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The role of artificial intelligence in teacher professional development: a systematic review

Papel de la inteligencia artificial en el desarrollo profesional docente: una revisión sistemática

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Abstract

The purpose of this systematic review was to examine the role of artificial intelligence (AI) in teacher professional development (TPD), analyzing its influence on pedagogical innovation, continuing education, and the redefinition of teaching competencies in formal educational contexts. The search was conducted in the Scopus, Web of Science, ERIC, and SciELO databases, considering studies published between 2020 and 2025 in English and Spanish, following the PRISMA methodology. After a rigorous screening process, 34 articles that met the inclusion and methodological quality criteria were selected. The results showed that artificial intelligence impacts educational transformation, promoting self-regulated learning, distributed pedagogical leadership, and the development of communities of practice. Furthermore, its implementation was observed to enhance personalized instruction, data analysis for pedagogical decision-making, and improved teacher self-efficacy. However, challenges remain related to digital literacy, ethical use, equitable access, and institutional resistance. Taken together, the findings highlight the urgent need to design training policies and models that integrate AI from a critical, ethical, and sustainable perspective, ensuring its role as a central element in teacher professional development and as a driver of educational innovation in the digital age.

Keywords: artificial intelligence, teacher innovation, teacher professional development.

Resumen

El propósito de esta revisión sistemática fue examinar el papel de la inteligencia artificial (IA) en el desarrollo profesional docente (DPD), analizando su influencia en la innovación pedagógica, la formación continua y la redefinición de las competencias docentes en contextos educativos formales. La búsqueda se realizó en las bases de datos Scopus, Web of Science, ERIC y SciELO, considerando estudios publicados entre 2020 y 2025 en inglés y español, siguiendo la metodología PRISMA. Tras un proceso de cribado riguroso, se seleccionaron 34 artículos

que cumplían los criterios de inclusión y calidad metodológica. Los resultados evidenciaron que la inteligencia artificial impacta la transformación educativa, favoreciendo la autorregulación del aprendizaje, el liderazgo pedagógico distribuido y la construcción de comunidades de práctica. Asimismo, se observó que su implementación potencia la personalización de la enseñanza, el análisis de datos para la toma de decisiones pedagógicas y la mejora de la autoeficacia docente. Sin embargo, persisten desafíos relacionados con la alfabetización digital, la ética de uso, la equidad en el acceso y la resistencia institucional. En conjunto, los hallazgos destacan la urgencia de diseñar políticas formativas y modelos de capacitación que integren la IA desde una perspectiva crítica, ética y sostenible, garantizando su papel como eje articulador del desarrollo profesional docente y como motor de innovación educativa en la era digital.

Palabras clave: inteligencia artificial, innovación docente, desarrollo profesional docente.

Introduction

Over the past few decades, the emergence of artificial intelligence (AI) in educational systems has reshaped the very foundations of teaching, learning, and knowledge management. This shift reflects more than a technological trend; it marks a profound epistemological realignment that is transforming the nature of teacher professional development (TPD) itself. AI has established itself as a tool that extends human capabilities by enabling personalized learning, automating processes, and generating predictive analyses of educational data, thereby providing useful evidence for the continuous improvement of pedagogical practice (Dogan et al., 2025; Al-Khresheh, 2024). Its effective integration, however, calls for teachers who can grasp its operating principles, weigh its ethical implications, and translate its potential into sustainable educational innovation. Seen from this angle, AI does more than revolutionize the technical environment of teaching; it introduces new cognitive and formative challenges that push educators toward a more analytical, mediating, and reflective role in the face of an increasingly complex digital landscape (Hoang, 2025; Aguilar-Cruz & Salas-Pilco, 2025).

Within this context of accelerating digital transformation, teacher professional development has become a strategic component for the effective integration of AI. Recent studies show that continuing-education programs focused on AI literacy strengthen teachers' pedagogical self-confidence, technological competence, and capacity for curricular innovation (Delcker et al., 2024). Beyond enhancing educational quality, these competencies foster professional autonomy and data-informed decision-making, both essential in an educational ecosystem increasingly mediated by algorithms and intelligent systems. Even so, the literature also points to structural inequalities in access to and preparation for AI use, particularly during initial teacher training and in regions where institutional frameworks have yet to incorporate professional development strategies tied to advanced digital literacy (Özüdoğru & Durak, 2025). This mismatch between technological innovation and teacher preparation represents a critical gap that contemporary educational research seeks to understand and close.

The adoption of generative AI tools such as ChatGPT has introduced a new paradigm in the interaction among teachers, students, and knowledge itself. In English as a Foreign Language (EFL) instruction, for instance, such tools have been shown to improve formative feedback, error analysis, and task personalization, redefining the teacher's role as a cognitive mediator rather than a mere transmitter of information (Metwally & Bin-Hady, 2025). Several studies nonetheless converge on the need to establish ethical and pedagogical guidelines that govern the responsible use of AI and guard against algorithmic bias and technological dependency (Yildirim & Akcan, 2024). Indeed, integrating AI into teacher preparation cannot be reduced to technical competence alone; it must also cultivate a critical understanding of AI's impact on cognition, assessment, and educational interaction, dimensions that underpin ethical and reflective professional practice (Villegas & Chavez, 2025).

Research on teacher leadership and institutional culture likewise shows that AI is reshaping how learning is organized and managed. Digital leadership models, and "*e-leadership,*" have gained prominence as frameworks linking technological innovation with teacher empowerment, fostering communities of practice that learn from the data generated by their own experience (Fusarelli & Fusarelli, 2024; Hoang, 2025). Within this landscape, teacher leaders act as mediators among education policy, classroom demands, and the opportunities AI offers for institutional improvement. Recent literature emphasizes that an "*AI-ready*" school culture requires a shared strategic vision grounded in ongoing training, interdisciplinary collaboration, and sound data ethics (García-Tudela et al., 2023; Arranz et al., 2025). TPD thus becomes a collective process, geared toward innovation and sustained by digital infrastructures that encourage reflection, co-creation, and evidence-based evaluation.

AI's impact on teacher preparation is likewise evident in the diversity of emerging learning models. Intelligent environments, adaptive systems, and educational metaverses support personalized, multisensory learning experiences, fostering creativity and problem-solving as core twenty-first-century competencies (Matovic et al., 2025; Howorth et al., 2024). Beyond enriching teaching practice, these experiences underscore the need for

competencies in algorithmic ethics, data management, and computational thinking, pillars that ensure the responsible, sustainable use of technology. Recent studies emphasize that AI literacy involves not only understanding its technical foundations but also cultivating a critical awareness of its social and educational implications (Özüdoğru & Durak, 2025; Luckin, 2025). From this vantage point, teacher preparation is redefined as a dynamic process of adapting and reinterpreting professional knowledge in response to the new forms of collective intelligence that AI promotes.

Available empirical evidence confirms that teachers who incorporate AI into their practice achieve higher levels of self-efficacy, innovation, and professional satisfaction (Dai, 2023; Delcker et al., 2024). As noted above, however, challenges also emerge around technological infrastructure, cultural resistance, and insufficient institutional support during digital transformation processes (Aguilar-Cruz & Salas-Pilco, 2025; Dogan et al., 2025). Understanding current trends in research on AI and teacher professional development is therefore a priority, so as to design training strategies that balance the technical dimension with pedagogical and ethical considerations. Such integration would pave the way toward more flexible, inclusive, and evidence-based models of teaching, in line with the quality and equity goals promoted by international bodies such as UNESCO.

Within this framework, the present systematic review aims to identify how AI has influenced innovation and TPD. Specifically, it sets out to (i) describe the main lines of research on AI and teacher education across diverse educational contexts; (ii) analyze the methodological approaches and competency dimensions that underpin professional development in AI-mediated settings; and (iii) synthesize the contributions and challenges reported in the recent literature regarding the ethical, pedagogical, and technological integration of AI into educational practice. In doing so, it seeks to offer a comprehensive, up-to-date overview that can inform future policies on teacher training, research, and digital transformation in education.

Methodology

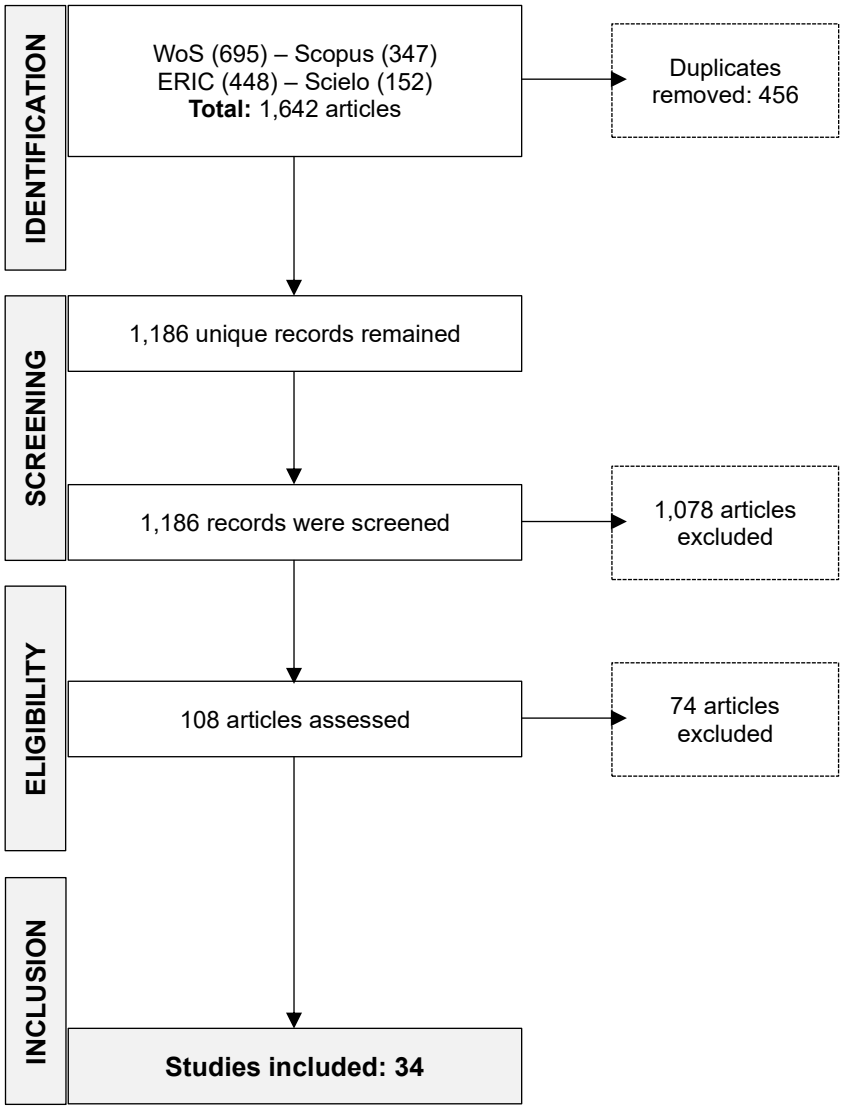
The purpose of this systematic review is to examine the role of AI in educational innovation and teacher professional development, identifying the trends, methodological approaches, and pedagogical effects reported in recent empirical research. The review is grounded in the need to understand how AI-based technologies are reshaping teacher preparation and practice, fostering new paradigms of learning, pedagogical leadership, and digital literacy within formal educational settings (Arranz et al., 2025; He et al., 2025). To ensure transparency, replicability, and scientific rigor, the process followed the guidelines set out in the PRISMA 2020 statement (Page et al., 2021), which made it possible to systematically structure the identification, screening, eligibility, and inclusion stages of the selected studies.

The literature search strategy was designed around a combinatorial approach that integrated controlled and uncontrolled descriptors associated with the study's two core constructs, artificial intelligence and teacher professional development. The following search strings were used: ("*artificial intelligence*" *OR* "*AI*") *AND* ("*teacher professional development*" *OR* "*teacher education*" *OR* "*teacher training*" *OR* "*pedagogical innovation*"), adapted to the specific syntax of each database. Searches were conducted in Scopus, Web of Science (WoS), ERIC, and SciELO, selected for their international coverage, their indexing of peer-reviewed journals, and their relevance to the fields of education, technology, and pedagogical innovation. The time frame spanned 2020 to 2025 and included publications in both English and Spanish; this period was chosen strategically to capture the most recent scientific output.

The inclusion criteria comprised empirical scientific articles (quantitative, qualitative, or mixed-methods in design) published in journals indexed in the selected databases, available in full text, and explicitly addressing the relationship between AI and TPD in initial, continuing, or higher-education contexts. Conversely, the exclusion criteria ruled out documents duplicated across databases, publications predating 2020 or postdating 2025, non-empirical articles, studies focused solely on student learning without addressing the teacher's role, and texts not available in full access. This delimitation preserved the internal validity of the analytic corpus, restricting it to verifiable evidence relevant to the study's objectives.

At the identification stage, 1,642 records were retrieved: Scopus (347), Web of Science (695), ERIC (448), and SciELO (152). A total of 426 duplicates were then removed using Zotero 6.0 software, yielding 1,216 unique records. During the screening stage, titles and abstracts were assessed against the inclusion criteria, and 1,055 articles were excluded for lacking thematic relevance, sufficient methodological rigor, or a direct link between AI and teacher training. As a result, 161 studies advanced to the eligibility stage. Following full-text review, 127 articles were discarded for not addressing professional development empirically or for failing to specify the nature of the AI component under analysis. In the end, 34 articles met all the methodological criteria and constituted the final sample for data extraction and analysis, as shown in the PRISMA flow diagram for this review.

Figure 1
PRISMA flow diagram of review phases



For data extraction and organization, a matrix was designed in Microsoft Excel, structured around key variables that facilitated cross-study comparison and analysis. Each record included the bibliographic reference in APA format (7th edition), country of study, design type (quantitative, qualitative, or mixed), target population, educational level, type of AI application, and professional development focus. In addition, emerging categories related to the dimensions of teacher development were coded, including digital competencies, AI literacy, pedagogical self-efficacy, educational leadership, and curricular innovation (Delcker et al., 2024; Wang et al., 2025). This process was carried out independently by two researchers, after which results were triangulated to ensure reliability. Following the recommendations of Arranz et al. (2025), thematic analysis involved tallying frequencies and mapping trends by year, country, and type of AI applied, with the aim of tracing the evolution of the field and identifying conceptual and emerging patterns in the integration of AI into teacher development. The analytic categories centered on three axes: teachers' perceptions and attitudes toward AI, AI-focused training and professional development models, and the pedagogical outcomes and impacts of AI adoption.

Taken together, the methodological procedure followed ensured the reliability, validity, and replicability of the results, providing a solid foundation for the comparative analysis and discussion of the transformative role of artificial intelligence in teacher professional development.

Results and discussion

The following table summarizes the main findings drawn from the 34 studies included in this systematic review. Each entry records essential information regarding author, year, country, methodological design, type of AI application, and its link to teacher professional development. This systematization made it possible to compare approaches, methodologies, and geographic contexts, revealing global trends in the integration of AI into teacher training and pedagogical practice. The analysis also helped identify common factors that strengthen digital literacy, curricular innovation, and teacher leadership in the age of artificial intelligence.

Table 1

Distribution of studies by research skills and methodological approach

No.	Author(s) Country and Year	Design	Artificial Intelligence (AI)	Professional Development (TPD)
1	Ayanwale, M., et al. (Nigeria, 2025)	Quantitative	AI adoption among in-service teachers; analysis of use intention and predictive factors.	Training and institutional support to strengthen teachers' psychological preparedness.
2	García-Tudela, P., et al. (Spain, 2023)	Quantitative	"Future Classroom/SLE" featuring technologies such as AI/analytics, sensors, and smart environments.	Identifies teacher training needs and opportunities for satisfaction.
3	Al-khresheh, M. H. (Multi-country, 2024)	Qualitative	Integration of ChatGPT in English language teaching; teacher perceptions.	Highlights the need for training and guidelines for the pedagogical/ethical use of GenAI.
4	Metwally, A., & Bin-Hady, W. (Saudi Arabia, 2025)	Mixed-methods	Training to integrate AI among EFL teachers; benefits and needs.	Proposes competency-based TPD programs for AI integration in EFL.
5	Delcker, J., et al. (Germany, 2024)	Quantitative	Teacher AI competence (6 dimensions) and self-perception.	Demonstrates the need for training opportunities to build AI competence.
6	Gümüş, M. M., & Kara, M. (Turkey, 2025)	Quantitative	GenAI literacy for learning (measurement scale).	Tool for diagnosing TPD needs in GenAI literacy.
7	Zhao, L., et al. (China, 2022)	Quantitative	AI literacy among primary and secondary school teachers.	Inputs for TPD programs that strengthen AI literacy and ethics.
8	Chounta, I. A., et al. (Estonia, 2022)	Quantitative	Teacher perceptions of AI as a support for K-12 practice.	Identifies support/training needs for the effective and ethical use of AI.
9	Wang, L., et al. (China, 2025)	Quantitative	AI integration in relation to self-efficacy and technological competence.	Mediating role of technological competence among teachers in training.
10	Özüdoğru, G., & Durak, H. (Turkey, 2025)	Quantitative	Relationship with AI literacy, digital citizenship, and AI-driven innovation.	Links between AI literacy and teacher preparedness; inputs for initial TPD.

11	Howorth, S. K., et al. (U.S., 2024)	Mixed-methods	Integration of emerging technologies (including AI) into teacher preparation.	Proposes teacher-preparation strategies based on AI implementation.
12	Azem, A., et al. (Palestine, 2025)	Qualitative	Factors influencing AI adoption in higher education.	Identifies barriers and facilitators relevant to teachers' technological TPD.
13	Matovic, S., et al. (Serbia, 2025)	Quantitative	Teacher perspectives on the AI-driven metaverse in education.	Points to training gaps and the need for systematic TPD in AI/VR-AR.
14	Al-Zyoud, H. (United Arab Emirates, 2020)	Qualitative	AI applications for teacher training and improvement.	Proposes intelligent learning environments and databases to support teachers' TPD.
15	Mohammadi, M. (Germany, 2024)	Qualitative	AI-assisted adaptive environments in teacher training.	Proposes collaborative AI environments to strengthen capacities and competencies.
16	Metwally, A., & Bin-Hady, W. (Saudi Arabia, 2025)	Mixed-methods	AI integration in English language teaching (EFL).	AI training improves teachers' technological and pedagogical competence.
17	Mouta, A., et al. (Spain, 2024)	Qualitative	Design of future scenarios for educational AI.	Develops ethical models for integrating AI into teachers' continuing education.
18	Li, M., & Manzari, E. (China, 2025)	Mixed-methods	Use of AI in primary mathematics education.	Shows how AI supports teacher self-efficacy and continuous improvement.
19	Delcker, J., et al. (Germany, 2024)	Quantitative	Scale of teachers' self-perceived AI competence	Identifies AI competence gaps to guide TPD programs.
20	Kim, J. (China, 2024)	Qualitative	Teacher–AI collaboration (TAC): curriculum, interaction, and learning environment.	Highlights ongoing TPD, an AI-ready culture, and the development of teacher data literacy.
21	Hoang, N. H. (Vietnam, 2025)	Mixed-methods	*E-leadership* in EFL teachers' integration of AI tools	Develops teachers' digital leadership competencies for planning and implementing AI.
22	Tang, S.; et al. (Malaysia, 2025)	Mixed-methods	University lecturers' leadership in promoting mobile AI integration.	Teachers' AI leadership increases motivation and shapes TPD content.
23	Luckin, R. (United Kingdom, 2025)	Qualitative	AI to nurture human intelligence (critical thinking, creativity, ethics)	Guides AI-centered TPD agendas grounded in ethical principles for teachers.
24	Nissim, Y., & Simon, E. (Israel, 2025)	Quantitative	Diffusion of innovation: integrating ChatGPT into initial teacher training.	Predicts attitudes toward AI; suggests GenAI-specific TPD.
25	Nadelson, L., et al. (U.S., 2025)	Quantitative	Teacher use of GenAI and support for student use; concerns and practices.	Identifies TPD needs regarding policy, support, and responsible GenAI practices.

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26	Baena-Morales, S., et al. (Spain, 2025)	Quantitative	Knowledge of and attitudes toward AI in Physical Education.	Shows PD needs differentiated by teaching experience.
27	Chen, D. C., et al. (Taiwan, 2020)	Quantitative	Professional AI competencies in finite element analysis (FEA).	Defines AI competencies for technical-teacher curricula and training programs.
28	Kurz, T., et al. (U.S., 2022)	Quantitative	AI (computer vision) in remote TPD.	Teacher conceptions following virtual TPD; inputs for future TPD programs.
29	Aguilar-Cruz, P. J., & Salas-Pilco, S. Z. (Colombia, 2025)	Quantitative	Teacher perceptions: technological AI access, TPD, and ethical awareness.	Maps gaps and priorities for AI-related teacher training in K-12.
30	Kumar, R., & Sharma, S. (Canada, 2025)	Qualitative	Opportunities/challenges, academic integrity, and teaching practice.	Identifies the need for TPD in GenAI ethics, along with guidelines and institutional support.
31	Van den Berg, S., & Pantelis, M. P. (International, 2024)	Qualitative	AI for summative assessment: implications for practice.	Suggests teacher training in AI-based assessment.
32	Bernardi, M., et al. (Italy, 2025)	Qualitative	GenAI in mathematics education: knowledge, uses, and challenges.	Direct implications for TPD in AI-assisted mathematics instruction.
33	Lee, H., & Bryan, L. (Philippines / U.S., 2025)	Mixed-methods	AI (ChatGPT) integration in initial teacher education and competencies.	Impact on professional competencies and the design of TPD programs.
34	Ghamrawi, N., et al. (Qatar / Arab States, 2024)	Qualitative	Impact of AI on teacher leadership: TPD support vs. regression.	Competencies needed to sustain AI leadership and the continuing education required to develop them.

A thorough examination of the 34 included studies reveals a thematic convergence that positions AI as a transformative force in TPD. Over the past five years, research has moved from a predominantly instrumental focus toward an epistemological and humanistic perspective, in which AI is understood as a mediator of innovation, self-regulation, and organizational learning. The evidence indicates that contemporary educational settings call for teachers capable of combining technological, ethical, and cognitive competencies in intelligent-system-mediated scenarios, giving rise to a “reflective-digital professional” paradigm (Aguilar-Cruz & Salas-Pilco, 2025; Dogan et al., 2025). AI, in this sense, ceases to be a mere auxiliary tool and becomes a central axis of pedagogical change, directly tied to the sustainability of learning and continuous improvement.

Within this context, the findings point to a clear relationship between advanced digital literacy and sustained professional development. Large-scale quantitative studies, such as those by Delcker et al. (2024) and Zhao et al. (2022), show that self-efficacy and perceived AI competence shape teachers' willingness to adopt these technologies. This pattern recurs in research conducted in emerging contexts, where ongoing training mediates between technological confidence and pedagogical quality. The findings suggest that the most effective TPD programs incorporate elements of *AI literacy*, critical thinking, and digital ethics, enabling educators to understand how algorithms work and to make informed pedagogical decisions (Özüdoğru & Durak, 2025). As AI increasingly permeates assessment practices and curriculum design, teachers need not only technical knowledge but also the capacity to discern the moral, cultural, and epistemological implications of its use.

The qualitative evidence likewise underscores that teachers' perceptions of AI are far from uniform, varying instead with institutional, generational, and disciplinary factors. In Al-Khresheh's (2024) study, foreign-language teachers praised the usefulness of generative tools such as ChatGPT for fostering linguistic creativity, while also voicing concerns about the reliability of the information generated and the erosion of intellectual authorship. These tensions expose a contemporary pedagogical dilemma: even as AI boosts productivity and personalizes learning,

it also tests the limits of teacher autonomy. As Brandão et al. (2024) note, TPD in digital environments must incorporate the ethics of educational artificial intelligence, understood as the ability to balance innovation with responsibility. Teacher professionalization, in this light, is being redefined not merely by technological mastery but by the capacity to discern, evaluate, and humanize the emerging practices that AI mediates.

Triangulating findings from mixed-methods studies reveals that inter-teacher collaboration and digital leadership are decisive factors for the sustainable adoption of AI. The work of Hoang (2025) and Tang et al. (2025) shows that teachers who exercise leadership in technological environments, through mentoring, co-teaching, and communities of practice, develop greater confidence and openness toward innovation. This finding aligns with the conclusions of He et al. (2025), who note that AI-mediated peer mentoring boosts self-efficacy and strengthens professional cohesion. The evidence suggests that AI-based TPD cannot be conceived as an isolated process but rather as a collective endeavor that drives organizational learning and institutional transformation. Pedagogical leadership in the age of AI thus emerges as a relational phenomenon that weaves together technical competencies with socio-emotional and ethical skills (Luckin, 2025).

The findings also point to an epistemological reconfiguration of the teacher's role, in which knowledge ceases to be a closed product and instead becomes a dynamic process of data-mediated interpretation. Mohammadi (2024) and García-Tudela et al. (2023) note that intelligent environments built on *learning analytics* and adaptive learning enable more precise, contextualized feedback, fostering the development of evidence-based pedagogy. Within this new ecosystem, teachers take on the role of cognitive mediator, weaving algorithmic information into their pedagogical decisions without losing sight of the human dimension of education. Studies such as that of Li and Manzari (2025) reinforce this idea, showing that applying AI in mathematics not only improves learning outcomes but also strengthens teachers' self-efficacy and reflective capacity. AI thus establishes itself as an agent of epistemic transformation that drives teaching centered on metacognition, creativity, and professional self-regulation.

With respect to challenges, the review reveals persistent structural and ethical gaps that constrain the uptake of AI in teacher training. Studies by Aguilar-Cruz and Salas-Pilco (2025) and Duan and Zhao (2024) point out that technological inequality, limited institutional infrastructure, and the absence of robust regulatory frameworks hinder the continuity of digital TPD. Compounding this is a lack of spaces for ethical reflection on educational automation, an issue that becomes especially critical where algorithms play a role in performance evaluation. Research by Ayanwale et al. (2025), however, points to an evolutionary way forward: a shift toward augmented intelligence, in which AI amplifies rather than replaces teachers' cognitive and affective competencies. Centered on human–algorithmic collaboration, this model proposes a more sustainable form of TPD grounded in the integration of technical, pedagogical, and ethical knowledge.

Taken together, the comparative synthesis of results supports the claim that AI acts as a catalyst for teacher professional development by fostering self-regulation, curricular innovation, and informed pedagogical leadership. Its impact, however, depends heavily on institutional policy, technological infrastructure, and teachers' ethical commitment. The review shows that continuing AI training must go beyond technical skill-building to become a critical process of knowledge construction oriented toward equity and the humanization of learning. In sum, the advances described here confirm that the future of teacher professional development lies not in the uncritical adoption of technology, but in building an educational ecosystem capable of sustaining an ongoing dialogue between human and artificial intelligence in the pursuit of transformation and improvement (Dogan et al., 2025; Luckin, 2025).

Conclusions

Carrying out this systematic review made clear that integrating AI into teacher training and professional development is not merely a technological trend but a structural process of pedagogical and epistemological transformation. The results show that the teacher's role is being redefined by the emergence of intelligent systems, which do more than automate tasks, they reshape how teaching, learning, and reflection on educational practice take place. This review confirmed that AI has become a central axis of teacher professionalization, fostering pedagogical innovation, informed decision-making, and the construction of new adaptive competencies that go beyond technical mastery. Effectively integrating AI, in this sense, requires understanding it not as an isolated tool but as a complex ecosystem that touches the cognitive, emotional, ethical, and organizational dimensions of teaching.

The relationship between AI and teacher professional development is built on an interdependent web of factors, ranging from digital literacy and strengthened technological self-efficacy to the creation of collaborative environments for leadership and peer mentoring. The findings show that the most effective training programs do more than transmit knowledge about AI, they promote a shift in professional mindset, sharpening analytical capacity,

curricular innovation, and reflection on the educational impact of algorithms. AI, then, does not replace the teacher's role but amplifies its reflective and creative potential, granting teachers a new centrality in pedagogical mediation and in the critical interpretation of data generated by intelligent systems. This process entails a profound reconfiguration of professional identity, moving it from an operational stance to a strategic and transformative one.

The analysis of results further reveals that AI's impact on teaching practice is far from uniform, depending instead on each context's institutional, cultural, and infrastructural conditions. In education systems with well-structured innovation policies, AI has enhanced personalized learning, the use of educational analytics, and evidence-based assessment, whereas other contexts still face limitations stemming from scarce resources, digital inequality, and insufficient training in computational thinking. This contrast makes clear that genuine teacher professional development in the age of AI cannot be measured merely by the number of tools employed, but by teachers' capacity to integrate them critically, contextually, and ethically, ensuring that technology remains in the service of humanizing the teaching and learning process.

The review also identified that AI is driving a more distributed, collaborative model of pedagogical leadership. Today's teacher is no longer an isolated actor but an active member of communities of practice that co-create knowledge and experiment with educational innovations. This paradigm shift fosters institutional cultures grounded in trust, mentoring, and self-regulation, in which leadership is understood as a shared competency that sustains digital practices over time. Collaborative work with AI has, moreover, enhanced educators' ability to design personalized strategies, carry out predictive diagnostics, and provide more precise feedback on student learning, thereby strengthening professional autonomy and educational quality.

Across the board, the evidence confirms that ethics stands as one of the fundamental pillars of teacher professional development in AI-mediated settings. As algorithms take on a greater role in assessment, knowledge management, and educational planning, it becomes essential for teachers to develop critical awareness of the risks tied to algorithmic bias, data privacy, and equitable access to knowledge. Teachers' ethical commitment, reinforced by digital literacy, becomes a necessary condition for ensuring that artificial intelligence contributes to social well-being rather than reproducing inequality. Continuing education, in this regard, must foster a humanistic understanding of AI in which professional judgment, empathy, and pedagogical responsibility remain the guiding principles of educational practice in increasingly automated settings.

Taken as a whole, this systematic review leads to the conclusion that AI is redefining not only the tools of teaching but the very meaning of being a teacher in a digital society. Its incorporation calls for rethinking the frameworks of initial and continuing teacher education, education policy, and assessment models, so that teacher professional development can keep pace with the ethical and cognitive demands of the twenty-first century. Within this new paradigm, the teacher is envisioned as an intelligent mediator who blends technological knowledge, critical thinking, and human sensitivity, capable of designing personalized, inclusive, and sustainable learning experiences. The challenge, then, lies not in mastering technology but in building a pedagogical vision that allows teachers to coexist with it through reflection, creativity, and responsibility. Only in this way can AI establish itself as a catalyst for authentic educational transformation, strengthening teacher autonomy and the capacity of education systems to respond to the challenges of the future with equity and purpose.

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