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AI LITERACY FOR LANGUAGE EDUCATORS: REDEFINING TEACHER TRAINING IN THE POST-DIGITAL ERA

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ABSTRACT

The rapid growth of Generative Artificial Intelligence (GenAI) in education has ushered in a post-digital era that demands a fundamental rethinking of teacher capabilities, particularly in language instruction. This literature study synthesizes thirty-three scholarly sources to investigate the idea of AI literacy for language educators and its implications for teacher education. The investigation reveals a field that grapples with ambiguous notions of AI literacy, often confusing it with broader digital competencies. Significant gaps in AI literacy have been documented empirically across pre-service and in-service teacher populations worldwide, with consistent weaknesses identified in ethical reasoning, critical evaluation, and pedagogical design of AI-enhanced learning domains required for responsible integration. Although language-specific frameworks are emerging, there is still a serious paucity of empirically proven training models. The review finds a contradiction between instructors' positive sentiments regarding AI and their low self-efficacy in practical applications. Key proposals include incorporating multidimensional AI literacy into teacher education courses, including technological, pedagogical, ethical, and critical dimensions. Furthermore, long-term, collaborative professional development approaches need significant expenditure. The conclusion emphasizes the urgent need to empower language educators as critical designers and ethical guides in the AI-augmented classroom, transforming them from passive consumers to adept practitioners capable of leveraging GenAI's potential while navigating its profound pedagogical and ethical challenges.

KEYWORDS: *AI Literacy, Language Teacher Education, Generative AI, Teacher Training, Post-Digital Era*

1. INTRODUCTION

The introduction of Generative language technologies has irreversibly changed the educational landscape, bringing in a post-digital era where technology is no longer a side tool but a transformative element embedded in the heart of teaching and learning (Stockwell, 2024; Pegrum, 2025). This change in language instruction is both revolutionary and disruptive. Tools like advanced language models provide unprecedented levels of personalized language practice, automated content creation, and instant feedback. These capabilities challenge traditional teaching methods and reshape the roles of both teachers and students (Du & Daniel, 2024; Nyaaba et al., 2024). However, this rapid innovation has exposed a significant and urgent gap in educator preparedness, creating the need for a global effort to rethink the essential skills required for language instruction (Sperling et al., 2024; Trust et al., 2023; Nabi et al., 2025).

This situation calls for a shift from basic digital literacy to a critical and specialized form of literacy suited to the demands of language teaching (The Open University, 2025; Ma et al., 2024). According to Tour et al. (2025) and Walter (2024), this literacy involves not only the technical skills to use these tools but, more importantly, the teaching expertise to integrate them effectively, the ethical judgment to handle bias and academic integrity, and the critical ability to assess the cultural and communicative appropriateness of generated language. Yet, inconsistent definitions, large skill gaps among pre-service and in-service teachers, and a lack of validated professional development models characterize the current state of teacher training (Karaduman, 2025; Lázas, Guerra, & Ferreira, 2024).

This study summarizes current research to address this need. It examines the disruptive emergence of these technologies in language education, critically analyzes the concept of literacy in this context, and maps the documented gaps in teacher preparedness across multiple settings. Furthermore, it evaluates existing frameworks and teaching methods for developing this literacy, with particular attention to the ethical and critical components that remain weak. This review aims to provide a full framework for rethinking language teacher training, showing

that equipping educators with solid, thoughtful literacy in these tools is essential for the future of language education in the post-digital era.

2. THE RISE OF AI IN LANGUAGE EDUCATION AND THE POST-DIGITAL SHIFT

Language instruction is undergoing a fundamental transformation due to the rapid growth and advancement of generative language technologies. This change brings a post-digital era in which technology is no longer a supplementary tool but a central and disruptive force that reshapes core educational practices (Stockwell, 2024). The journey began with rule-based, scripted computer-assisted language learning (CALL) tools designed for predictable, task-oriented practice following skill-acquisition theory (Godwin-Jones, 2022). However, the introduction of generative models, particularly large language models like ChatGPT, represents a sharp break from earlier, more constrained systems. These models can generate fluent, context-aware dialogue and text (Woollaston et al., 2024; Zhu and Wang, 2024). The speed at which these tools were adopted, with ChatGPT becoming the fastest-growing consumer application in history, forced educational institutions to confront a significant gap in systemic readiness (Trust et al., 2023). This technological development can be seen as a seismic shift in the landscape of practice for language instructors (Wenger-Trayner & Wenger-Trayner, 2015).

A teacher's professional world is composed of interconnected communities of practice, including the “Grammar Teaching” community, the “Communicative Language Teaching” community, and the “Assessment” community. The integration of generative models introduces new landmarks into this familiar terrain, such as rapid content generation, algorithmic bias, and ethical considerations in technology use. It also creates new and complex boundaries between existing communities and emerging technology-focused communities. For example, a teacher must now negotiate the boundary between their pedagogical expertise in giving formative feedback (the Assessment community) and the technical understanding of how to effectively prompt a model to generate that feedback. According to Wenger-Trayner and Wenger-Trayner (2015), the main challenge is to develop the “boundary competence” necessary to translate knowledge and reconcile practices across these domains, integrating new technology-related skills without losing the core pedagogical identity.

This shift is fundamentally changing the roles of both teachers and students. Generative models are increasingly positioned as both a learning companion for students, offering personalized practice and nonjudgmental feedback, and as a teaching assistant for educators, automating tasks such as material creation and assessment design (Nyaaba et al., 2024; Ramana et al., 2024). This dual role requires teachers to move from being the primary source of information and basic feedback to facilitators of higher-order critical thinking, communication, and ethical management of technological tools (Du & Daniel, 2024; Stockwell, 2024). The shift is not only technical but also pedagogical, demanding new skills that extend beyond traditional digital literacy (Pegrum, 2025).

The discussion around this integration has often been polarized between utopian enthusiasm and dystopian concern. A more balanced perspective is now emerging. Some researchers suggest that the impact of generative technologies should be understood as an evolutionary process in which technology is gradually and thoughtfully integrated into the complex social, political, and cultural ecosystem of education (Pegrum, 2025). This perspective highlights significant benefits, such as automating routine tasks and enhancing language practice, while also warning against risks, including threats to academic integrity, the spread of bias, and potential over-reliance by students (Cogo et al., 2024; Stockwell, 2024). This balanced, critical stance provides the foundation for the new literacy expectations placed on language educators in the post-digital era.

3. FRAGMENTED DEFINITIONS OF AI LITERACY IN TEACHER EDUCATION

As the need for educational preparedness in the use of advanced learning tools becomes more apparent, a serious difficulty has emerged: the idea of "AI literacy" itself remains fragmented and inconsistently articulated throughout the literature (Sperling et al., 2024). A thorough scoping review reveals that the term is frequently used imprecisely, being conflated with or subsumed under broader concepts such as "computational thinking" or "digital literacy," failing to capture the unique challenges posed by autonomous, data-driven learning systems (Sperling et al., 2024). The absence of a standardized conceptual framework hinders teacher education programs from designing effective curricula, leaving educators unsure of the specific knowledge and skills required (Sperling et al., 2024; Peña-Acuña & Durão, 2024). To address this conceptual confusion, numerous frameworks have been developed to structure the domain of AI literacy for educators. Early models frequently emphasized a tripartite structure of information, skills, and attitudes, which, while important, sometimes lacked the granularity required for language training (Lérias, Guerra, & Ferreira, 2024). Ma et al. (2024) made a significant contribution by developing the six-construct ChatGPT literacy model, which provided an experimentally verified framework particular to language instructors and included aspects of Benefits, Limitations, Prompts, Evaluation, Assessment,

and Ethics. This approach was critical in shifting the field away from a binary perspective of AI adoption (use versus non-use) and toward a multidimensional understanding of competency.

Further developing these principles, broader frameworks have been constructed to emphasize the critical and ethical factors required for responsible integration. The Open University (2025) suggested a Critical AI Literacy paradigm with four components: technological/data literacy, functional/application literacy, ethical literacy, and critical/reflective literacy. This approach expressly emphasizes critical reflection on AI's societal impact and the preservation of human agency as non-negotiable components. Walter (2024) defined a "triumvirate" of necessary skills, including AI Literacy (conceptual knowledge), Prompt Engineering (functional skill), and Critical Thinking (evaluative capacity). These growing frameworks show a field in the process of consolidating, gradually shifting from fragmented definitions to a more holistic understanding that incorporates technical, pedagogical, and critical competencies.

4. AI LITERACY GAPS IN PRE-SERVICE TEACHER TRAINING

Empirical investigations have shown that pre-service teachers (PSTs), the next generation of educators, enter the profession with considerable gaps in AI literacy and ability. In the case of China, a large-scale study indicated that teacher trainees exhibited an "insufficient" AI knowledge reservoir, "weak" AI ability, and AI awareness that still required improvement, exposing a comprehensive gap across cognitive, skill, and attitudinal dimensions (Shi, 2024). This widespread lack of preparation is especially acute among language educators. A qualitative study of pre-service English as a Foreign Language (EFL) teachers in Turkey discovered that they lacked confidence in their practical skills, struggled with conceptual understanding, and reported receiving little to no formal AI literacy training in their teacher education curriculum (Karaduman, 2025). This indicates a systemic failure to equip future language educators with the tools needed for the classrooms they will inherit.

The specific nature of these gaps frequently distinguishes literacy and competency. PSTs may have a favorable attitude and identify the potential benefits of AI as a teaching assistant and learning friend, but their self-assessed competence to apply this knowledge pedagogically is limited (Nyaaba et al., 2024; Karaduman, 2025). This attitude-competency gap is a major problem because it shows that teacher trainees understand the value of AI but are ill-equipped to apply that knowledge in effective and ethical classroom practice. Their ethical concerns, particularly about academic integrity and bias, are frequently high, but they lack the skills and guided experience to build meaningful solutions for dealing with these difficulties (Karaduman, 2025).

This widespread deficiency among PSTs is directly linked to a glaring omission in Teacher Education (TE) programs. Peña-Acuña & Durão's (2024) systematic review found that while there is growing research on AI's impact on student language learning, there is a lack of practical guidance and approved frameworks for educating pre-service language teachers. The contemporary TE landscape is marked by a lack of integrated AI literacy curriculum, forcing PSTs to rely on self-initiated, informal exploration of tools such as ChatGPT without the requisite critical and pedagogical scaffolding (Karaduman, 2025; Nyaaba et al., 2024). A pattern of reactive rather than proactive professional development is perpetuated by this absence of rigorous pre-service preparation, which produces a pipeline of new teachers unprepared for the reality of technology-integrated classrooms.

5. AI LITERACY CHALLENGES AMONG IN-SERVICE EDUCATORS AND HIGHER EDUCATION FACULTY

The challenge of AI literacy is not limited to pre-service teachers; in-service educators and higher education faculty also face major gaps in preparation. Empirical investigations conducted in various global contexts consistently reveal a medium-high overall level of AI digital competency, but this aggregate score conceals serious deficiencies in certain crucial domains (Ng et al., 2023; Lérias, Guerra, & Ferreira, 2024). For example, a large-scale study of primary and secondary school teachers in Hong Kong discovered that, while technical knowledge was the highest-rated competency, understanding of the ethical and societal implications of AI was the lowest, indicating a concerning technocentric focus that ignores the profound social and moral dimensions of these tools (Ng et al., 2023). This pattern is particularly evident among language educators, who, while understanding the benefits and general ethics of AI, perform poorly on the practical and critical competencies of assessment and prompt engineering (Ma et al., 2024). A recurring theme in the research is the disparity between positive attitudes and practical proficiency. Many in-service instructors recognize AI's potential value for improving teaching and streamlining administrative tasks, demonstrating high perceived usefulness, a key factor in the Technology Acceptance Model (Ng et al., 2023; Lérias, Guerra, & Ferreira, 2024). However, this positive attitude frequently coexists with low self-efficacy and a self-assessed lack of the skills required to integrate AI effectively and ethically into their pedagogy (Lérias, Guerra, & Ferreira, 2024; Nabi et al., 2025; Acquah et al., 2025). This "attitude-skill" gap suggests that professional development should go beyond motivating speeches and include

hands-on, practical training that develops tangible competencies. Contextual and systemic variables, rather than individual effort, have a significant impact on in-service instructors' AI literacy development. Research on English as a Foreign Language (EFL) teachers has shown that institutional support, including access to resources, dependable technical infrastructure, and dedicated professional development time, is the single most important predictor of digital literacy development, which serves as a foundational layer for AI literacy (Zhang, 2023; Nabi et al., 2025). Furthermore, a favorable school culture and strong peer influence, in which colleagues collaborate to share best practices, indirectly improve competency by creating an environment of creativity and mutual support (Zhang, 2023). This emphasizes the need for systemic investment and leadership to close the AI literacy gap. Even the most eager educators will find it difficult to acquire the requisite knowledge in the absence of a supportive institutional setting that offers the tools and cultural encouragement for experimentation (Kelley & Wenzel, 2025; Nyaaba, 2024).

6. LANGUAGE-SPECIFIC AI LITERACY FRAMEWORKS

Recognizing that generic AI literacy models are insufficient, researchers have begun to create frameworks adapted to the specific needs of language teaching. These specialized models address the reality that language is more than a set of rules; it is also a medium for communication, culture, and identity, all of which are relevant to AI use. Ma et al. (2024) validated a six-construct framework for ChatGPT literacy, which includes Benefits, Limitations, Prompts, Evaluation, Assessment, and Ethics. This framework was created for and empirically tested with language teachers, making it an essential tool for identifying abilities and creating targeted instruction.

Building on this, Tour, Pegrum, and Macdonald (2025) established a conceptual framework specifically for engaging English Language Learners (ELLs) in AI literacy practices. Their model is important because it adds a third, language-specific factor to the existing technical and ethical components. It consists of three parts: (1) Technical/Functional Literacy (the 'how' of tool functioning), (2) Ethical/Critical Literacy (the 'why' of prejudice and social impact), and (3) Communicative/Cultural Literacy (the 'what' of language appropriateness, tone, and cultural authenticity). This third component is a key innovation because it enables educators to teach students how to critically evaluate AI-generated language not only for accuracy but also for its usefulness in real-world communicative contexts, recognizing AI as a "cultural artifact" rather than an objective tool.

These frameworks transform the teacher's position from a passive technology consumer to an active designer of AI-integrated learning experiences. This viewpoint is effectively stated through the lens of Activity Theory, as evidenced in Li, Zhou, Yin, and Chiu's systematic review (2025). Their model describes chatbot-supported learning as a system in which the Subject (learner), Tools (chatbot), Object (learning goal), Rules (pedagogical guidelines), Community, and Division of Labor (teacher-AI-student roles) interact. This theoretical approach provides a strong framework for language educators to intentionally create activities that determine how AI will mediate learning, ensuring that the tool serves pedagogical goals rather than dictating them. It enables teachers to make strategic decisions about the division of labor by defining when the AI provides corrective feedback and when the teacher facilitates higher-order discussion or cultural interpretation.

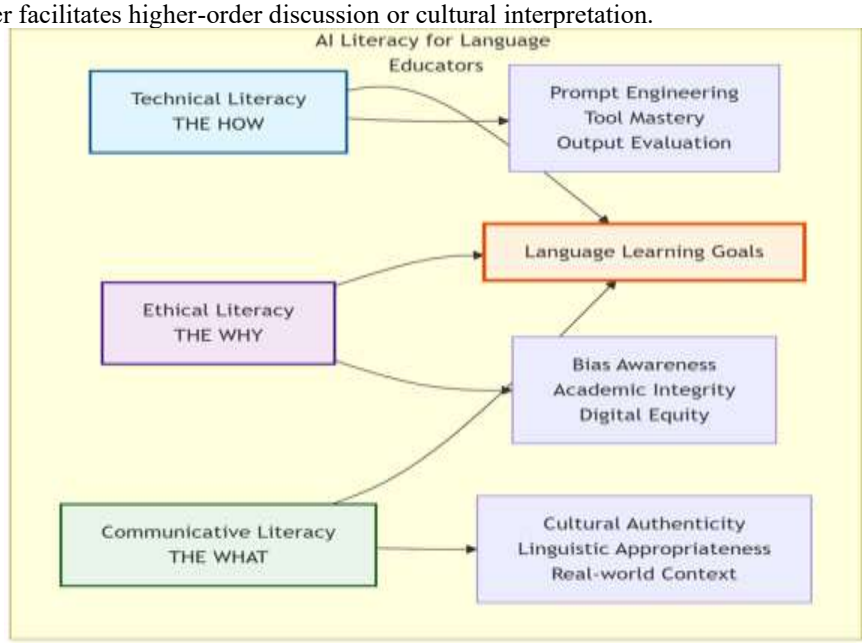


Figure 1: Three-Dimensional AI Literacy Framework for Language Educators

Interpretation of Diagram 1:
This framework illustrates that AI literacy for language educators requires three interconnected dimensions:

- Technical Literacy (Blue): The practical "how-to" skills needed to operate AI tools effectively
- Ethical Literacy (Purple): The critical understanding of "why" AI decisions matter for fairness and equity
- Communicative Literacy (Green): The language-specific "what", evaluating AI output for cultural and linguistic appropriateness

Key Insight: All three literacies must work together to serve the central goal of effective language learning. A teacher who is strong in technical skills but weak in ethical awareness risks perpetuating AI biases. Similarly, ethical concern without communicative competence may lead to culturally inappropriate AI use in language teaching contexts.

7. ETHICAL AND CRITICAL AI LITERACY AS PERSISTENT WEAK POINTS

Across all teacher groups, pre-service, in-service, and higher education faculty studies consistently identify ethical and critical literacy as the most underdeveloped aspect of AI proficiency. Empirical evidence from various scenarios shows that practical instructors consistently get the lowest scores on AI digital competency scales in the "Ethics and Societal Implications" category (Ng et al., 2023). Similarly, while language teachers may claim to be highly aware of ethical issues, their practical ability to manage these challenges in complex classroom situations, such as evaluating biased AI output or preventing student over-reliance, remains a significant weakness (Ma et al., 2024; Karaduman, 2025). This disconnect between theoretical knowledge and actual, crucial skills is a fundamental impediment to responsible AI integration.

The ethical problems are numerous and especially apparent in the culturally and subjectively complicated field of language education. Key concerns raised in the literature include algorithmic bias, in which AI tools may perpetuate stereotypes or provide culturally insensitive language; issues of academic integrity and the blurring of the line between student work and AI-generated content; and data privacy concerns regarding the input of student data into corporate AI platforms (Cogo, Patsko, & Szoke, 2024; Stockwell, 2024; Daher, 2025). Furthermore, experts such as Pegrum (2025) call on the profession to explore broader key issues, such as the environmental cost of powering massive AI models and the possibility that AI integration would worsen existing digital inequalities, disproportionately hurting underprivileged student populations.

Addressing this critical literacy gap demands a shift from basic awareness-raising to instructional techniques that encourage deep, deliberate involvement. Dilek, Baran, and Aleman's (2025) "Critical Co-Discovery" approach serves as a prime example. This method places educators as collaborative critical investigators, investigating GenAI technologies while also examining the ethical, prejudiced, and educational consequences of the AI's output. Teachers who participate in this approach gain not just Tool Literacy but also Ethical Literacy (understanding bias and fairness), Pedagogical Literacy (application in teaching), and Design Literacy (developing AI-integrated assignments). This concept is critical for integrating ethical concern into practical professional judgment, allowing teachers to become "designers of responsible AI practice" rather than passive consumers of technology.

8. PEDAGOGICAL AND DESIGN-FOCUSED AI LITERACY

Beyond the operational usage of AI tools, a higher-order dimension of AI literacy entails the pedagogical and design skills required to incorporate these technologies meaningfully into language learning activities. This elevates the teacher's position from ordinary technology user to curricular designer and pedagogical architect (Dilek, Baran, & Aleman, 2025; Kelley & Wenzel, 2025). Effective integration is about harnessing AI's capabilities to meet specific learning objectives, which necessitates a thorough understanding of second language acquisition concepts and instructional design (Tour, Pegrum, & Macdonald, 2025). This design-focused literacy allows educators to move beyond automation and toward pedagogical revolution.

Activity Theory, which offers a framework for creating AI-supported learning as a cohesive system, is a potent theoretical lens for comprehending this integration. AI chatbots serve as a tool that mediates the activity between the Subject (the learner) and the Object (the learning goal), as Li, Zhou, Yin, and Chiu (2025) demonstrate in their systematic review. However, the Community (the classroom), the Division of Labor (the changing roles of the teacher, student, and AI), and the Rules (pedagogical guidelines and task design) determine how effective this system is. This perspective gives teachers a powerful toolkit for intentional course design. For example, an instructor can establish clear guidelines that require students to actively analyze and improve conversations generated by AI. Alternatively, they might strategically divide responsibilities, allowing the AI to provide initial grammar corrections while the teacher dedicates their time to guiding students in developing more persuasive arguments and sharper critical thinking skills (Li, Zhou, Yin, & Chiu, 2025).

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The reimagination of assessment is central to this pedagogical literacy, an area in which instructors worldwide express poor confidence (Ma et al., 2024). In the age of GenAI, traditional output-based evaluations such as essays are vulnerable to automation, prompting a move to process-oriented, multimodal, and collaborative assessments that AI cannot simply mimic (Stockwell, 2024). Pedagogically literate teachers create assessments that incorporate AI as part of the process, such as having students document their iterative prompt engineering to refine an AI-generated text or using AI for peer-review simulations, while the final evaluation focuses on the student's demonstrated critical engagement and metacognitive reflection (Dilek, Baran, & Aleman, 2025). This approach is consistent with the call for "pedagogical modeling" in teacher education, which changes the focus from material delivery to building complex, AI-enhanced learning performances (Nyaaba, 2024).

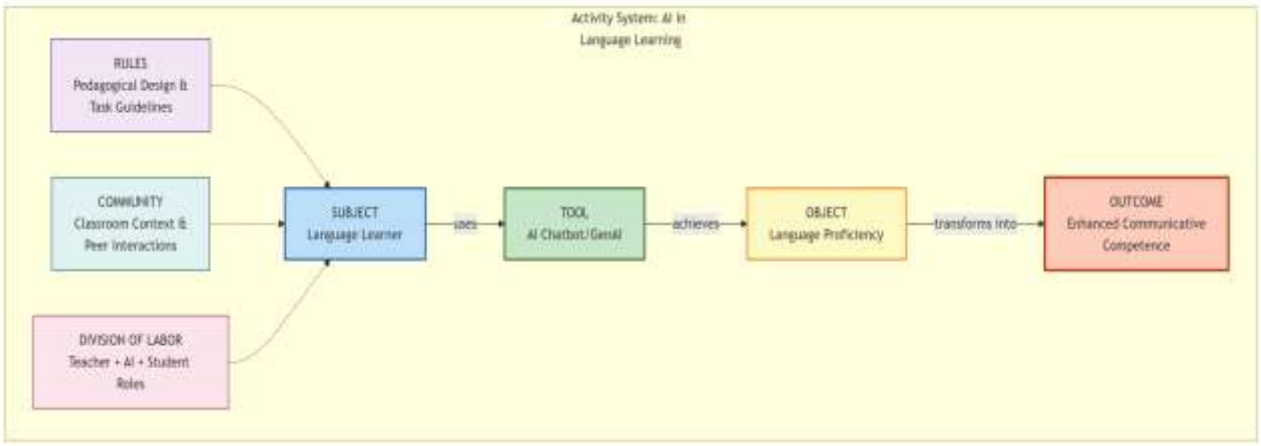


Figure 2: Activity Theory Framework for AI-Enhanced Language Learning

Interpretation of Figure 2:
This Activity Theory model shows how AI integration transforms the entire language learning ecosystem:
Core Activity Flow (Solid Lines): The learner (Subject) uses AI tools to achieve language proficiency (Object), resulting in enhanced communicative competence (Outcome).
Contextual Influences (Dashed Lines):

- Rules: Pedagogical decisions determine how AI is used (e.g., "AI for grammar feedback only")
- Community: Classroom dynamics and peer interactions shape AI adoption
- Division of Labor: Redefines roles (AI handles routine tasks, teachers focus on higher-order thinking)

Critical Implication: Successful AI integration requires careful design of ALL system elements. Changing the AI tool (Tool) necessitates rethinking teacher roles (Division of Labor), assessment methods (Rules), and social interactions (Community). The model emphasizes that technology never operates in isolation; it transforms the entire educational activity system.

9. TECHNICAL AND FUNCTIONAL AI LITERACY (PROMPTING, EVALUATION, TOOL MASTERY)

While critical and pedagogical literacies are crucial, they must be undergirded by a solid foundation of technical and functional abilities that enable educators to interact effectively with AI systems. This facet of AI literacy includes the practical skills required to use AI tools, design effective prompts, and critically evaluate their outcomes (Walter, 2024; The Open University, 2025). Without these functional competencies, teachers' well-intentioned pedagogical designs will fail in practice, resulting in frustration and rejection of technology. Empirical evidence confirms that functional skills, particularly in prompt engineering and output evaluation, are critical for educators (Ma et al., 2024; Chen et al., 2025).

Walter (2024) describes prompt engineering as a "key competency" and an essential feature of "Functional/Application Literacy" (The Open University, 2025). It is a practical technique that enables teachers to convert their instructional goals into particular, high-quality, and contextually relevant AI outputs. Language educators must create prompts that elicit linguistically appropriate and pedagogically sound materials, such as reading passages at a specific CEFR (Common European Framework of Reference for Languages) level, dialogues that exemplify a target grammatical structure, or simulated conversations for diverse cultural contexts (Tour, Pegrum, & Macdonald, 2025). Mastery of rapid engineering is thus more than just a technical skill; it serves as a critical link between instructional design and practical application.

The functional ability to assess and troubleshoot AI results is equally important. Instructors need to be skilled at spotting AI-generated content, evaluating its veracity, and spotting any "hallucinations" or biases (Chen et al., 2025; Walter, 2024). This is particularly important in language instruction, where linguistic accuracy, cultural appropriateness, and subtleties of fluency are crucial (Tour, Pegrum, & Macdonald, 2025). Furthermore, technical literacy includes the capacity to manage the inherent limitations of AI systems, such as inaccurate speech recognition in chatbots or unanticipated mistakes, as well as offer students troubleshooting solutions (Du & Daniel, 2024). Professional development programs such as the "AI Academy" have shown that focused training can result in significant gains in these functional areas, including GenAI tool use and AI-generated content detection, demonstrating that these competencies are both measurable and teachable (Chen et al., 2025).

10. STUDENT EXPECTATIONS FOR AI-ENABLED LANGUAGE TEACHING

The increasing expectations of the students themselves, who are becoming more digital natives and tech consumers, further emphasize the necessity of teacher AI literacy. There is a clear need for educators who can successfully use digital tools, such as AI, to create more individualized and responsive learning experiences, according to research on the viewpoint of students (Lü, 2025). In particular, university students have grand expectations for their foreign language instructors to be Data Literacy Competent (DLC), which includes using AI tools for digital assessment, personalized learning, and providing dynamic, data-informed feedback (Lü, 2025). This student voice offers a compelling, demand-side justification for the pressing need to rethink teacher preparation.

Students recognize the psychological and practical benefits that AI-mediated learning can offer. According to research on AI-powered chatbots, students value the 24/7 availability of a conversation partner and the "non-judgmental" practice environment, which effectively reduces speaking anxiety and increases their willingness to communicate (WTC), benefits that are difficult to replicate at scale in traditional teacher-led classrooms (Du & Daniel, 2024; Ramana et al., 2024). This student preference for low-stakes, on-demand practice raises the expectation that teachers will be able to curate, recommend, and seamlessly incorporate these AI tools into the broader language curriculum, linking informal practice and formal instruction.

However, this student-driven demand introduces new obstacles and underscores the importance of critical AI literacy. The language surrounding AI in education is frequently molded not by pedagogical specialists but by tech firms, policymakers, and administrators, a dynamic that can reduce teachers to mere "objects of AI discourse" rather than empowered professionals (Kennedy & Castek, 2025). This emphasizes the vital significance of preparing instructors not only to meet student expectations for technology integration but also to critically moderate them. Educators need to be ready to help students utilize AI responsibly and ethically, teaching them to be aware of its biases and limitations as well as to retain their own academic agency (Tour, Pegrum, & Macdonald, 2025; Cogo, Patsko, & Szoke, 2024). Therefore, in the post-digital learning environment, a teacher must be technically skilled and a critical mentor and ethical role model to match students' expectations.

11. SYNTHESIS OF GAPS IN THE CURRENT LITERATURE

A comprehensive synthesis of the reviewed literature reveals several persistent and interconnected gaps that hinder the systematic development of AI literacy among language educators. For starters, there is a distinct paucity of empirically verified, subject-specific training models. Although there are numerous conceptual frameworks and theoretical models (e.g., Sperling et al., 2024; Tour et al., 2025) and isolated professional development programs that show promise (Chen et al., 2025; Yang & Kong, 2024), there is a critical shortage of large-scale, longitudinal studies that test the efficacy of these models specifically within language teacher education programs (Peña-Acuña & Durão, 2024; Nabi et al., 2025; Acquah et al., 2025). Because of the lack of empirical validation, institutions are unable to confidently implement evidence-based procedures.

Second, the literature reveals a severe lack of ethical and critical literacy in practice. Although ethical considerations are widely recognized as a major shortcoming (Ng et al., 2023; Ma et al., 2024), most research only identifies the problem. There is a scarcity of research that goes beyond diagnosis to create, implement, and test concrete pedagogical strategies or professional development modules that improve teachers' ability to navigate algorithmic bias, data privacy, and academic integrity in their daily practice (Daher, 2025; Karaduman, 2025; Nabi et al., 2025). The gap between ethical awareness and actionable skill remains a significant hurdle.

Third, critical domain-specific competencies are still being established and not fully integrated into mainstream frameworks. The critical facet of "Communicative/Cultural Literacy," introduced by Tour et al. (2025), which addresses the unique challenges of linguistic authenticity and cultural complexity in AI-generated language, is not yet a standard component of most AI literacy frameworks or tests. Furthermore, assessment literacy is a

particularly acute deficiency in the AI era, teachers are unsure how to construct reliable evaluations that either utilize AI or reduce its potential for abuse, revealing a gap that ties directly to basic pedagogical practice (Ma et al., 2024; Stockwell, 2024; Nabi et al., 2025). Finally, the field lacks longitudinal and qualitative studies. Because AI technology evolves so quickly, snapshots of instructor skill go out of date. There is an urgent need for research that monitors the long-term development of teacher AI literacy and employs rich qualitative methods to investigate the lived experiences, identity negotiations, and socio-cultural dynamics of teachers who incorporate AI into their language classrooms (Kennedy & Castek, 2025; Zhang, 2023; Nabi et al., 2025).

12. IMPLICATIONS AND RECOMMENDATIONS FOR FUTURE TEACHER TRAINING

The synthesis of literature has clear and urgent consequences for redesigning language teacher education in the post-digital era. A comprehensive, systemic revamp is necessary, transitioning from ad hoc workshops to a continuous, integrated, and critical approach. The ideas below provide a detailed path for this transition, covering curriculum, professional development, equity, and policy.

12.1 Curricular Redesign and Integration

First, teacher education courses must be completely revised to integrate AI literacy as a required, cross-cutting core ability. Pre-service integration is crucial to fill a global gap (Karaduman, 2025; Peña-Acuña & Durão, 2024). Adding a single educational technology course is insufficient; AI literacy must be integrated vertically and horizontally throughout the entire teacher development program. Curricula should be expressly designed on holistic frameworks such as the Critical AI Literacy model (The Open University, 2025) or Tour et al.'s language-specific model (2025), guaranteeing that technical skills, pedagogical design, and ethical criticality are trained simultaneously. For example, a methodology course for teaching writing should include modules on using GenAI to produce essay questions, as well as critical debates on how to train students to recognize and evaluate AI-generated work for arguing fallacies or stylistic blandness. A practicum seminar should encourage teacher candidates to document and reflect on their attempts to incorporate an AI tool into a lesson plan, examining the ensuing division of labor among themselves, the student, and the technology (Li, Zhou, Yin, & Chiu, 2025). This widespread integration ensures that AI is not considered as a distinct technical talent but rather as an integral aspect of modern pedagogical reasoning.

12.2 Investment in Sustained and Collaborative Professional Development

Second, educational authorities and institutions need to make investments in models of professional development for in-service teachers that are collaborative, scalable, and sustainable. It has been demonstrated that the conventional one-time workshop format is insufficient for developing the sophisticated skills necessary for crucial AI integration (Chen et al., 2025). Instead, funding and support should be channeled into evidence-based models that prioritize ongoing collaboration and peer support. Several proven approaches can serve as blueprints, including the "AI Academy" (Chen et al., 2025), which provides a structured, multi-faceted learning journey; the "Critical Co-Discovery" approach (Dilek et al., 2025), which brings educators together to jointly critique AI outputs and build knowledge; and the "Professional Partnership Inquiry" (Kelley & Wenzel, 2025), which empowers teachers to conduct action research on AI integration in their own classrooms. For instance, a school district could launch a year-long "Critical Co-Discovery" program in which small groups of language teachers meet monthly to analyze student interactions with a conversational AI, collaboratively developing guidelines for identifying and discussing cultural biases in the AI's responses. Furthermore, systemic reform must be governed by broad frameworks such as EQUIP (Daher, 2025), which emphasizes Ethical governance (Establishing clear institutional policies and oversight for data privacy, algorithmic bias, and academic integrity), Qualified professional learning (Providing deep, sustained training that moves beyond technical skills to address pedagogical and ethical implications), Unified collaborative partnerships (Fostering collaboration between educators, policymakers, industry, and the community), Implementation readiness (Ensuring the necessary technological infrastructure, resources, and leadership support are in place), and Progressive adaptation (Maintaining a flexible, iterative approach to keep pace with rapidly evolving AI technologies and practices).

This holistic structure ensures that professional development is not an isolated event but a continuous process embedded within institutional policies, technological infrastructure, and a culture of ongoing learning. Recent evidence from STEM education demonstrates that long-term, equity-focused, and collaborative professional development models are more effective in promoting innovation and sustaining teacher competency than one-off workshops (Acquah et al., 2025). By applying these lessons to AI literacy, educational institutions can support teachers in developing both the technical and critical skills required for meaningful AI integration.

12.3 A Non-Negotiable Focus on Equity and Ethical Leadership

Third, all AI literacy projects must prioritize equity and ethical leadership. As Daher (2025) persuasively cautions, without a critical and equity-driven approach, AI integration risks widening the digital divide and disadvantaging marginalized students. Teacher education must expressly equip educators to become ethical leaders and advocates. This entails moving beyond abstract talks of bias and toward real training in critically auditing AI tools for linguistic, racial, and cultural stereotypes (Tour et al., 2025). It necessitates providing instructors with the ability to construct inclusive learning activities that do not presume universal or equitable access to high-end AI tools beyond the classroom. Furthermore, educators must be prepared to engage students in critical discussions concerning AI's socioeconomic and environmental consequences, ranging from data center energy use to data annotation labor practices (Pegrum, 2025). This puts the language educator as a vital mediator, an ethical role model, and a custodian of human-centered learning ideals in a complex socio-technical system (Cogo et al., 2024; Kennedy & Castek, 2025).

12.4 Policy, Leadership, and Systemic Enablers

Finally, without supportive leadership and policy, transformation cannot be successful. According to Daher (2025), the EQUIP paradigm correctly recognizes "Ethical Governance" and "Implementation Readiness" as fundamental pillars. This suggests that to create clear guidelines for the appropriate and moral application of AI in educational contexts, ministries of education, accreditation organizations, and teacher training institutions must work together. These regulations should cover important topics, including the privacy of student data, academic integrity in the era of GenAI, and rules for acquiring AI tools that are good for education. School and district leaders must be prepared to serve as "gatekeepers" and conveners (Tondeur et al., 2019), ensuring robust technological infrastructure, allocating dedicated time for teacher collaboration and professional development, and cultivating a school culture that encourages innovation while remaining critical. Leadership is critical for establishing the united collaborative alliances between universities, schools, and industry required to keep teacher education relevant in the face of rapidly evolving technologies.

12.5 A Robust and Targeted Future Research Agenda

To support these proposals, a broad and focused future research program is required. Methodological diversity and an emphasis on impact should characterize this agenda. Key priorities include:

1. Developing and Validating Performance-Based Assessments: The field must urgently move beyond self-report questionnaires. Research must focus on developing dependable, performance-based measures to assess the many characteristics of teacher AI literacy. Assessments, for example, could include evaluating a teacher's ability to design an AI-integrated lesson plan that includes a strategy for mitigating algorithmic bias or their ability to create a sequence of prompts to generate a pedagogically appropriate reading comprehension text (Chen et al., 2025; Tour et al., 2025).
2. Conducting Longitudinal and Qualitative Studies: There is a lack of research on the long-term growth of teacher AI literacy and its impact on student results. Longitudinal research is required to see how teachers' methods change over time while utilizing AI. Furthermore, comprehensive qualitative investigations, such as ethnographies and in-depth case studies, are required to understand instructors' lived experiences, identity struggles, and socio-cultural dynamics as they integrate AI into their language classrooms (Zhang, 2023; Kennedy & Castek, 2025).
3. Promoting Cross-Disciplinary Collaboration in Tool Design: Research should examine and assess collaboration models among language education specialists, AI researchers, and instructional designers. The goal is to move beyond repurposing generic LLMs and toward developing the next generation of pedagogically sound AI tools based on an understanding of second language acquisition principles, communicative competence, and cultural context (Kelley & Wenzel, 2025; Daher, 2025).

In summary, reinventing teacher preparation for the AI era entails more than just acquiring new technical skills. It is about fostering a profound pedagogical shift, developing a generation of language educators who are critically literate, ethically grounded, and design-minded professionals who can confidently harness the potential of AI to enrich language learning while thoughtfully navigating its challenges to protect education's core humanistic values. This calls for a systemic, sustained, and ongoing commitment from all stakeholders in the educational environment.

13. CONCLUSION

This review unambiguously reveals that the post-digital era calls for a fundamental rethinking of language teacher training, with a focus on the development of rich, multidimensional AI literacy. The research portrays a field in transition, with fragmented definitions and large competency gaps among educators at all levels, especially in critical and ethical domains. While developing frameworks and potential pedagogical approaches offers a way ahead, the continuous dearth of empirically verified, subject-specific training remains a significant impediment.

Moving forward, the urgency is clear: teacher education must undergo systemic transformation to incorporate required, critical AI literacy courses for pre-service teachers and provide ongoing, collaborative professional development for in-service faculty. The objective is to enable language instructors to become critical practitioners, ethical advisors, and astute designers who are capable of navigating the challenges and utilizing AI's potential for enhanced language learning.

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