered questionnaire benefits from a faster response rate, fewer unanswered questions, and an appealing format (Bryman, 2016). The Google Forms platform allowed the researcher to mark items as "required," ensuring that all participants answered every question. The questionnaire's initial page provided participant information, followed by a consent form on the second page, with demographic information collected on the third page. Participants were given 10 days to complete the questionnaire, with a reminder email sent two days before the deadline.

Data analysis

The data analysis was carried out in three main stages, following established practices in educational and psychological measurement research. First, descriptive statistics, including means and standard deviations, were calculated to summarize participants' responses across all observed variables. This step provided an initial overview of the data distribution and central tendencies (Tabachnick & Fidell, 2019).

Second, a confirmatory factor analysis (CFA) was conducted to test the hypothesized three-factor structure: *Familiarity with GenAI*, *Language Acquisition Support*, and

Acceptance of GenAI in Teaching. The CFA was performed using the maximum likelihood (ML) estimation method. Model fit was evaluated using multiple indices, including the Comparative Fit Index (CFI; Bentler, 1990), Tucker-Lewis Index (TLI; Tucker & Lewis, 1973), Root Mean Square Error of Approximation (RMSEA; Browne et al., 1993), and the Standardized Root Mean Square Residual (SRMR; Hu & Bentler, 1999). Acceptable model fit was considered based on widely recommended cut-off criteria (e.g., CFI and TLI $\geq .90$, RMSEA $\leq .08$, SRMR $\leq .08$). Third, measurement invariance testing across gender was conducted to examine whether the factor structure, loadings, and intercepts were equivalent for male and female participants as the same strategy. A hierarchical approach was employed by testing configural invariance (same factor structure across groups), metric invariance (equal factor loadings), and scalar invariance (equal factor loadings and intercepts) (Milfont & Fischer, 2010). Changes in model fit indices, especially ΔCFI and ΔRMSEA, and chi-square difference tests were used to evaluate invariance (Chen, 2007). Measurement invariance ensures that meaningful comparisons can be made between groups without bias. All analyses were performed using R software (R Core Team, 2023) with the lavaan package (Rosseel, 2012).

Findings

The authors conducted a survey to gather the perceptions of 150 English PSTs regarding the use of GenAI in English language teaching. The survey results were organized into three sections to analyse the pre-service EFL teachers' views on different aspects of GenAI tools, namely, *familiarity with GenAI in the academic context*, *the relationship between GenAI and language acquisition*, and *the acceptance of GenAI in academic settings*.

RQ1. Descriptive Statistics

To assess PSTs' familiarity with GenAI, the survey results were analysed and presented in Table 5.

Table 5 presents participants' familiarity with GenAI in the academic context, summarizing mean (*M*) and standard deviation (*S*) scores across six items. Overall, the results indicate that participants somewhat to strongly agreed with statements about their familiarity and understanding of GenAI in education. Mean scores clustered slightly above *3.00* on a *0–4* scale, suggesting generally positive perceptions.

Table 5 Familiarity with GenAI in the academic context

No	No question	M	S
1	I am familiar with generative AI applications that can be used in an academic context, such as ChatGPT, Perplexity AI, Otter.ai, and others	3.01	0.95
2	I understand the basic concept of generative AI ChatGPT in the context of teaching and learning	3.15	0.97
3	I understand how generative AI works in responding to its users	3.01	0.94
4	I use generative AI for teaching purposes, such as creating Lesson Plans, practice questions, or giving feedback on student work	2.98	1.17
5	I need to improve my knowledge and understanding of generative AI academically	2.81	1.14
6	I strongly recognize the importance of integrating generative AI into the current education curriculum, and I am eager to learn more about how to do so effectively	3.14	0.99

Participants reported the highest mean scores for understanding the basic concepts of GenAI in teaching and learning (*M = 3.15, SD = 0.97*) and for recognising the importance of integrating AI into curricula (*M = 3.14, SD = 0.99).* Slightly lower but still positive mean scores were observed for reported familiarity with commonly used GenAI tools such as ChatGPT and Otter.ai (*M = 3.01, SD = 0.95*) and for understanding how GenAI systems operates (*M = 3.01, SD = 0.94*).

In contrast, mean scores were lower for reported instructional use of GenAI in teaching-related tasks (*M = 2.98, SD = 1.17*) and for perceived adequacy of academic knowledge about generative AI (*M = 2.81, SD = 1.14*). Participants generally somewhat to strongly agreed with being familiar with GenAI and acknowledged its importance, this awareness has not yet translated fully into consistent pedagogical application, indicating an ongoing need for targeted professional learning opportunities.

To assess PSTs' perceptions about GenAI and its relation to language acquisition, the survey results were analysed and presented in Table 6.

Table 6 summarizes participants' perceptions of how GenAI supports language acquisition, based on mean (*M*) and standard deviation (*S*) scores. Mean values ranged from 2.51 to 3.27, reflecting generally positive but differentiated evaluations across language skill domains. The highest mean score was observed for the item stating that generative AI helps improve writing accuracy by providing suggestions (*M = 3.27, SD = 0.85*), followed by support in grammar understanding (*M = 3.16, SD = 0.82*) and personalized language learning (*M = 3.09, SD = 0.83).*

Participants also somewhat agreed that GenAI expands vocabulary and language skills (*M = 3.01, SD = 1.03*) and creates a comfortable, motivating environment for making mistakes privately (*M = 3.01, SD = 0.98*). Moderate agreement was reported for AI's role in improving speaking skills (*M = 2.69, SD = 1.13*) and writing skills (*M = 3.02, SD = 1.04*).

Comparable mean scores were reported for perceived support in vocabulary and general language development (M = 3.01, SD = 1.03) and for creating a low-anxiety, private learning environment (M = 3.01, SD = 0.98). In contrast, participants showed lower agreement regarding the idea that generative GenAI reduces interest in conventional language learning methods such as private courses (*M = 2.51, SD = 1.15),* suggesting that AI tools are seen more as complementary rather than a replacement

Table 6 GenAI and its relation to language acquisition

No	No question	M	S
7	Generative AI expands the vocabulary and language skills of its users	3.01	1.03
8	Generative AI helps its users improve their speaking skills in the target language	2.69	1.13
9	Generative AI helps its users improve their writing skills in the target language	3.02	1.04
10	The use of generative AI reduces the interest of its users in learning languages conventionally, such as through private courses or tutoring	2.51	1.15
11	Generative AI helps users better understand grammar by confirming and explaining grammatical errors	3.16	0.82
12	As it can be used privately, generative AI helps facilitate personalized language learning according to the needs of its users	3.09	0.83
13	Generative AI helps improve language accuracy as it can provide suggestions for writing (such as essays)	3.27	0.85
14	Generative AI creates a motivating language learning environment where the learner feels comfortable that no one else knows when he or she makes a mistake in the learning process	3.01	0.98

for traditional methods. Participants generally agreed that GenAI enhances grammar understanding, writing accuracy, and personalizes the language learning experience, while showing mixed views on its impact on traditional language learning pathways.

To assess PSTs' acceptance of use of GenAI in a language teaching context, the survey results were analysed and presented in Table 7.

Table 7 presents participants' acceptance of GenAI use in language teaching contexts, as reflected in mean (*M*) and standard deviation (*S*) scores. Mean values across items ranged from 3.01 to 3.27, indicating consistently positive evaluations of GenAI as a pedagogical resource. The highest mean score was observed for the item stating that GenAI saves time in lesson planning, finding materials, and reviewing student work (*M = 3.27, SD = 0.94*), highlighting the prominence of perceived efficiency gains in shaping participants' AI-supported teaching. that teachers particularly value its practical benefits.

Slightly lower but still positive mean scores were reported for perceptions of GenAI's contribution to the efficiency and effectiveness of the teaching process (*M = 3.09, SD = 0.91)* and for its role in enhancing the quality of language learning (*M = 3.07, SD = 0.93*). The lowest mean score within this subscale concerned GenAI's perceived impact on students' understanding of language learning materials (*M = 3.01, SD = 0.90*), indicating more cautious evaluations of its instructional effects at the learner level. Taken together, these results indicate a generally high level of acceptance of GenAI in language teaching, driven primarily by perceived gains in efficiency and instructional support, while perceptions of direct learning impact appear comparatively more reserved.

Prior to conducting the confirmatory factor analysis, the internal consistency of each scale was examined. Cronbach's alpha coefficients indicated good to very good reliability for all constructs, with values of 0.81 for Familiarity, 0.84 for Language Acquisition, and 0.89 for Acceptance of AI. These results suggest satisfactory internal consistency and provide a sound basis for subsequent factor-analytic procedures.

RQ2. Confirmatory Factor Analysis Result

A confirmatory factor analysis (CFA) was conducted to evaluate the three-factor model, comprising *Familiarity with GenAI*, *Language Acquisition Support*, and *Acceptance of GenAI in Teaching*. The model fit the data reasonably well (χ^2 (128) = 267.06, $p < .001$). Although the chi-square test was significant, indicating some misfit, which is common in large models, the alternative fit indices suggested an acceptable model fit.

The Comparative Fit Index (CFI) was 0.911 and the Tucker-Lewis Index (TLI) was 0.894, both approaching the recommended threshold of 0.90 for acceptable fit (Hu &

Table 7 Acceptance of use of GenAI in a language teaching context

No	No question	M	S
15	I believe that generative AI can help improve the efficiency and effectiveness of the language teaching process	3.09	0.91
16	Generative AI saves my time making lesson plans, looking for teaching materials, and reviewing student work	3.27	0.94
17	I feel that generative AI can help increase students' understanding of language learning material	3.01	0.90
18	I accept the use of generative AI as a teaching aid and feel that it is a positive step toward improving the quality of language learning	3.07	0.93

Bentler, 1999). The Root Mean Square Error of Approximation (RMSEA) was 0.085 (90% CI [0.071, 0.099]), slightly above the conventional cutoff of 0.08 but still within an acceptable range considering model complexity (Browne et al., 1993). The Standardized Root Mean Square Residual (SRMR) was 0.059, indicating a good fit (Hu & Bentler, 1999).

All factor loadings were statistically significant ($p < .001$) and substantial in magnitude. Standardized loadings ranged from 0.485 to 0.844, demonstrating that all items were meaningful indicators of their respective latent constructs. Furthermore, the three latent factors were strongly and significantly correlated with each other:

- Familiarity and Language Acquisition Support (r = 0.792),
- Familiarity and Acceptance (r = 0.803),
- Language Acquisition Support and Acceptance (r = 0.955).

The very high correlation between the Language Acquisition and Acceptance factors suggests a strong conceptual association; however, these constructs were specified as distinct based on their theoretical focus on perceived pedagogical effects versus attitudinal endorsement of GenAI use, consistent with the conceptualisation adopted in Chung and Jeong (2024).

Additionally, several residual covariances were specified based on modification indices to improve model fit, specifically between items related to *Language Acquisition* and *Acceptance* constructs. Overall, the CFA results supported the hypothesized three-factor structure and provided a sound basis for subsequent analyses.

RQ3. Measurement Invariance Results by Gender

In Table 8, to examine the equivalence of the measurement model across gender groups, a series of increasingly constrained models were tested, following established guidelines (Cheung & Rensvold, 2002; Putnick & Bornstein, 2016). First, the configural model, which allowed all parameters to vary across groups, demonstrated an acceptable fit to the data ($\chi^2(256) = 474.70$, $p < .001$, CFI = 0.872, TLI = 0.847, RMSEA = 0.107). Next, the metric invariance model, in which factor loadings were constrained to be equal across groups, showed a slight decrease in model fit (χ^2 (271) = 501.10, $p < .001$, CFI = 0.865, TLI = 0.848, RMSEA = 0.106), with a significant chi-square difference compared to the configural model ($\Delta\chi^2(15) = 26.40$, $p = .034$). However, the change in CFI was smaller than the recommended cutoff of 0.01 (Cheung & Rensvold, 2002), supporting the conclusion of metric invariance. Finally, the scalar invariance model, in which item intercepts were additionally constrained, did not significantly worsen model fit compared to the metric model ($\Delta\chi^2$ (15) = 12.02, $p = .678$), and model fit

Table 8 Measurement invariance results by gender

Model	Chi-Square	df	*p*-value	CFI	TLI	RMSEA	ΔChi-Square	Δdf	*p*-value for ΔChi-Square
Configural	474.7	256	< .001	0.872	0.847	0.107			
Metric	501.1	271	< .001	0.865	0.848	0.106	26.4	15	0.034
Scalar	513.12	286	< .001	0.867	0.858	0.103	12.02	15	0.678

indices remained acceptable (χ^2 (286) = 513.12, $p < .001$, CFI = 0.867, TLI = 0.858, RMSEA = 0.103). These results indicate that full metric and scalar invariance were achieved, allowing for meaningful comparisons of latent means across gender groups. These results provide **support for metric and scalar invariance**, based on changes in fit indices (ΔCFI < .01), although absolute model fit should be interpreted cautiously given the sample size.

Discussion

This study examined ELT PSTs' perceptions of GenAI in English language teacher education in Türkiye, focusing on their familiarity with GenAI, perceived contributions to language acquisition, and acceptance of GenAI as a pedagogical tool. By integrating descriptive findings with confirmatory factor analysis and measurement invariance testing, the study provides a multidimensional account of how PSTs currently engage with GenAI and how these engagements are structured across key perceptual dimensions. Overall, the findings suggest that while PSTs demonstrate generally positive orientations toward GenAI, their engagement remains uneven, with stronger conceptual awareness than pedagogically enacted use.

Pre-service teachers' familiarity, perceived benefits, and acceptance of GenAI familiarity with GenAI tools

The findings reveal that PSTs possess a moderate level of familiarity with GenAI tools, particularly widely used platforms such as ChatGPT, alongside a general understanding of how these tools function within educational contexts. With mean scores clustering just above 3.0 on a 4-point scale, PSTs generally perceive themselves as knowledgeable yet express a continued need for professional development in this area as this familiarity appears to be largely conceptual rather than practice-oriented. The relatively lower mean scores for instructional use and for perceived adequacy of academic knowledge point to a persistent gap between awareness and enactment.

This partial familiarity aligns with recent studies suggesting that while GenAI has entered educational discourse rapidly, teacher education programs are only beginning to integrate it in systematic and pedagogically meaningful ways (Aldim et al., 2025; Aydin & Zeinolabedini, 2024). The relatively lower mean scores for practical use (M = 2.98) and for perceived adequacy of academic knowledge (M = 2.81) point to a persistent gap between theoretical awareness and hands-on pedagogical engagement. Such a discrepancy reflects a well-documented challenge in educational innovation, whereby teachers may recognise the potential of new technologies but lack experience or confidence required to integrate them effectively into classroom practice (Yang et al., 2023).

Rather than reflecting resistance or reluctance, this gap is more plausibly interpreted as a structural issue within teacher education. PSTs may recognise the relevance of GenAI and feel confident discussing it in abstract terms, yet lack opportunities for guided experimentation, modelling, and feedback that would enable meaningful classroom integration. Similar patterns have been reported in recent studies, which caution that early-stage AI integration in teacher education often prioritises exposure to tools over pedagogical enactment (Aldim et al., 2025; Aydin & Zeinolabedini, 2024; Yang et al.,

2023). In this sense, familiarity without practice risks remaining superficial, limiting PSTs' ability to translate knowledge into pedagogically sound action.

Perceived contributions of GenAI to language acquisition

PSTs generally perceived GenAI as contributing positively to various aspects of language learning, particularly in improving writing accuracy (M = 3.27), grammar understanding (M = 3.16), and enabling personalized learning (M = .09). These patterns suggest that PSTs view GenAI not merely as a digital assistant but as a pedagogical tool with the potential to enhance core language skills.

These perceptions are consistent with prior findings in computer-assisted language learning (CALL) and AI-assisted language learning research, which indicate that AI-driven tools can provide effective scaffolding for grammar and writing, reduce learner anxiety, and promote learner autonomy (Chun et al., 2016; Godwin-Jones, 2023; Zhao, 2023). By contrast, the more moderate rating for GenAI's role in improving speaking skills (M = 2.69) may reflect both the current technological limitations of speech-based AI applications and PSTs' pedagogical limited experience with these tools.

Importantly, the relatively low endorsement of the view that GenAI reduces interest in conventional language learning (M = 2.51) suggests that PSTs largely perceive GenAI as a complementary rather than substitutive. This finding supports broader arguments that emerging technologies are most productively positioned as augmenting rather than replacing traditional language instruction (Leis, 2025; Lee et al., 2024).

Acceptance of GenAI in language teaching

PSTs demonstrated strong acceptance of GenAI in language teaching, with high agreement on its time-saving benefits (M = 3.27) and potential to enhance teaching efficiency and quality (M = 3.09–3.07). This indicates a pragmatic orientation: PSTs appreciate GenAI's practical affordances for lesson planning, material creation, and assessment, which are time-intensive tasks in language education.

This aligns with technology acceptance models that emphasize perceived usefulness and ease of integration as key predictors of adoption (Davis, 1989; Venkatesh et al., 2003). Furthermore, PSTs' openness to using GenAI for pedagogical support echoes calls for embedding AI literacy into teacher education to prepare future educators for AI-enhanced classrooms (Luckin et al., 2022; Williamson & Eynon, 2020).

Overall, these insights indicate that while EFL PSTs hold generally positive views toward GenAI, their current engagement is shaped more by perceived potential than by widespread usage. There is strong interest in learning how to integrate GenAI into educational contexts more effectively, especially for enhancing language instruction. However, the gap between conceptual familiarity and practical application underlines the need for targeted professional development and curriculum redesign in teacher education programs (Aldim et al., 2025; Aydin & Zeinolabedini, 2024; Yang et al., 2023). From a technology acceptance perspective, these findings align with TAM- and UTAUT2-informed research suggesting that perceived usefulness and confidence are central to pre-service teachers' willingness to adopt emerging technologies, particularly when pedagogical guidance is limited.

The discussion of the CFA results

The confirmatory factor analysis (CFA) results from this study support the three-factor model encompassing *Familiarity with GenAI*, *Language Acquisition through GenAI*, and *Acceptance of GenAI* among ELT PSTs in Türkiye. The model demonstrated an acceptable fit to the data, reflecting the multi-dimensional nature of GenAI engagement in language learning teacher education. This finding aligns with prior research, highlighting that teachers' interactions with GenAI extend beyond technical awareness to include pedagogical perceptions and attitudinal orientations (Guan et al., 2025; Lucas et al., 2025).

Closer examination of the latent constructs provides further insight into how pre-service teachers conceptualise GenAI use. The *Familiarity* factor captured PSTs' self-reported exposure to and understanding of GenAI tools, such as ChatGPT or Grammarly. Items related to prior use and confidence loaded strongly on this factor, reinforcing the importance of foundational knowledge in building confidence, as suggested by Moorhouse and Kohnke (2024). The *Language Acquisition* factor reflected participants' perceptions of GenAI's contribution to language learning, particularly in areas such as vocabulary and writing. Consistent with earlier studies, these perceptions were stronger for written and form-focused skills than for speaking or higher-order language use (Chung & Jeong, 2024), suggesting that pre-service teachers currently associate GenAI more readily with certain skill domains. In contrast, the Acceptance factor captured broader attitudinal openness to integrating GenAI into instructional practice, with high-loading items emphasising its perceived usefulness for lesson planning, materials development, and feedback provision. This pattern is consistent with findings reported by Abbasi et al. (2024), which highlight efficiency and instructional support as key drivers of positive attitudes toward AI in teaching.

One noteworthy finding concerns the very strong correlation observed between the Language Acquisition Support and Acceptance constructs. This high association suggests that, for pre-service teachers, perceptions of GenAI's pedagogical value for language learning are closely linked to their willingness to accept and endorse its use in instructional contexts. In the case of emerging technologies such as GenAI, acceptance may be largely driven by perceived learning benefits, leading to a degree of conceptual proximity between these dimensions. While the two constructs were modelled as analytically distinct, reflecting differences between perceived learning outcomes and attitudinal endorsement, their strong relationship highlights the need for caution in interpretation and suggests potential construct overlap. Future research may benefit from further refining these dimensions, for example by distinguishing more clearly between affective acceptance and pedagogical efficacy, or by testing alternative or higher-order factor models.

Taken together, these findings reinforce the importance of exploring GenAI engagement in teacher education through a multidimensional lens that integrates technological awareness, pedagogical perceptions, and attitudinal factors. In line with earlier calls by Moorhouse and Kohnke (2024) and Dimas et al. (2025), this multidimensional model demonstrates that successful integration of GenAI into language teacher education requires more than exposure to tools alone; it also depends on pedagogical clarity and positive attitudes. Accordingly, teacher education

programmes should prioritise opportunities for pre-service teachers to engage deeply and reflectively with GenAI, supporting not only skill development but also informed and responsible pedagogical decision-making.

The discussion of the measurement invariance

Measurement invariance analyses revealed that the proposed three-factor model holds across male and female PSTs, with configural, metric, and scalar invariance achieved. This supports the idea that gender does not influence how PSTs conceptualize the three dimensions of GenAI engagement: *familiarity*, *language acquisition*, and *acceptance*. This finding aligns with the broader body of literature, which suggests that gender differences in AI acceptance are minimal in education settings (e.g., Liu et al., 2024). Additionally, the scalar invariance result highlights that observed scores on these factors can be compared meaningfully across gender groups, ensuring that any perceived differences in engagement with GenAI are not biased by measurement issues.

However, it is important to interpret these results in light of overall model fit considerations. Although the model demonstrated acceptable fit, the slight increase in RMSEA could be attributed to the sample size and model complexity, as observed in other studies on AI integration (Özer-Altınkaya & Yetkin, 2025). This limitation highlights the need for larger samples in future research to confirm these findings and refine the measurement model further.

Comparison to previous studies

The findings of this study align with previous research highlighting variability in PSTs' readiness and preparedness to integrate GenAI into language teaching. For example, as reported by Guan et al. (2025), PSTs may exhibit surface-level confidence in using AI tools but often lack deeper, conceptual engagement with these technologies. Similarly, consistent with findings from Chung and Jeong (2024) and Liu et al. (2024), the present study confirms that PSTs recognize the potential benefits of GenAI for language acquisition, especially in areas like vocabulary, writing, and grammar. At the same time, ongoing concerns regarding the limitations of GenAI in supporting speaking skills and fostering critical thinking persist. These findings underscore the need for comprehensive training programs that move beyond superficial tool use toward pedagogically grounded and critically informed integration of GenAI in teacher education.

Furthermore, the study contributes to the growing body of research on gender equality in AI adoption (e.g., Nissim & Simon, 2025; Sergeeva et al., 2025), emphasizing that both male and female teachers exhibit similar levels of engagement with educational technologies. This finding supports the integration of AI tools without gender bias, promoting a more equitable and inclusive approach to teacher preparation.

Practical implications

The findings of this study have several concrete implications for curriculum designers and teacher educators in initial teacher education programs:

- *Introduce practice-oriented GenAI modules* Teacher education programmes should move beyond awareness-raising and include structured, hands-on modules on *AI-supported language pedagogy*. These modules could involve tasks such as designing GenAI-supported lesson plans, using AI tools to generate and evaluate feedback on student writing, and critically reviewing AI-generated materials in relation to curriculum objectives.
- *Embed GenAI use within methodology and practicum courses* Rather than treating GenAI as a stand-alone topic, AI-related tasks should be integrated into existing methodology and practicum components. For example, pre-service teachers could trial GenAI-supported activities during micro-teaching or school-based practicum and reflect on their pedagogical effectiveness with guidance from teacher educators or mentors.
- *Model skill-specific and pedagogically selective uses of GenAI* Given that PSTs perceive GenAI as more effective for certain skills (e.g., writing and grammar) than others (e.g., speaking), teacher educators should explicitly model context-sensitive uses of GenAI. Demonstrating when GenAI is pedagogically appropriate—and when human interaction is preferable—can help PSTs develop informed and balanced instructional practices.
- *Integrate critical AI literacy across the curriculum* Teacher education programmes should incorporate critical AI literacy components that address ethical, epistemic, and professional concerns. These may include case-based discussions on AI bias and reliability, analysis of inaccurate or misleading AI outputs, and reflective tasks focusing on academic integrity, learner agency, and responsible AI use.
- *Design inclusive, cohort-wide GenAI training initiatives* Given the absence of gender-based differences in GenAI perceptions, curriculum designers can implement GenAI-focused learning outcomes and assessment tasks for all PSTs without gender differentiation, ensuring equitable access to resources, support, and guided practice across the cohort.

Limitations and directions for future research

Despite its contributions, this study is not without limitations. First, the sample size, particularly with respect to gender distribution, was relatively small. While measurement invariance across gender was achieved, larger and more diverse samples are needed to strengthen generalizability of the findings and to further validate the proposed measurement model. While the RMSEA was within an acceptable range, future studies should aim to refine the model by testing alternative structures or adding qualitative insights. In addition, the study was conducted within a single institutional and national context, and the cultural and educational context of Türkiye may limit the broader applicability of findings. Future comparative studies across different countries and teacher education systems could provide valuable cross-cultural insights into GenAI engagement.

Second, the study relied on self-reported questionnaire data, which may be subject to social desirability bias (Dörnyei, 2007). Given the growing institutional and societal emphasis on digitalisation and AI integration in education, participants may have

felt inclined to report more favourable attitudes toward GenAI than those reflected in their actual practices. Although anonymity was ensured to minimise this effect, future research could benefit from triangulating self-report data with classroom observations, learning artefacts, interviews, or usage data to obtain a more nuanced understanding of pre-service teachers' engagement with GenAI.

A further methodological limitation concerns model fit. Although the confirmatory factor analysis supported the proposed three-factor structure, one limitation concerns the RMSEA value, which was slightly above the commonly recommended threshold for ideal model fit. This may suggest a degree of model approximation or minor misspecification, potentially influenced by sample size or the complexity of modelling perceptions of an emerging and multifaceted construct such as GenAI engagement. Accordingly, the results of the CFA should be interpreted with caution. Nevertheless, the overall model demonstrated acceptable fit based on multiple indices, and the successful establishment of measurement invariance across gender provides additional support for the robustness of the measurement model. Although measurement invariance across gender was supported based on relative fit indices, the small subgroup sizes and suboptimal absolute fit of the configural model suggest that these findings should be interpreted with caution.

Building on these limitations, future studies could benefit from replicating this research with a larger and more balanced sample to validate the findings and ensure the robustness of the measurement model. Furthermore, exploring other forms of invariance, such as across age groups, teaching experience, or teaching contexts, would provide deeper insights into how different factors influence GenAI adoption. Longitudinal studies examining changes in PSTs' attitudes and practices toward GenAI over time would also be valuable. Such research would contribute to a deeper and more dynamic understanding of responsible and sustainable GenAI integration in English language teacher education. Future research could also adopt mixed-methods designs that combine large-scale survey data with qualitative approaches such as interviews, classroom observations, or analysis of teaching artefacts to gain deeper, context-sensitive insights into how pre-service teachers interpret and enact GenAI use in pedagogical practice.

Conclusion

This study offers a comprehensive examination of how pre-service English language teachers in Türkiye perceive and engage with GenAI in initial English language teacher education. By conceptualising GenAI engagement through three interrelated dimensions, familiarity, language acquisition, and acceptance, the study reveals a balanced yet cautious optimism among PSTs toward GenAI integration and offers a nuanced perspective on how PSTs interact with AI in English language teaching. The findings underscore the importance of pedagogical integration of GenAI tools in teacher education programs, as well as the need for structured, reflective training that considers both technological and ethical aspects of AI use in the classroom.

The study offers important implications for curriculum designers, teacher educators, and policymakers by emphasising the need for structured, practice-oriented, and reflective GenAI training that integrates pedagogical and ethical considerations. The absence of gender-based differences in GenAI perceptions further supports the adoption of inclusive and equitable approaches to AI integration in teacher education. Preparing

future English language teachers therefore requires not only technical competence but also critical judgement, ethical awareness, and pedagogical clarity. Finally, this research provides a foundation for future studies to examine the longitudinal impact of GenAI on teaching practices and learner outcomes across diverse educational contexts, as AI continues to reshape language education.

Author contributions
ME and NE jointly designed the study, collected and analyzed the data, and co-wrote the manuscript. Both authors read and approved the final version of the manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethical approval and consent to participate
This study received ethical approval from the Ethics Committee of Muğla Sıtkı Koçman University (Approval Date: 30 January 2025). All participants were informed about the study's purpose and voluntarily provided written consent to participate.

Consent for publication
Not applicable.

Competing interest
The authors declare no competing interests.

Human ethics and consent to participate declarations
All procedures were conducted in accordance with institutional and national research ethics standards. Human Ethics and Consent to Participate declarations: applicable as described above.

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References

Abbasi, K. J., Solangi, M. A., & Golo, M. A. (2024). Use of ChatGPT in English language teaching: Teachers' perspective. *Journal of Applied Linguistics and TESOL (JALT), 7*(4), 714–721.
Aldim, Ü. F., Selvi, B., & Ulaş, G. P. (2025). Preparing to teach in the age of AI: insights from pre-service English teachers. *International Journal of Eurasia Social Sciences/Uluslararasi Avrasya Sosyal Bilimler Dergisi*, *16*(62), 2194–2219.
Aydın, S., & Zeinolabedini, M. (2024). Integrating artifi cial intelligence into foreign language learning: Learners' perspectives. EJER Congress: 2024 International Eurasian Educational Research Congress, Conference Proceedings, Ani Publishing, 2024, pp. 121–126.
Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2), 238–246. https://doi.org/10.1037/0033-2909.107.2.238
Browne, M. W., Cudeck, R., Bollen, K. A., & Long, J. S. (1993). Alternative ways of assessing model fit. *Testing Structural Equation Models, 154*(4), 136–162.
Bryman, A. (2016). *Social research methods*. Oxford University Press.
Butler, Y. G., & Jiang, S. (2025). How do pre-service language teachers perceive generative AIs' affordance?: A case of ChatGPT. *System*. https://doi.org/10.1016/j.system.2025.103606
Chen, F. F. (2007). Sensitivity of goodness of fit indexes to lack of measurement invariance. *Structural Equation Modeling: A Multidisciplinary Journal, 14*(3), 464–504. https://doi.org/10.1080/10705510701301834
Cheung, G. W., & Rensvold, R. B. (2002). Evaluating goodness-of-fit indexes for testing measurement invariance. *Structural Equation Modelling, 9*(2), 233–255. https://doi.org/10.1207/S15328007SEM0902_5
Chun, D., Kern, R., & Smith, B. (2016). Technology in language use, language teaching, and language learning. *The Modern Language Journal, 100*(S1), 64–80.
Chung, J. Y., & Jeong, S.-H. (2024). Exploring the perceptions of Chinese pre-service teachers on the integration of generative AI in English language teaching: Benefits, challenges, and educational implications. *Online Journal of Communication and Media Technologies, 14*(4), e202457. https://doi.org/10.30935/ojcmt/15266
Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1989). Technology acceptance model. *Journal of Management Sciences, 35*(8), 982–1003.

Dimas, D., Alvindi, A., Khoirunnisa, T., Yani, R., Pardamean, P., & Simanjuntak, K. (2025). Exploring pre-service teachers' difficulties of ChatGPT as a tool for planning the learning process. *Innovative: Journal of Social Science Research, 5*(1), 5906–5922.
Dörnyei, Z. (2007). *Research methods in applied linguistics: Quantitative, qualitative, and mixed methodologies*. Oxford University Press.
Godwin-Jones, R. (2023). Emerging spaces for language learning: AI bots, ambient intelligence, and the metaverse. *Language Learning & Technology, 27*(2), 6–27.
Guan, L., Zhang, Y., & Gu, M. M. (2025). Pre-service teachers' preparedness for AI-integrated education: An investigation from perceptions, capabilities, and teachers' identity changes. *Computers and Education: Artificial Intelligence, 8*, 100341.
Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*, 1–55.
Hu, L., Wang, H., & Xin, Y. (2025). Factors influencing Chinese pre-service teachers' adoption of generative AI in teaching: An empirical study based on UTAUT2 and PLS-SEM. *Education and Information Technologies*. https://doi.org/10.1007/s10639-025-13353-7
Kalenda, P. J., Rath, L., Abugasea Heidt, M., & Wright, A. (2025). Pre-service teacher perceptions of ChatGPT for lesson plan generation. *Journal of Educational Technology Systems, 53*(3), 219–241.
Lee, S., Jones-Jang, S. M., Chung, M., Kim, N. & Choi, J. (2024). Who is using ChatGPT and why? Extending the unified theory of acceptance and use of technology (UTAUT) model. *Information Research, 29*(1), 54–72. https://doi.org/10.47989/ir291647
Leis, A. (2025). How speech-to-text technology aff ects pronunciation gains and self-confidence in EFL learners. *Computer Assisted Language Learning,* 1–24
Liu, Y., Park, J., & McMinn, S. (2024). Using generative artificial intelligence/ChatGPT for academic communication: Students' perspectives. *International Journal of Applied Linguistics, 34*(4), 1437–1461. https://doi.org/10.1111/ijal.12574
Lucas, M., Bem-haja, P., Zhang, Y., Llorente-Cejudo, C., & Palacios-Rodríguez, A. (2025). A comparative analysis of pre-service teachers' readiness for AI integration. *Computers and Education: Artificial Intelligence*. https://doi.org/10.1016/j.caeai.2025.100396
Luckin, R., Cukurova, M., Kent, C., & Du Boulay, B. (2022). Empowering educators to be AI-ready. *Computers and Education: Artificial Intelligence, 3*, 100076.
Milfont, T. L., & Fischer, R. (2010). Testing measurement invariance across groups: Applications in cross-cultural research. *International Journal of Psychological Research, 3*(1), 111–130.
Moorhouse, B. L., & Kohnke, L. (2024). The effects of generative AI on initial language teacher education: The perceptions of teacher educators. *System (Oxford), 122*, 103290. https://doi.org/10.1016/j.system.2024.103290
Nissim, Y., & Simon, E. (2025). The diffusion of artificial intelligence innovation: Perspectives of preservice teachers on the integration of ChatGPT in education. *Journal of Education for Teaching*. https://doi.org/10.1080/02607476.2025.2469128
Özer-Altınkaya, Z., & Yetkin, R. (2025). Exploring pre-service English language teachers' readiness for AI-integrated language instruction. *Pedagogies: An International Journal*. https://doi.org/10.1080/1554480X.2025.2451299
Punch, K. F., & Oancea, A. E. (2014). *Introduction to research methods in education*. SAGE.
Putnick, D. L., & Bornstein, M. H. (2016). Measurement invariance conventions and reporting: The state of the art and future directions for psychological research. *Developmental Review, 41*, 71–90. https://doi.org/10.1016/j.dr.2016.06.004
R Core Team. (2023). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/
Rosseel, Y. (2012). Lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(2), 1–36. https://doi.org/10.18637/jss.v048.i02
Sergeeva, O. V., Zheltukhina, M. R., Shoustikova, T., Tukhvatullina, L. R., Dobrokhotov, D. A., & Kondrashev, S. V. (2025). Understanding higher education students' adoption of generative AI technologies: An empirical investigation using UTAUT2. *Contemporary Educational Technology, 17*(2), ep571. https://doi.org/10.30935/cedtech/16039
Sun, J., Wu, Q., Ma, Z., Zheng, W., & Hu, Y. (2025). Understanding pre-service teachers' acceptance of generative artificial intelligence: An extended technology acceptance model approach. *Educational Technology Research and Development*. https://doi.org/10.1007/s11423-025-10495-w
Tabachnick, B. G., & Fidell, L. S. (2019). *Using multivariate statistics* (7th ed.). Pearson.
Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika, 38*(1), 1–10. https://doi.org/10.1007/BF02291170
Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view1. *MIS Quarterly, 27*(3), 425–478.
Williamson, B., & Eynon, R. (2020). Historical threads, missing links, and future directions in AI in education. *Learning, Media and Technology, 45*(3), 223–235.
Yang, L., Garcia-Holgado, A., & Martinez-Abad, F. (2023). Digital competence of K-12 pre-service and in-service teachers in China: A systematic literature review. *Asia Pacific Education Review, 24*(4), 679–693.
Zhao, X. (2023). Leveraging artificial intelligence (AI) technology for English writing: Introducing word tune as a digital writing assistant for EFL writers. *RELC Journal, 54*(3), 890–894.

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