Castledown

OPEN ACCESS

Technology in Language Teaching & Learning
ISSN 2652-1687
https://www.castledown.com/journals/tltl/

Technology in Language Teaching & Learning, 7(2), 102841 (2025)
https://doi.org/10.29140/tltl.v7n2.102841

Preparing Teachers for the Algorithmic Educational Landscape: A Critical Mapping of Generative AI Integration in Language Teacher Education

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Abstract

The increasing integration of generative Artificial Intelligence (AI) tools, such as ChatGPT, in education has prompted growing interest in their pedagogical potential and the emergent competencies required for their effective use in language instruction. While generative AI is beginning to influence language

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teaching and learning practices, emerging research suggests a burgeoning need to address AI-related literacies and ethical considerations within language teacher education programs. Despite the growing number of studies examining generative AI use in language learning contexts, there remains a notable gap in systematically reviewing how generative AI is being addressed in teacher preparation and professional development. To address this gap, this study presents a bibliometric-based systematic literature review of research on generative AI in language teacher education, employing text-mining algorithms, data-mining heuristics, and social network analysis. The findings identify five major thematic clusters in the literature: (1) Professional Development and AI Literacy in Teacher Education, (2) Chatbots and Conversational AI in Language Learning, (3) Generative AI for Instructional Design, Assessment, and Lesson Planning, (4) Generative AI as a Tool for Enhancing EFL Writing Skills, and (5) Pre-Service Teachers' Perceptions and Readiness. This review contributes to the expanding discourse on AI in education by mapping the current research landscape and identifying critical directions for advancing generative AI integration in language teacher education.

Keywords: generative AI, artificial intelligence, higher education, pre-service teachers, language teacher education, educational technology, chatbot, EFL

Introduction

The rapid evolution of artificial intelligence (AI), driven by innovations in machine learning and natural language processing (NLP), is transforming the landscape of language education. Among the most significant developments is generative AI that produces coherent, contextually relevant, and human-like language output. Generative AI technologies such as ChatGPT, Gemini, Grok, and Claude exemplify this shift, offering dynamic conversational interfaces mirroring human dialogue and making it possible for language learners to engage with AI in responsive and interactive ways (Law, 2024). These capabilities seem to align with foundational learning theories in language teacher education, including cognitive approaches to second language learning (Long, 1985, 1996) and sociocultural theory (Lantolf & Thorne, 2007; Vygotsky, 1978), which emphasize the conversational interaction and meaningful communication in language development. AI-based systems, initially emerging as tools for tutoring and automated writing evaluation, have progressed toward enabling personalized learning and more natural, dialogic interaction between humans and machines (Roll & Wylie, 2016). This shift has paved the way for a new generation of language learning tools that extend beyond traditional computer-assisted language learning (CALL) and mobile-assisted language learning (MALL), into what is now framed as AI-based or assisted language learning (AILL) (e.g., Qiao & Zhao, 2023).

Generative AI technologies such as ChatGPT present unique opportunities for language teachers to support various instructional activities, ranging from material development across language modalities to the generation of personalized feedback, automated assessments, and content adaptation for diverse learner needs (Sun et al., 2025). For language teacher educators, this shift introduces both promise and complexity. While generative AI offers teachers novel ways to scaffold and personalize learning experiences, it simultaneously demands new forms of professional competence. These include the ability to critically assess AI-generated content for accuracy, pedagogical relevance, ethical considerations, and responsible classroom implementation (Giannakos et al., 2024; Law, 2024).

Recent review studies have highlighted the notable influence of generative AI in language teaching and learning, especially in writing instruction and automated feedback (Godwin-Jones, 2022; Ji et al.,

2023). However, relatively less attention has been given to how pre-service and in-service language teachers are being prepared to integrate these technologies into their practice. To address this gap, the present study conducts a bibliometric and thematic analysis of empirical research at the intersection of generative AI and language teacher education. The purpose of this study is to map the current state of scholarship, identify prevailing trends and conceptual directions, and inform future research and practice in teacher preparation.

Literature Review

Over the past two decades, the role of artificial intelligence in language education has expanded considerably, evolving from rule-based tutoring systems to adaptive platforms capable of real-time feedback and personalized support. Early applications of AI in language learning primarily focused on student-facing technologies, such as automated writing evaluation systems, intelligent tutoring, and speech recognition tools (e.g., Heift & Schulze, 2007; Warschauer & Ware, 2006). These technologies were typically situated within the paradigms of CALL and MALL, where teacher involvement in the AI interaction was often indirect. However, the advent of generative AI has changed this dynamic, positioning teachers not only as facilitators but also as direct users, evaluators, and co-designers of AI-mediated learning experiences (Zhai, 2024). This change brings new questions about teacher readiness, pedagogical adaptation, and the development of AI-related competencies within teacher education frameworks.

While CALL and MALL mainly delivered set language exercises and opened up mobile access to resources, the shift toward the AILL (Khajavi & Ezhdehakosh, 2025; Qiao & Zhao, 2023) brings in an extra level of interactivity and personal touch. Generative AI and conversational agents may create reading passages tailored to various skill levels, adjust vocabulary and sentence difficulty in real-time, and initiate dynamic dialogues (Al-Khresheh, 2024). This shift is not just technical; the generative AI has brought about new roles for teachers entailing human creativity and interpreting machine-generated outputs. Exploring the potential of generative AI by teachers in language teaching practices appears as an utmost critical skill as it goes beyond interacting with machine-generated outputs to the transformation of educational materials and experiences (Pahi et al., 2024).

Generative AI in Language Teacher Education

Currently, generative AI is integrated into several activities for training language teachers through different platforms. For instance, chatbots now support micro-teaching sessions, and simulation technologies providing adaptable and NLP-driven feedback are used in the classroom environment. Experimental studies (e.g., Bauer et al., 2025) suggest that pre-service teachers who engage in these simulations enhance their diagnostic reasoning abilities, particularly in articulating their teaching judgments. Tools like ChatGPT may rapidly generate lesson plans, provide interactive activities tailored to various ability levels, and provide personalized feedback that alleviates instructors' administrative burdens (Case et al., 2025; Trust et al., 2023). Simultaneously, maximizing the benefits of these technologies necessitates that educators acquire new digital competencies, such as "prompt engineering" to guide AI towards solutions that are appropriate for the classroom. The emergence of automated assessment systems facilitates expedited feedback and enhances grading uniformity; nonetheless, it raises issues with algorithmic bias, equity, and the transparency of these systems (Allen & Mizumoto, 2024; Mizumoto & Eguchi, 2023). In many instances, it is evident that prospective language educators must possess proficiency not just in utilizing these AI technologies but also in discerning the underlying ethical, pedagogical, and societal implications they entail.

Benefits and Challenges of AI Integration

Recent empirical work highlights the potential of AI to enhance personalization, engagement, and learner autonomy in language teacher education. It can personalize learning experiences, create interactive simulations that grab students' attention, and offer almost instant, data-driven feedback that helps shape instructional decisions (Chiu et al., 2024; Mosher et al., 2020). For example, a study comparing teacher and ChatGPT-generated written corrective feedback in an EFL setting found that ChatGPT pointed out weaknesses in learner writing and provided many personalized revision suggestions, outperforming the teacher, especially in providing meaning-level feedback on content (Yu & Xie, 2025). However, it was also noted that teacher feedback concentrated more on the language-related errors and feedback. In addition, by taking over routine tasks, such as automating grading, keeping tabs on learner progress, and generating adaptive materials, AI lets teachers divert their energy toward more creative and higher-level planning (Ng et al., 2023). For example, Xerri and Block (2024) conducted a collaborative action research study with writing instructors using generative AI. While teachers had varied experiences using generative AI in writing instruction, the participating teachers reported that their students "engaged more deeply with the process and better understood the relevance of the lessons, reinforcing the idea that GenAI tools offer opportunities for a deeper exploration of writing as a language skill by facilitating feedback, generating ideas, and organizing thoughts" (p. 72). However, there are lingering ethical concerns about data privacy, surveillance, and achieving true fairness in automated grading (Ding et al., 2024; Salas-Pilco et al., 2022). Another significant study largely focusing on the ecological perspective of using generative AI in language instruction is Kamali et al. (2024b) in which the authors analyzed teachers' points of view at micro, meso, and macro levels. The researchers found that incorporating ChatGPT at the micro level may reduce teachers' agency, ultimately resulting in learners being overdependent on ChatGPT and losing their critical thinking skills. This may in turn reduce learners` autonomy and encourage plagiarism as suggested by earlier research (Kohnke et al., 2023). While generative AI has an unprecedented potential to ease language teachers' jobs in the provision of lower-level feedback and serve as an assistant to both teachers and learners, it poses the risk of diminishing learners' agency and autonomy. Thus, while AI offers considerable opportunities to innovate in language teacher preparation, its pedagogical value will depend on addressing these ethical, technical, and pedagogical challenges.

What Do Other Systematic Reviews / Bibliometric Studies Tell Us?

Recent systematic reviews and bibliometric analyses, which are methodical examinations of scientific literature aimed at discerning patterns, trends, and influences within a certain domain (Passas, 2024), have examined the role of AI in language teacher education, providing insights into methodological trends and significant gaps. Liang et al. (2023) analyzed 71 articles from prominent educational databases, covering the period from 1990 to 2020, and discovered that the research predominantly focuses on AI tools such as intelligent tutoring systems and natural language processing, primarily addressing reading, writing, and vocabulary development. Meanwhile, areas like critical thinking, complex problem-solving, or collaborative learning have been given far less attention. Similarly, Ji et al. (2023) conducted a review of 24 empirical studies from 2015 to 2021 examining the collaboration between conversational AI and human language instructors. Their research indicated that this technology could enhance intelligence amplification and alleviate teachers' workloads; however, the evidence remains insufficient, highlighting the necessity for more defined strategies to promote genuine AI-human teacher collaboration. Additional reviews have expanded the discourse further. For example, Kovari (2025) investigated AI-driven collaborative learning in higher education and emphasized the potential of tools such as predictive analytics

and recommender systems to transform personalized learning and student engagement. Kovari identified challenges including data privacy and the opacity of algorithmic decisions, emphasizing the necessity for a judicious combination of automated assistance and human supervision. Similarly, Tan et al. (2024) explored 95 studies from 2015 to 2024 focusing on AI's role in teaching and in shaping teacher professional development. Their findings indicated a disparity: classroom instruction receives ample AI focus, whereas teacher development does not, necessitating further investigation into teacher preparedness, ethical considerations, and the technical obstacles of incorporating AI into professional advancement. Lastly, additional reviews, such as Li et al. (2025) and Lo et al. (2024), synthesized research on ChatGPT in language learning and teaching, covering various empirical studies, respectively. These reviews found that applications overwhelmingly target writing support, idea generation, and feedback provision, with fewer studies addressing speaking, listening, or integrated skills.

Collectively, these syntheses demonstrate that while generative AI is increasingly present in language education research, the evidence base for its integration into language teacher education remains limited in scope, uneven in methodological rigor, and heavily skewed toward learner-facing writing applications. Most existing systematic reviews focus broadly on the use of generative AI in language learning and teaching, mapping rapid growth, particularly in writing, while giving comparatively little attention to teacher learning, practicum integration, or assessment redesign.

Present Study

The present study centers specifically on the integration of generative AI in language teacher education, targeting empirical research published after the launch of ChatGPT and other chatbots in late 2022. This focus addresses a critical gap by situating findings within the post-ChatGPT era and offering a pedagogically grounded, ethically informed, and teacher-centered perspective on how generative AI can be purposefully incorporated into teacher preparation. Although some narrative and conceptual reviews have touched on the implications of AI for education broadly, there is a lack of systematic mapping that synthesizes empirical evidence, research trends, and thematic priorities related to teacher roles, competencies, and instructional uses of generative AI in language education. A bibliometric systematic literature review is, therefore, warranted to consolidate this emerging knowledge base, identify patterns and gaps, and provide a comprehensive overview of how generative AI is shaping the discourse in language teacher education. This approach is particularly effective for mapping the intellectual structure and evolution of a rapidly growing field of study in a systematic and reproducible manner (Zupic & Čater, 2015). By moving beyond traditional narrative reviews, a bibliometric analysis can quantitatively identify influential research, key conceptual clusters, and collaborative networks defining the field (Donthu et al., 2021). To achieve a more granular and nuanced understanding, this study enhances the bibliometric review with computational methods, including text-mining and network analysis. This integrated approach allows for a deeper synthesis of research trends by analyzing the core thematic content and latent semantic structures directly from the literature itself (Wagire et al., 2020). The combination of these methods provides a robust, data-informed overview of how generative AI is being used and conceptualized in language teacher education, thus addressing the study's research questions with both quantitative breadth and qualitative depth. As a result, the study is guided by the following research question:

1. What are the bibliometric trends and emerging thematic patterns on generative AI in language teacher education?

Methodology

Research Design

This study seeks to elucidate emergent trends and thematic patterns in the deployment of generative AI within language teacher education. To this end, we adopted a multi-method methodological framework that integrates (i) a systematic literature review (SLR) guided by the procedural standards of Gough et al. (2012), and (ii) a bibliometric analysis grounded in the techniques articulated by Donthu et al. (2021). The study sampled a corpus using Biblioshiny through the Bibliometrix package in R (Aria & Cuccurullo, 2017).

To probe the corpus more deeply, we complemented the SLR-bibliometric nexus with a suite of advanced computational analytics. Specifically, we applied (a) text-mining algorithms to extract high-frequency terms and latent semantic structures (Feldman & Sanger, 2007); (b) data-mining heuristics for pattern discovery and rule induction (Fayyad et al., 2002); and (c) Social Network Analysis (SNA) to visualize and quantify author-, institution-, and keyword-level interaction networks (Hansen et al., 2010).

Employing these complementary techniques fulfills a dual methodological mandate. First, the convergence of qualitative synthesis, quantitative bibliometrics, and computational analytics furnishes robust data triangulation, thereby strengthening the credibility and internal validity of the findings (Thurmond, 2001). Second, the multidimensional perspective thus obtained enables a richer, more nuanced characterization of the research landscape, capturing not only publication growth and citation impact, but also the semantic evolution of key concepts and the structural dynamics of collaborative scholarship. Collectively, this integrative approach positions the study to advance a holistic understanding of how generative AI is reshaping the preparation and professional development of language teachers.

Research Corpus

A comprehensive literature search was conducted using two academic databases: Web of Science (WoS) and Scopus**.** The same search strings (see Table 1) were applied to both databases to ensure consistency. The initial search explored the use of generative AI in language teacher education, yielding a total of 322 records.

Table 1 *Search Strings Used to Extract Records from Online Databases*

Title, abstract, keywords	“teacher education” OR “teacher training” OR “pre-service teacher*” OR “in-service teacher*” OR “language teacher education”
Title, abstract, keywords	“chatbot*” OR “chatgpt” OR “artificial intelligence” OR “ai” OR “generative ai”
Title, abstract, keywords	“language “ OR “second language” OR “L2” OR “foreign language” OR “elt “ OR “efl” OR “tefl” OR “tesol” OR “language education” OR “language teach*” OR “language learn*”

In the screening phase, the results were initially refined within the database interfaces prior to export based on the language, document type, and time filters. That is, the filtered search covered the peer-reviewed articles published between 2022 and 2025 in English, resulting in 218 records. Since the first generative AI model accessible to everyone appeared in 2022, the baseline year for the study was chosen as 2022. Next, a title and abstract screening was conducted within each database following the screening criteria listed below.

Table 2 *Inclusion and Exclusion Criteria*

Criteria	Inclusion	Exclusion
Context	Studies focusing on AI in the context of language teacher education.	Studies focusing solely on AI for language learning
Topic	Studies involving pre-service or in-service language teachers as primary participants and addressing AI within the context of their education or professional development	Studies on AI in other teacher education domains (e.g., STEM, science, math education)
Language	Studies published in English	Studies that primarily examined the technical or computational aspects of AI and large language models (LLMs), particularly from a computer science perspective
Publication dates	Studies published between 2022-2025	Studies with a broad focus on AI in education or AI in teacher education without specific relevance to language teachers

Following this screening process using the inclusion and exclusion criteria in Table 2, a total of 102 records were retained (56 records from Scopus and 46 records from WoS). These screened records were exported in RIS and BibTeX formats and imported into Zotero reference management software. Automatic and manual deduplication procedures were applied to identify overlapping records across the two databases. 36 duplicates were removed, and a final corpus of 66 peer-reviewed journal articles was included for the full-text screening.

Findings and Discussion

Bibliometric Trends

In order to answer our research question regarding the key topics and trends, first of all, the dataset was checked. The final dataset encompasses peer-reviewed articles published between January 2022 and March 2025, a period that coincides with the rapid uptake of generative AI tools in language education research. Systematic screening against the predefined inclusion and exclusion criteria reduced the initial pool to 66 journal and conference papers drawn from 44 distinct publication venues. Authorship analysis shows that 139 individual scholars contributed to these papers, yielding a mean collaboration rate of 2.11 authors per article. Although multi-author collaboration predominates, 16 papers (24%) were produced by a single author, reflecting a continued, albeit minority, presence of solo scholarship alongside increasingly networked research teams. This corpus, therefore, offers a balanced portrait of both institutional and individual engagement with the emerging field.

Thematic Patterns

To thematically investigate the emerging themes resulting from our corpus of studies on generative AI and language teacher education, we employed *bibliometric and thematic analysis*. This bibliometric and thematic analysis of 66 empirical studies reveals a rapidly expanding body of research exploring the integration of generative AI in language teacher education. The findings highlight five major themes: (1) Professional Development and AI Literacy in Teacher Education, (2) Chatbots and Conversational AI in Language Learning, (3) Generative AI for Instructional Design, Assessment, and Lesson Planning, (4) Generative AI as a Tool for Enhancing EFL Writing Skills, and (5) Pre-Service Teachers' Perceptions and Readiness. These themes are discussed in relation to the broader goals and

challenges of preparing future language teachers in an era increasingly shaped by generative AI tools such as ChatGPT.

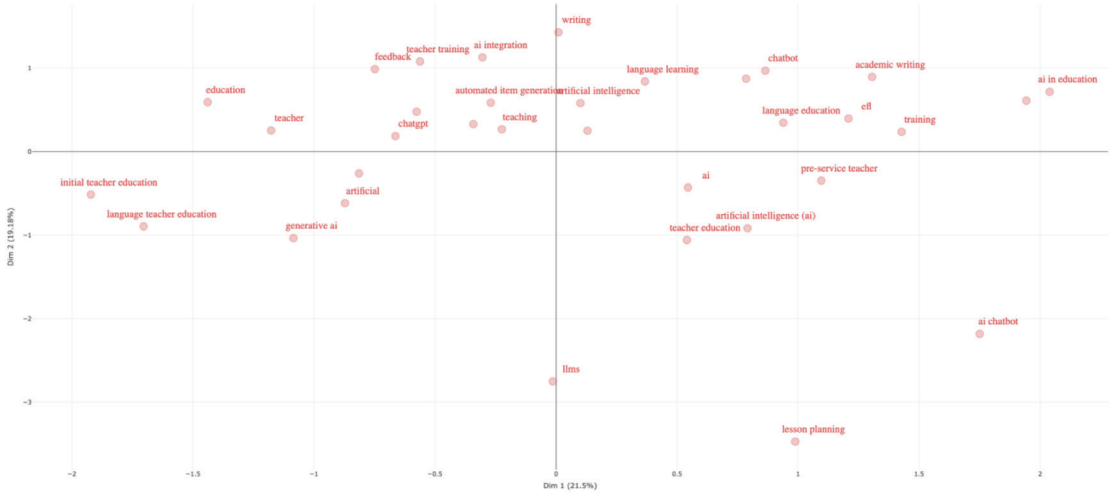

Figure 1 *Factorial Analysis of Keywords Extracted from the Study Corpus*

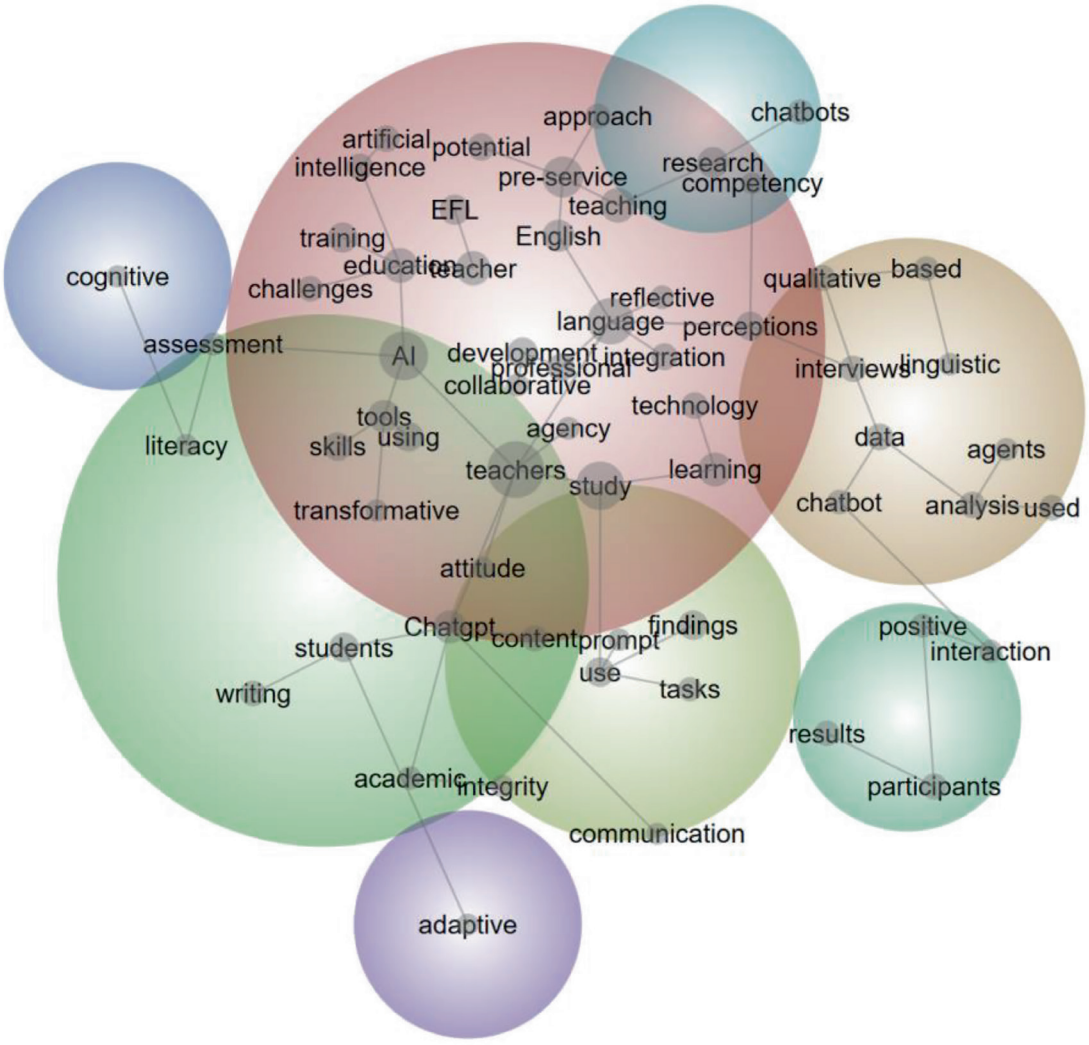

Figure 2 *Text-Mining of Abstracts from the Study Corpus*

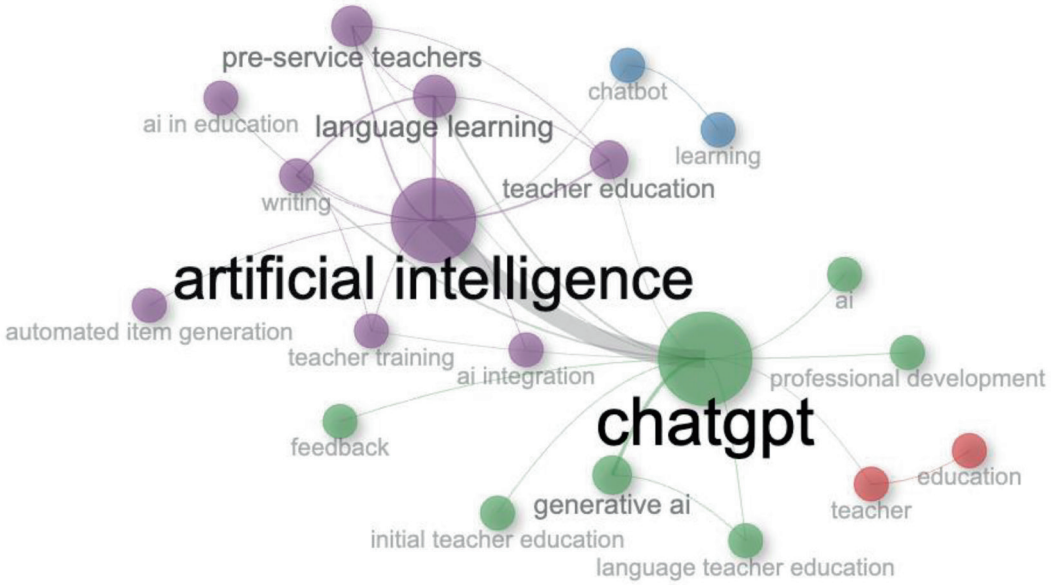

Figure 3 *SNA of Keywords Extracted from Study Corpus*

Theme 1: Professional Development and AI Literacy in Teacher Education

The centrality of professional development and AI literacy as a research theme is strongly substantiated by multiple forms of data analysis. The factorial analysis of article titles, for instance, shows a tight clustering of key terms such as *pre-service teacher, AI in education, and generative AI,* which indicate a primary focus on this area in the literature (Figure 1). This focus is further supported through the text-mining of abstracts (Figure 2), which reveals interconnected conceptual pathways linking *AI, teachers, professional development, and agency* with the need for new *cognitive* skills and *literacy* to leverage these transformative tools. Reinforcing this point, the social network analysis of keywords (Figure 3) positions *professional development* as a strategic node that bridges the concepts of *generative AI* and *language teacher education*. In all, this evidence highlights a significant scholarly focus on the need for structured training and the development of AI-related competencies for educators.

Several studies evaluated structured professional development (PD) programs aimed at building teachers' AI competencies. These ranged from short-term interventions to semester-long courses incorporating reflective journals, AI task experimentation, and collaborative learning activities. Many interventions were framed by models such as TPACK (Mishra & Koehler, 2006), SAMR (Puentadure, 2013), or the UNESCO (2024) framework for AI teacher competencies. For example, Kaya (2024) used cognitive apprenticeship and socio-constructivist approaches to develop instructors' self-efficacy in AI integration. The study found significant improvements in participants' AI-related knowledge and instructional application. Moorhouse et al. (2024) also demonstrated that targeted intervention enhanced teachers' pedagogical and critical AI awareness, though gaps remained in areas such as guiding student use of generative AI. Furthermore, Moorhouse and Konhke (2024) highlighted teacher educators' own uncertainty and the need for institutional support to confidently embed generative AI topics into their curricula. These insights suggest that future PD programs should incorporate not only technical competencies but also emphasize ethical reflection and student-centered AI design.

The findings consistently emphasize the transformative potential of PD when it fosters not only technical proficiency but also transformative agency—teachers' ability to critically evaluate, adapt, and

meaningfully integrate generative AI technologies into their practice (Bahari et al., 2025). Nonetheless, studies also reported gaps in ethical preparedness, especially regarding data privacy, AI bias, and overdependence on automated outputs, which resonate with the calls for more ethically grounded AI literacy in teacher education (Ayanwale et al., 2024; Holmes & Tuomi, 2022; OECD, 2023; UNESCO, 2024).

Theme 2: Chatbots and Conversational AI in Language Learning

Based on the data, the role of chatbots and conversational AI in language learning emerges as another significant research theme. The factorial analysis of titles highlights a distinct cluster around terms like *artificial intelligence, generative AI,* and *AI chatbot,* signaling the importance of this topic in the titles of the reviewed articles (Figure 1). This theme is further explored in the text-mining analysis of abstracts, which uncovers strong associations between *chatbot, ChatGPT, interaction, and communication*, directly linking these tools to the technology of learning (Figure 2). The social network analysis confirms this by showing that *chatbot* and *learning* are strategic nodes connected to *artificial intelligence*, reinforcing the concept of chatbots as a key application of AI in educational settings (Figure 3).

A focused subset of studies explored the design and implementation of chatbots and conversational agents in language education. These studies documented how pre-service teachers created or used AI-powered chatbots in classroom settings, including immersive environments such as the metaverse. Chatbots were reported for their ability to simulate real-time interaction, foster learner motivation, and support communicative competence. Wiboolyasarin et al. (2024) found five factors influencing chatbot design, including learner autonomy and self-directed learning, along with content and interaction design for language skill development. Similarly, Hwang et al. (2025) revealed that teachers in the chatbot-metaverse group within immersive virtual environments created more interactive and authentic learning tasks than the chatbot-only group.

Designing and interacting with chatbots helped pre-service teachers deepen their understanding of language input-output dynamics, learner engagement, and scaffolding strategies. These findings suggest that engaging pre-service teachers in chatbot design not only improves their digital skills but also helps them conceptualize more responsive, learner-centered instruction. These innovations demonstrate the potential of generative AI to serve as both a pedagogical partner and a training tool for future teachers. However, studies also cautioned about chatbot limitations such as cultural insensitivity or conversational rigidity, reinforcing the need for teacher mediation and critical adaptation (e.g., Shin & Lee, 2024).

Theme 3: Generative AI for Instructional Design, Assessment, and Lesson Planning

A third prominent theme identified in the literature is the application of generative AI for practical instructional tasks such as design, assessment, and lesson planning. The factorial analysis of titles in Figure 1 underscores this theme by grouping terms like *AI integration, lesson planning,* and *automated item generation*. The text-mining analysis of abstracts further details this focus, revealing connected pathways between the use of AI *tools* for *assessment* and the application of *prompt* engineering to generate educational *tasks* (Figure 2). Finally, the social network analysis of keywords (Figure 3) solidifies this theme by showing strategic links between *generative AI, feedback,* and *writing,* indicating a strong focus on using these tools to create and evaluate instructional content.

The bibliometric analysis revealed the use of generative AI in instructional design, especially for planning lessons, creating assessment items, and developing teaching materials. These studies showcase how tools like ChatGPT, Q-Craft, or MagicSchool were leveraged to generate reading tests, interactive tasks, and chatbot-based lesson plans. Teachers reported increased efficiency, enhanced creativity,

and access to differentiated resources tailored to learners' proficiency levels. For instance, through an exploratory study, Shin et al. (2025) compared AI-generated questions using a chatbot builder and a GPT-4-based tool, finding both effective for generating reading assessments with minimal human input. Similarly, Kerr and Kim (2025) analyzed how pre-service EFL teachers used generative AI for lesson development, highlighting the role of prompt engineering and critical review in producing effective plans.

Despite these advantages, concerns about the pedagogical depth of AI-generated outputs were noted. For example, while generative AI facilitated task generation and content adaptation, it often fell short in aligning outputs with learner needs or curriculum standards. These insights highlight the importance of equipping teachers with both prompt engineering skills and instructional design frameworks that help them critically evaluate AI-generated content. This calls for a reimagining of teacher preparation, integrating AI-supported instructional design as a core competency in language teacher education.

Theme 4: Generative AI as a Tool for Enhancing EFL Writing Skills

The scholarly focus on leveraging generative AI to enhance EFL writing skills is strongly evidenced across the data. The factorial analysis of article titles reveals a significant cluster around the concepts of *writing, academic writing, feedback,* and *language learning*, indicating this is a primary topic of investigation (Figure 1). This emphasis is further detailed in the text-mining of abstracts, which shows interconnected pathways linking *writing, students,* and *ChatGPT* in academic contexts, as well as highlighting *collaborative* and *reflective* language practices (Figure 2). The social network analysis confirms the centrality of this theme, positioning *writing* as a key strategic node that connects *language learning, teacher education,* and *artificial intelligence* (Figure 3).

A substantial proportion of studies focused on using generative AI, particularly ChatGPT, as a tool to improve English as a Foreign Language (EFL) learners' writing proficiency. These studies highlight the benefits of AI-generated feedback in enhancing grammatical accuracy, lexical variety, and writing structure, often surpassing peer or teacher feedback in perceived usefulness. Participants frequently valued generative AI's immediacy and adaptability, which facilitated independent learning and revision. For example, Kurt and Kurt (2024) remarked that Turkish pre-service teachers valued ChatGPT's adaptability and usefulness, although they noted occasional inconsistencies and dependence on prompt quality. Similarly, Werdiningsih et al. (2024) reported that while students appreciated AI for vocabulary support and content suggestions, they also recognized the importance of human judgment to maintain authenticity in their work.

The studies caution against overreliance and reduced authenticity, noting potential risks to creativity and critical thinking when AI is used without guidance (e.g., Alyami et al., 2025). These findings align with the broader debate in language education about maintaining the balance between technological affordances and learner autonomy (Godwin-Jones, 2023). For language teacher educators, this highlights the need for AI literacy among pre-service teachers in writing pedagogy and suggests that language teacher education programs should include instruction on evaluating and integrating AI-generated feedback responsibly.

Theme 5: Pre-service Teachers' Perceptions and Readiness

A final core theme emerging from the analysis centers on the perceptions, attitudes, and readiness of pre-service teachers to adopt generative AI. The factorial analysis of titles in Figure 1 highlights this focus, with a clear grouping of terms like *teacher training, teacher education,* and *language teacher education.* The text-mining of abstracts provides further detail, revealing distinct conceptual paths that

connect *teachers' attitudes* toward *AI* and research into *pre-service language teachers'* perceptions (Figure 2). This theme is reinforced by the social network analysis in Figure 3, which identifies the interconnected nodes of *teacher, education,* and *AI integration* as a strategic cluster, underscoring the importance of teacher-centric factors in the adoption of this technology.

Many studies examined pre-service English language teachers' beliefs, experiences, and readiness to integrate generative AI into instructional contexts. Using theoretical frameworks such as the Technology Acceptance Model (TAM) (Davis, 1989) and AI-TPACK (Ning et al., 2024), these studies reveal generally positive attitudes toward generative AI, accompanied by uncertainty about ethical issues, critical use, and potential pedagogical constraints. For instance, Mustroph and Steinbock (2024) reported that pre-service teachers saw potential in AI-enhanced teaching but expressed uncertainty about its long-term pedagogical implications. In Ozer-Altinkaya and Yetkin (2025), participants reported enthusiasm toward AI-supported teaching but emphasized the need for targeted training. Similarly, Moorhouse (2024) found that early-career teachers were more familiar with generative AI than beginning teachers, primarily due to exposure through tools like ChatGPT.

This variation in teacher readiness reflects broader concerns in teacher education literature about technological self-efficacy and the need for scaffolded digital pedagogical preparation (Ertmer & Ottenbreit-Leftwich, 2010; Koehler et al., 2013). These findings suggest that language teacher education programs must move beyond surface-level technology exposure to offer systematic training that includes AI ethics, digital authorship, and reflective practice.

Taken together, our five themes both align with and extend prior syntheses. Prior reviews show that post-2022 scholarship has surged but remains largely learner-facing and writing-centric; our writing theme corroborates this trend (e.g., ChatGPT's prominence in ESL/EFL writing), while our teacher-education emphasis (themes 1, 3, and 5) addresses what those reviews flag as a persistent gap in teacher-focused inquiry and outcomes. Specifically, Li et al.'s (2025) review and the ESL/EFL synthesis by Lo et al. (2024) map the rapid uptake of ChatGPT but report comparatively little attention to teacher learning, practicum orchestration, or assessment redesign areas directly reflected in our themes. In addition, GenAI reviews in higher education call for clearer guidance, governance, and embedded training, further validating our emphasis on AI literacy and assessment redesign (themes 1 and 3). Finally, prior reviews emphasized the writing support generative AI tools provided (theme 4) yet also documented risks around feedback quality and academic integrity; our study findings suggest repositioning those insights within teacher education, linking tool affordances to concrete competencies, practicum design, and ethical enactment.

Across themes emerging from our corpus of empirical studies on generative AI in language teacher education, the literature is primarily dominated by surveys, case studies, and exploratory designs, with few longitudinal, comparative, or theory-driven studies. More experimental studies, particularly in authentic teacher education settings, are needed to deeply investigate the relationship between generative AI and language learning and teaching outcomes. As the post-2022 surge in generative AI continues, scholarship on AI in language teacher education will require cross-institutional, mixed-methods research grounded in robust theoretical frameworks, with greater attention to AI literacy, ethics, and preparing teachers to navigate evolving AI capabilities.

In addition to the aforementioned key findings emanating from our analysis, the results across these themes suggest one unifying insight: generative AI is not merely a tool to automate tasks, but a pedagogical agent reshaping how language teachers design, deliver, and reflect on instruction. The reviewed studies collectively argue for the intentional, ethical, and critical integration of generative AI in language teacher education as follows:

- Embedding AI literacy and ethics into curricula
- Providing experiential learning opportunities with generative AI tools
- Supporting reflective and collaborative practices for teacher agency
- Encouraging prompt literacy and critical evaluation of AI-generated content

As language teaching continues to evolve in the generative AI era, teacher education must not only keep pace but lead innovation by fostering teachers who are not just AI users but critical and innovative users of AI.

Conclusion

This study has mapped the evolving discourse on the integration of generative AI in language teacher education through a bibliometric and thematic analysis of recent empirical research. The results indicate that generative AI tools, particularly ChatGPT, are being increasingly adopted across various stages of teacher preparation, from instructional planning to student feedback, transforming both pedagogical approaches and teacher roles. Notably, while the reviewed studies highlight benefits such as increased instructional efficiency, personalized learning design, and support for reflective practice, they also underscore persistent challenges, including ethical concerns, inconsistent digital readiness, and a lack of sustained institutional support. A central insight emerging from the review is that generative AI is not merely a technological add-on but a pedagogical force that is reshaping the core of language teacher education. Generative AI has shown promise in enhancing writing instruction through real-time, adaptive feedback (Yu & Xie, 2025). Yet, concerns about overreliance and authenticity underscore the need for pedagogical mediation. Pre-service teachers, while generally receptive to AI tools, require structured training to critically evaluate, adapt, and ethically implement these technologies in ways that align with learner needs and professional standards. The findings also suggest a need for deliberate curriculum design that incorporates AI literacy, prompt engineering, and socio-technical awareness, especially in response to varying levels of teacher readiness (Satvati et al., 2025).

Studies also reveal generally positive attitudes among pre-service teachers toward generative AI, though accompanied by uncertainty about ethical use and long-term implications, suggesting gaps in teacher preparation programs (Kerr & Kim, 2025; Kovari, 2025). In instructional design and assessment, generative AI tools are valued for their efficiency and adaptability but often require human oversight to ensure alignment with curricular goals. Professional development programs that embed AI training within reflective, constructivist learning frameworks have demonstrated success in building teacher agency (Moorhouse et al., 2024). Finally, conversational AI and chatbots offer new possibilities for communicative competence and learner engagement, particularly when teachers are involved in their design and contextual adaptation.

Limitations and Future Research Directions

Although this study aims to provide a comprehensive overview of generative AI research in language teacher education, several methodological limitations constrain the scope and generalizability of its findings. First, database coverage is inherently partial. Our search strategy drew exclusively on Scopus and the WoS Core Collection, widely regarded as the two most comprehensive indexes of peer-reviewed literature, yet nonetheless characterized by discipline-specific gaps and language biases (Bramer et al., 2017). As a result, pertinent contributions archived in specialist repositories (e.g., ERIC, LLBA), open-access portals (e.g., DOAJ), or multidisciplinary platforms with broader crawl algorithms (e.g., Google Scholar) may have been overlooked. Second, format restrictions further narrow the evidentiary base. Neither Scopus nor WoS systematically indexes grey literature

which includes conference proceedings, doctoral dissertations, white papers, technical reports, or pre-print manuscripts, despite growing recognition that emergent technologies are often discussed first in these outlets (Paez, 2017). Consequently, the empirical and conceptual contours mapped in this review should be interpreted as a conservative estimate of the field's true scope. Third, temporal and linguistic parameters may introduce additional bias. The corpus is bounded by a January 2022–March 2025 window and limited to English language records; early explorations of generative AI published in other languages or before 2022 (particularly in computer-assisted language learning forums) remain outside the analytical frame. Such constraints risk under-representing regional or non-Anglophone perspectives that could nuance, or even challenge, dominant thematic patterns.

Based on the findings of this study, several interconnected recommendations emerge for advancing the integration of generative AI in language teacher education, which can also serve as suggestions for policymakers. First, there is a pressing need to embed AI-specific pedagogies into core teacher education curricula, ensuring that pre-service teachers gain practical experience with generative AI tools in authentic classroom scenarios (Tan et al., 2024). This includes the design of AI-supported writing tasks, chatbot-facilitated communicative activities, and AI-informed assessment practices. Additionally, structured opportunities for developing prompt literacy and critical reflection should be prioritized. Teachers must learn not only how to craft effective prompts to guide generative AI outputs but also how to evaluate these outputs for relevance, appropriateness, and alignment with learning objectives. This goes hand-in-hand with fostering ethical AI literacy, which includes understanding issues such as algorithmic bias, data privacy, digital authorship, and the cultural implications of automated decision-making (Kovari, 2025). As generative AI tools become more prevalent, teacher education programs must cultivate not just technical competence but also ethical discernment. Moreover, professional development models, for in-service teachers, should move beyond one-off workshops and adopt more sustained, practice-oriented frameworks that blend technical training with pedagogical reflection and collaborative exploration. Such models can enhance teacher agency and confidence in using generative AI in ways that align with learner needs and institutional values (Ji et al., 2023). Importantly, language teachers should be viewed not only as users of AI technologies but also as co-designers and evaluators (Kerr & Kim, 2025), actively contributing to the development, customization, and contextualization of AI tools such as chatbots and instructional planning platforms (Wiboolyasarin et al., 2024). Their involvement in design processes can enhance both pedagogical relevance and user trust. Finally, the study underscores the importance of longitudinal, cross-cultural, and practice-based research to effectively capture the evolving dynamics of AI integration. Future research should investigate how generative AI impacts teacher identity, student engagement, and instructional decision-making over time, particularly in diverse sociocultural settings where infrastructure, policy, and pedagogical traditions vary.

Final Remarks

As generative AI accelerates the shift from traditional CALL and MALL toward AILL, language teacher preparation stands at an inflection point (Bahari et al., 2025). The literature reviewed here signals that tomorrow's educators must be more than competent users of discrete AI tools. Indeed, they must become design-savvy orchestrators of human–machine interaction, capable of blending algorithmic adaptivity with pedagogical intentionality, ethical literacy, and cultural sensitivity (Al-Khresheh, 2024; Ding et al., 2024; Hwang et al., 2025). If AILL is to realize its promise of truly personalized, socially responsive language education, teacher education programs must embed AI literacy, prompt engineering, and critical data ethics at their core (Holstein et al., 2019; Kamali et al., 2024a).

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