

Artificial intelligence in education: Possibilities and challenges for pedagogical practice

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Abstract

Artificial Intelligence (AI) has brought about significant changes in the educational landscape, driven primarily by the advancement of generative models and the increasing availability of tools capable of supporting teaching and learning processes. This study aimed to analyze the main possibilities and challenges associated with AI in pedagogical practice through a structured narrative literature review. Searches were conducted in the Web of Science Core Collection, Scopus, ERIC, SciELO, and Google Scholar, prioritizing publications from 2019 to 2026, while earlier foundational sources were retained when methodologically or conceptually relevant. The final interpretive corpus comprised 31 core sources, including peer-reviewed empirical studies, systematic and scoping reviews, meta-analyses, and institutional guidance. Evidence was synthesized into four themes: evolution and educational applications of AI, pedagogical potential, ethical and institutional challenges, and the changing role of teachers. The literature identifies opportunities for personalized learning, pedagogical planning, accessibility, formative assessment, and teaching-material development, but also recurring concerns involving information reliability, academic integrity, privacy, algorithmic bias, digital inequality, and teacher preparedness. Recent evidence indicates that positive outcomes are heterogeneous and depend on pedagogical scaffolding, human verification, institutional governance, and AI literacy. AI should therefore be understood as a supportive educational technology rather than a substitute for teacher mediation. Its integration requires critical, ethical, and pedagogically grounded use that preserves student autonomy, assessment validity, and educational equity.

Keywords: personalized learning, artificial intelligence literacy, teacher training, educational technologies, digital education.

Inteligência artificial na educação: Possibilidades e desafios para a prática pedagógica

Resumo

A Inteligência Artificial (IA) tem promovido mudanças significativas no cenário educacional, impulsionadas principalmente pelo avanço dos modelos generativos e pela crescente disponibilidade de ferramentas capazes de apoiar processos de ensino e aprendizagem. Este estudo teve como objetivo analisar as principais possibilidades e desafios associados à IA na prática pedagógica por meio de uma revisão narrativa estruturada da literatura. As buscas foram realizadas nas bases Web of Science Core Collection, Scopus, ERIC, SciELO e Google Scholar, priorizando publicações entre 2019 e 2026, com manutenção de fontes anteriores quando metodologicamente ou conceitualmente fundamentais. O corpus interpretativo final foi composto por 31 fontes centrais, incluindo estudos empíricos revisados por pares, revisões sistemáticas e de escopo, meta-análises e documentos institucionais. As evidências foram sintetizadas em quatro eixos: evolução e aplicações educacionais da IA, potencial pedagógico, desafios éticos e institucionais e mudanças no papel docente. A literatura identifica oportunidades para aprendizagem personalizada, planejamento pedagógico, acessibilidade, avaliação formativa e produção de materiais didáticos, mas também preocupações recorrentes relacionadas à confiabilidade das informações, integridade acadêmica, privacidade, vieses algorítmicos, desigualdade digital e preparação docente. Evidências

recentes indicam que os resultados positivos são heterogêneos e dependem de mediação pedagógica, verificação humana, governança institucional e letramento em IA. Assim, a IA deve ser compreendida como tecnologia de apoio, e não como substituta da mediação docente, exigindo uso crítico, ético e pedagogicamente fundamentado que preserve a autonomia discente, a validade da avaliação e a equidade educacional.

Palavras-chave: aprendizagem personalizada, letramento em inteligência artificial, formação docente, tecnologias educacionais, educação digital.

1. Introduction

Artificial Intelligence (AI) encompasses a set of computational technologies and methods capable of performing tasks associated with cognitive processes, such as pattern recognition, language processing, prediction, problem-solving, and decision-making support. In the educational field, AI is not an entirely recent phenomenon, as intelligent tutoring systems, adaptive platforms, automated assessment mechanisms, and data analysis tools have been investigated for several decades. However, the recent development of generative models has significantly increased the visibility, accessibility, and reach of these technologies in teaching and learning environments (Ouyang; Jiao, 2021; Zawacki-Richter et al., 2019).

The application of AI in education encompasses different dimensions of the educational process, including the personalization of content and learning pathways, the provision of automated feedback, monitoring of student performance, identification of learning difficulties, support for assessment, and automation of certain academic and administrative tasks. A systematic review conducted by Zawacki-Richter et al. (2019) identified four major areas of AI application in higher education: profiling and prediction, assessment, adaptive and personalized systems, and intelligent tutoring systems. Subsequently, Chiu et al. (2023) demonstrated that AI technologies can perform different functions in the domains of learning, teaching, assessment, and educational administration, although their implementation remains associated with technical, pedagogical, and ethical limitations.

The widespread adoption of generative Artificial Intelligence, particularly following the public availability of conversational systems based on large language models, has introduced a new stage in this process. Unlike applications focused solely on classification, prediction, or recommendation, generative models can produce text, images, code, summaries, explanations, questions, and other content in response to user prompts. This capability has accelerated their integration into study activities, instructional planning, academic writing support, and teaching-material development (Lo, 2023; Zhang et al., 2024; Qian, 2025).

Within pedagogical practice, these tools can assist in developing lesson plans, activities, examples, instructional scripts, questions, formative assessments, and materials adapted to different levels of learning. Recent systematic reviews show recurring uses in tutoring, content generation, automated and formative feedback, learning support, and instructional planning across higher education and K-12 contexts (Alfarwan, 2025; Belkina et al., 2025; Luo et al., 2025; Qian, 2025). However, effects vary according to educational level, subject area, tool design, learning strategy, and degree of pedagogical scaffolding (Chen; Cheung, 2025; Dong et al., 2025). Educational benefit therefore depends on how AI is embedded within teaching rather than on technological capability alone.

The incorporation of AI into education also involves significant risks and challenges. Generative systems may produce incorrect, incomplete, or plausible but unsupported responses, reproduce biases present in training data, and create new uncertainties concerning authorship, academic integrity, privacy, and assessment validity. Recent reviews show that these concerns increasingly affect how institutions redesign assessment and establish guidance for acceptable AI use (Funa; Gabay, 2025; Memarian; Doleck, 2026; Ncube et al., 2026).

These concerns demonstrate that AI integration cannot be guided exclusively by the technical availability of such tools. UNESCO (2023) recommends a human-centered approach in which the adoption of generative AI is accompanied by privacy protection, ethical and pedagogical evaluation of systems, promotion of equity, and preservation of individual autonomy. From this perspective, technologies should complement human capabilities and contribute to clearly defined educational goals, rather than indiscriminately replacing interaction between teachers and students or automatically determining the direction of the educational process.

Teachers occupy a central position in this context because they are responsible for aligning technological resources with learning objectives, selecting strategies appropriate to the context, assessing the reliability of information, and guiding students toward ethical and critical AI use. Recent frameworks and reviews characterize teacher readiness as a combination of technical understanding, pedagogical judgment, ethical awareness, and capacity for continuous professional learning (Miao; Cukurova, 2024; Sperling et al., 2024; Tan et al., 2025). These competencies are increasingly treated as components of teacher professionalism rather than optional digital skills.

Despite the rapid growth of publications on AI in education, the evidence base remains uneven across educational levels, countries, disciplines, and sociocultural contexts. Recent reviews show that higher education still dominates the literature, while K-12 research, teacher professional development, inclusion, and long-term learning effects remain less mature or more heterogeneous (Alfarwan, 2025; Liang et al., 2025; Mustafa et al., 2024; Tan et al., 2025). This imbalance reinforces the need for synthesis that distinguishes demonstrated outcomes from anticipated benefits and explicitly considers the institutional conditions required for responsible adoption.

In this context, this article aims to analyze the possibilities and challenges associated with the use of Artificial Intelligence in pedagogical practice, with an emphasis on its contributions to teaching and learning, the ethical and educational risks associated with its use, and the competencies required of teachers for the critical, responsible, and pedagogically grounded integration of these technologies.

2. Materials and Methods

2.1 Study design

This study is a structured narrative literature review with a qualitative and descriptive orientation. The approach was selected to integrate evidence from a rapidly evolving and interdisciplinary field while preserving the interpretive flexibility required to compare pedagogical, technological, ethical, and institutional dimensions of Artificial Intelligence (AI) in education. The use of a structured search strategy was intended to improve transparency and breadth of coverage; it does not convert the study into a systematic review or meta-analysis. Accordingly, the manuscript does not claim PRISMA-level exhaustiveness, effect estimation, or comprehensive identification of every publication on the topic.

2.2 Literature search strategy

The literature search was conducted between July 10 and 25, 2026, in the Web of Science Core Collection, Scopus, ERIC (Education Resources Information Center), SciELO, and Google Scholar. These sources were selected to capture peer-reviewed and institutional literature in Education, Educational Technology, Computer Science, and related interdisciplinary fields.

The search strategy was developed by combining English-language descriptors using the Boolean operators AND and OR, considering that a substantial proportion of the international scientific literature is indexed in English. The search expression used was:

("Artificial Intelligence" OR "Generative Artificial Intelligence" OR "Generative AI" OR "ChatGPT" OR "Large Language Model*") AND ("Education" OR "Teaching" OR "Learning" OR "Pedagogical Practice" OR "Teacher*" OR "Higher Education" OR "Basic Education")

Search strings were adapted to the indexing syntax of each source. Publications from 2019 to 2026 were prioritized because this interval captures both the recent pre-generative-AI literature and the rapid expansion following the public diffusion of large language models. Earlier sources were retained only when they provided foundational conceptual or methodological context. During revision, priority was given to recent peer-reviewed evidence from 2024–2026, especially systematic reviews, meta-analyses, and empirical studies published in journals indexed by major scholarly databases.

The search was used to construct a conceptually relevant evidence base rather than to estimate a complete universe of publications. The final interpretive corpus comprised 31 core sources: 28 peer-reviewed journal articles or reviews and three foundational or institutional sources. All sources used in the synthesis are listed in the References, and their design, educational context, and role in the review are summarized in Table 1.

2.3 Inclusion and exclusion criteria

Eligible sources included peer-reviewed empirical articles, systematic reviews, scoping reviews, meta-analyses, and technical or normative documents from recognized international organizations that addressed the use of Artificial Intelligence in educational contexts.

The inclusion criteria comprised:

- publications addressing the application of Artificial Intelligence in education;
- studies discussing pedagogical, technological, ethical, or social aspects related to the use of AI;

- articles published in indexed scientific journals;
- full-text publications available in English or Portuguese.

The following were excluded:

- conference abstracts without full-text publication;
- editorials, letters to the editor, news articles, and opinion pieces;
- duplicate records or publications with substantially overlapping content;
- studies exclusively focused on the technical development of algorithms without educational applications;
- studies without a direct relationship to teaching and learning processes.

2.4 Study selection and reporting transparency

Candidate publications were assessed sequentially for relevance to the review objective using title, abstract, keywords, and, when retained, full-text reading. Eligibility was determined by the inclusion and exclusion criteria described above and by direct conceptual relevance to pedagogical practice, educational outcomes, teacher roles, assessment, ethics, or institutional implementation. The thematic synthesis presented in the manuscript reflects the authors' collective interpretation of the retained evidence. The original review records did not preserve reviewer-level allocation of screening tasks; therefore, the revised manuscript does not claim independent duplicate screening or calculate inter-rater agreement.

Because the study was originally planned as a narrative review, database-specific retrieval totals, the number of duplicates removed, and a PRISMA-style screening log were not prospectively archived. These counts cannot be reconstructed retrospectively with sufficient accuracy and are therefore not reported as if they had been recorded at the time of the search. This limitation is explicitly acknowledged in the Discussion. To make the evidence base auditable without fabricating search-flow numbers, the revised manuscript reports the final corpus size and composition, describes the selection sequence, provides a source-characterization table, and avoids wording that would imply a formally enumerated systematic-review sample.

2.5 Data extraction and thematic synthesis

For each retained source, the synthesis considered publication year, study or review design, educational level or context, type of AI application, reported pedagogical opportunities, identified risks, assessment implications, teacher-related findings, and institutional conditions. Because the objective was narrative integration rather than effect pooling, these elements served as interpretive comparison categories rather than variables for meta-analysis.

The evidence was organized into four thematic axes defined a priori and refined during reading: (i) evolution and educational applications of AI; (ii) pedagogical potential; (iii) ethical, technological, and institutional challenges; and (iv) the changing role of teachers. In the revised structure, the Results section reports recurrent findings and patterns in the retained sources. In contrast, the Discussion interprets how those findings relate to one another, identifies convergence and heterogeneity, and develops implications for pedagogy, assessment, governance, and teacher education.

Table 1. Characteristics of the 31 core sources retained in the structured narrative synthesis.

Source	Design/type	Educational context	Role in the synthesis
Alfarwan (2025)	Systematic review	K-12 education	Generative-AI applications, opportunities, risks, and evidence gaps.
Baggia et al. (2026)	Systematic review + meta-analytic component	University teachers	Teacher perceptions, practices, adoption conditions, and institutional support.
Belkina et al. (2025)	Systematic review of case studies	Higher education	Implemented GenAI uses and conditions shaping educational practice.

Source	Design/type	Educational context	Role in the synthesis
Bittle; El-Gayar (2025)	Systematic review	Higher education	Academic integrity risks, responses, and research agenda.
Casal-Otero et al. (2023)	Systematic review	K-12 education	Conceptualization and development of AI literacy.
Chan; Tsi (2024)	Teacher/student perception study	Higher education	Views on teacher replacement versus teacher assistance.
Chen; Cheung (2025)	Systematic review + meta-analysis	University students	Effects of GenAI on learning outcomes and heterogeneity across outcomes.
Chiu et al. (2023)	Systematic literature review	Education	Opportunities, challenges, application domains, and research directions.
Dong et al. (2025)	Meta-analysis	Student learning	Association between AI-supported instruction and academic achievement; moderators.
Funa; Gabay (2025)	Meta-synthesis	Teaching and learning policy	Institutional policy recommendations, governance, ethics, and responsible use.
Grant; Booth (2009)	Methodological review	Review methodology	Conceptual basis for distinguishing narrative and systematic review designs.
Holmes et al. (2019)	Scholarly book/conceptual synthesis	Education	Foundational framing of AI opportunities and implications for teaching and learning.
Ikram et al. (2026)	Systematic review	Personalized learning	Trends, implementation patterns, and future directions in AI-supported personalization.
Kasneci et al. (2023)	Interdisciplinary perspective/review	Education	Opportunities and challenges of large language models in education.
Kofinas et al. (2025)	Higher-education assessment study	Higher education	Academic integrity and authentic assessment under GenAI conditions.
Liang et al. (2025)	Systematic review	Higher education	Early impacts on curriculum, instruction, and assessment.
Lo (2023)	Rapid review	Education	Early evidence on ChatGPT opportunities and challenges.
Luo et al. (2025)	Systematic review	Higher education	Design and assessment of AI-based learning tools.
Memarian; Doleck (2026)	Systematic review	Higher education	Academic integrity, misconduct, and institutional responses involving AI.
Miao; Cukurova (2024)	UNESCO competency framework	Teacher education	Human-centered teacher AI competencies, ethics, pedagogy, and professional learning.
Mouta et al. (2024)	Systematic review	AI ethics in education	Ethics blind spots, fairness, accountability, transparency, and stakeholder participation.
Mustafa et al. (2024)	Review of literature reviews	AI in education	High-level mapping of evidence, gaps, and future research agenda.
Ncube et al. (2026)	Systematic review	AI-infused assessment	Assessment redesign and strategies for academic integrity.
Ouyang; Jiao (2021)	Conceptual review	AI in education	Three paradigms of AI in education and human-AI relationships.

Source	Design/type	Educational context	Role in the synthesis
Qian (2025)	Systematic review	Higher education	Pedagogical applications of GenAI and conditions for meaningful implementation.
Sperling et al. (2024)	Scoping review	Teacher education	AI literacy in teacher education and competence gaps.
Tan et al. (2025)	Systematic review	Teaching and teacher PD	AI uses in teaching versus teacher professional development; preparation gap.
UNESCO (2023)	International guidance	Education and research	Human-centered governance, privacy, equity, and responsible GenAI use.
Wang et al. (2023)	Empirical readiness study	Teachers	Dimensions of teacher readiness for AI-enhanced education.
Zawacki-Richter et al. (2019)	Systematic review	Higher education	Foundational mapping of AI applications and educator-related gaps.
Zhang et al. (2024)	Systematic review	Generative AI in education	Empirical applications, learning support, feedback, planning, and emerging evidence.

Note. The table describes the final interpretive corpus rather than a PRISMA screening sample. Database-level retrieval and duplicate-removal counts were not prospectively archived and are therefore not reconstructed retrospectively. Source: Authors, 2026.

3. Artificial Intelligence and Education

3.1 Evolution and applications of artificial intelligence in education

The retained sources document a marked expansion of research and educational experimentation with Artificial Intelligence (AI), especially after the public diffusion of generative systems in late 2022. Earlier work emphasized intelligent tutoring, prediction, adaptive systems, educational data mining, and automated assessment, whereas recent literature increasingly addresses conversational generation, feedback, teacher support, assessment redesign, and multimodal content production (Chiu et al., 2023; Liang et al., 2025; Qian, 2025).

Applications now span multiple educational functions. In higher education, recent reviews identify tutoring, personalized feedback, content generation, writing and programming support, learning analytics, and assessment assistance as recurrent uses (Belkina et al., 2025; Luo et al., 2025; Qian, 2025). K-12 research reports similar categories, although the evidence base is smaller and more heterogeneous (Alfarwan, 2025).

General-purpose generative platforms have become particularly visible because they combine conversational interaction with rapid production of text, code, explanations, examples, and study materials. Across case studies, their educational use is concentrated in learning support, instructional preparation, feedback, content development, and assessment-related tasks, with implementation ranging from informal individual use to intentionally designed course activities (Belkina et al., 2025; Qian, 2025).

Institutional adoption is uneven. The literature reports substantial variation in access, policy maturity, privacy safeguards, acceptable-use guidance, and professional-development opportunities. Policy-oriented syntheses consistently identify governance, transparency, equity, data protection, and human oversight as recurrent implementation requirements (Funa; Gabay, 2025; UNESCO, 2023).

Teacher-focused literature increasingly emphasizes AI literacy rather than operational proficiency alone. Recurrent competencies include understanding AI capabilities and limitations, formulating appropriate prompts, verifying outputs, recognizing bias, protecting data, evaluating ethical implications, and aligning technology with learning objectives (Miao; Cukurova, 2024; Sperling et al., 2024; Tan et al., 2025).

Taken together, the results indicate a transition from AI as a specialized educational technology toward AI as a general-purpose layer embedded across teaching, learning, assessment, and academic work. The breadth of adoption has expanded more rapidly than evidence on long-term learning effects and institutional readiness.

3.2 Potential of artificial intelligence for pedagogical practice

The retained evidence identifies four recurring areas of pedagogical potential: personalization, instructional support, formative feedback, and accessibility. These benefits are reported across different contexts, but their magnitude and consistency vary according to the learning design, educational level, subject area, duration of intervention, and type of AI system (Chen; Cheung, 2025; Dong et al., 2025; Luo et al., 2025).

Personalized learning is among the most frequently reported uses. AI systems can adapt explanations, tasks, feedback, and recommended resources to learner performance or expressed needs, supporting differentiated learning pathways. Recent reviews nevertheless show that personalization is implemented in diverse ways and is not synonymous with fully automated individualized teaching (Ikram et al., 2026; Luo et al., 2025).

Generative AI also supports lesson planning, question generation, examples, instructional scripts, case studies, differentiated materials, tutoring, and revision activities. Systematic reviews in higher education and K-12 environments identify these functions repeatedly, although the evidence is concentrated in relatively recent and often short-duration implementations (Alfarwan, 2025; Belkina et al., 2025; Qian, 2025).

Assessment-related applications include immediate feedback, error-pattern identification, practice-question generation, rubric support, and formative assessment. At the same time, the presence of generative AI has accelerated interest in authentic, staged, oral, reflective, and process-oriented assessment designs that make student reasoning more visible (Kofinas et al., 2025; Liang et al., 2025; Ncube et al., 2026).

Accessibility is another recurrent benefit. Speech recognition and synthesis, translation, captioning, alternative explanations, and content adaptation may reduce communication and information barriers. The literature, however, emphasizes that such benefits depend on accessible infrastructure, linguistic quality, privacy safeguards, and equitable access to the relevant systems (UNESCO, 2023).

Quantitative syntheses indicate positive but non-uniform learning effects. Dong et al. (2025) reported an overall positive relationship between AI-supported instruction and academic achievement, with important moderator effects. Chen & Cheung (2025) likewise found favorable effects on several university learning outcomes, while the effect on metacognition was not statistically significant. These findings indicate that learning gains depend on implementation conditions rather than on AI use alone.

For teachers, AI can reduce time spent on repetitive preparatory tasks and support professional learning, reference exploration, instructional design, and material development. Teacher studies nevertheless show that perceived usefulness and actual adoption vary with confidence, disciplinary context, institutional support, and access to professional development (Baggia et al., 2026; Tan et al., 2025).

3.3 Challenges and risks of artificial intelligence integration in education

The retained sources consistently identify four interacting risk clusters: reliability and epistemic quality, academic integrity and assessment validity, privacy and algorithmic fairness, and inequitable or poorly governed implementation (Bittle; El-Gayar, 2025; Funa; Gabay, 2025; Mouta et al., 2024).

Reliability remains a core concern because generative systems can produce fluent but inaccurate, incomplete, outdated, or unsupported content. The literature therefore treats source verification and critical evaluation as necessary educational practices whenever AI-generated material is used for learning or teaching (Lo, 2023; Qian, 2025).

Academic integrity has become a major focus of recent scholarship. Reviews published in 2025–2026 show that generative AI complicates plagiarism detection, authorship attribution, assessment validity, and the interpretation of unsupervised written products. At the same time, they caution that integrity cannot be addressed solely through prohibition or automated detection (Bittle; El-Gayar, 2025; Memarian; Doleck, 2026; Ncube et al., 2026).

Privacy and data-protection concerns arise when students or teachers submit personal, institutional, copyrighted, or sensitive material to external AI systems. Policy syntheses therefore emphasize data-minimization practices, transparency about platform terms, informed use, and institutional guidance on acceptable inputs (Funa; Gabay, 2025; UNESCO, 2023).

Algorithmic bias is a further limitation because model outputs can reproduce or amplify social, cultural, linguistic, and socioeconomic patterns present in training data. Ethical analyses accordingly emphasize fairness, transparency, accountability, and participation of affected educational stakeholders in governance decisions (Mouta et al., 2024).

Unequal access to devices, connectivity, paid AI services, and advanced digital competencies may deepen existing educational inequalities. This risk becomes particularly relevant when course requirements implicitly assume access to tools or subscription tiers that are not universally available (UNESCO, 2023).

Teacher preparedness intersects with all of these risks. Responsible integration requires not only tool familiarity but also pedagogical judgment, source evaluation, ethical reasoning, assessment literacy, and the ability to communicate transparent rules for student use (Miao; Cukurova, 2024; Sperling et al., 2024; Tan et al., 2025).

Thus, the results show that the main constraints are produced by the interaction between system limitations and implementation conditions. Technical performance alone does not resolve questions of trust, authorship, fairness, learning validity, or institutional responsibility.

3.4 The role of teachers in the era of artificial intelligence

The retained literature positions teachers as essential mediators in AI-rich educational environments. Rather than supporting simple replacement, recent evidence describes a redistribution of professional tasks in which teachers increasingly design learning situations, establish acceptable-use boundaries, interpret learner needs, verify AI outputs, and retain responsibility for pedagogical decisions (Baggia et al., 2026; Chan; Tsi, 2024). These interrelated responsibilities are summarized in (Figure 1).

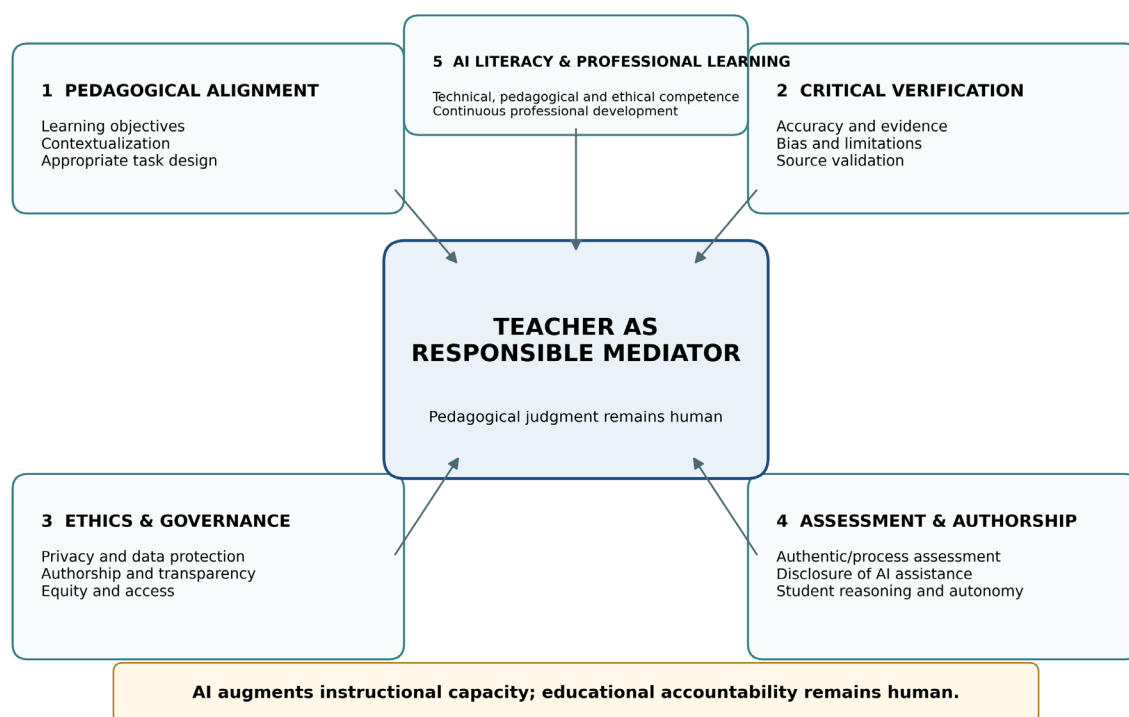


Figure 1. Teacher-centered framework for responsible AI integration in education. The retained literature positions teachers as responsible mediators who align AI with learning objectives, verify outputs, address ethical and governance issues, redesign assessment, and develop AI literacy through continuous professional learning. Source: Authors' synthesis based on the reviewed literature. Source: Authors, 2026.

As access to generative systems expands, the teacher role increasingly includes designing tasks that require students to explain reasoning, validate sources, justify decisions, and disclose appropriate AI assistance. This shifts emphasis from the final product alone toward the learning process and the evidentiary basis for student work (Qian, 2025; Sperling et al., 2024).

Critical evaluation of AI outputs is therefore a central professional competency. Teachers need to detect unsupported claims, verify evidence, recognize bias and uncertainty, and contextualize generated material before incorporating it into instruction or assessment (Miao; Cukurova, 2024; Sperling et al., 2024).

AI literacy extends beyond operational knowledge. The UNESCO AI Competency Framework for Teachers

organizes teacher development around a human-centered mindset, ethics, AI foundations and applications, AI pedagogy, and professional learning, reinforcing the need to connect technical competence with pedagogical and ethical judgment (Miao; Cukurova, 2024).

Continuing professional development is repeatedly identified as a condition for responsible adoption. Tan et al. (2025), reviewing 95 studies, found that research has concentrated more heavily on AI for teaching than on AI-supported teacher professional development, indicating a mismatch between rapid classroom adoption and systematic preparation of educators. Teacher perceptions also vary according to experience, discipline, institutional support, and confidence in AI use (Baggia et al., 2026).

Assessment is one of the domains most affected by this transition. Recent literature recommends greater use of authentic tasks, staged submissions, oral defense, reflection, collaboration, process evidence, and transparent AI-use declarations so that assessment captures reasoning and authorship rather than only a polished final product (Kofinas et al., 2025; Memarian; Doleck, 2026; Ncube et al., 2026).

Across these findings, the teacher role is characterized less by information transmission and more by orchestration, verification, ethical guidance, assessment design, and professional judgment. This pattern supports an augmentation model in which AI may expand instructional capacity while educational accountability remains human.

4. Discussion

The central interpretation arising from this review is that the educational value of AI is conditional rather than intrinsic. Across the evidence, the same technological capability can support learning when it is embedded in purposeful pedagogy, yet encourage superficial delegation when used without instructional structure. This distinction helps reconcile enthusiastic reports of efficiency and personalization with persistent concerns about dependence, reliability, and reduced cognitive engagement. Case-based and systematic evidence therefore supports a model of designed augmentation rather than unrestricted substitution (Belkina et al., 2025; Qian, 2025).

Recent quantitative syntheses strengthen this interpretation because positive outcomes are accompanied by heterogeneity. Dong et al. (2025) found an overall positive association between AI-supported instruction and academic achievement but identified moderator effects, while Chen & Cheung (2025) reported favorable effects for several university learning outcomes without a statistically significant improvement in metacognition. Consequently, evidence of performance gains should not be generalized into a claim that AI necessarily promotes deeper learning. The pedagogical mechanism, duration of use, learner characteristics, and degree of human scaffolding remain decisive.

Personalization should likewise be interpreted as differentiated support rather than as automated individual teaching. AI can vary explanations, examples, feedback, and pacing efficiently, but it does not independently determine which educational objective is most appropriate, whether a student's difficulty is conceptual or contextual, or when productive struggle should be preserved. The teacher's interpretive judgment therefore remains the mechanism that converts adaptive capability into educationally meaningful personalization (Ikram et al., 2026; Luo et al., 2025).

The most consequential tension concerns assessment. Generative AI reduces the evidentiary value of unsupervised products when assessment design cannot distinguish student reasoning from machine-generated output. The literature converges on redesign rather than detection alone: process evidence, staged production, oral explanation, authentic contextual tasks, reflection, and transparent disclosure can make learning more observable while still allowing legitimate AI support (Bittle; El-Gayar, 2025; Kofinas et al., 2025; Memarian; Doleck, 2026; Ncube et al., 2026). This reframes academic integrity as a problem of assessment validity and learning design, not only misconduct surveillance.

Ethical governance also needs to move beyond lists of prohibited behaviors. Privacy, bias, transparency, equity, authorship, and accountability are interconnected because institutional decisions about approved tools, data handling, access, and assessment determine who benefits and who bears risk. Policy synthesis and ethics reviews therefore converge on human oversight, clear responsibility, data protection, equitable access, and transparent rules as core governance principles (Funa; Gabay, 2025; Mouta et al., 2024).

Teacher education is the point at which many of these dimensions converge. Teachers must understand AI sufficiently to evaluate its outputs, make pedagogical choices, protect learners, redesign assessment, and communicate ethical expectations. The UNESCO framework and recent teacher-education reviews consistently treat AI competence as multidimensional rather than purely technical (Miao; Cukurova, 2024; Sperling et al.,

2024). Tan et al. (2025) further show that research attention to teacher professional development has lagged behind research on classroom applications, suggesting that implementation is advancing faster than systematic preparation of educators.

The evidence base also has important limitations. Much of the current literature documents perceptions, short-term implementations, or early post-ChatGPT adaptations, whereas fewer studies provide longitudinal evidence on durable learning, equity, professional practice, or institutional outcomes. The present review has an additional reporting limitation: database-level retrieval totals, duplicate-removal counts, reviewer allocation, and PRISMA-style screening numbers were not prospectively archived because the study was designed as a narrative review. Retrospective numerical reconstruction would risk producing inaccurate methodological claims; consequently, the revision reports the final 31-source corpus and its characteristics instead. Future evidence syntheses intended to make systematic-review claims should prospectively register the protocol, archive complete database outputs, document independent screening, and report the full selection flow.

From a practical perspective, the evidence supports an augmentation-with-accountability model organized around five mutually dependent conditions: a clear pedagogical purpose, visible human verification, valid and transparent assessment, institutional governance, and continuing AI literacy development. Weakness in any one condition can compromise the others. For example, sophisticated tools without assessment redesign can reduce authorship validity, while restrictive policies without teacher preparation may suppress productive uses without improving critical judgment. Responsible integration is therefore an institutional and pedagogical design problem, not merely a question of access to technology.

5. Conclusions

This review indicates that Artificial Intelligence is becoming embedded across pedagogical planning, learning support, feedback, assessment, and educational administration. Its strongest documented contributions involve adaptable support, rapid feedback, instructional assistance, and expansion of educational resources; however, recent evidence also shows that outcomes are heterogeneous and conditioned by learning design, human verification, infrastructure, and institutional governance. Reliability, academic integrity, privacy, bias, unequal access, and insufficient teacher preparation remain substantive constraints.

The evidence does not support replacing teachers with AI. Instead, it supports an augmentation model in which teachers retain responsibility for pedagogical judgment, contextualization, verification, ethical guidance, assessment validity, and the development of student autonomy. Responsible implementation therefore requires continuous professional development, clear institutional policies, adequate infrastructure, AI literacy, and assessment designs that make reasoning and authorship visible.

Future research should prioritize longitudinal and comparative studies across educational levels, disciplines, and sociocultural contexts, with particular attention to durable learning, metacognition, inclusion, teacher workload, equity, and the consequences of different governance models. When systematic evidence claims are intended, future reviews should use prospectively documented and, where appropriate, preregistered protocols with complete search-flow reporting. The central research question should increasingly move from whether AI is present in education to which forms of human-AI collaboration produce demonstrable pedagogical value without weakening accountability or educational equity.

6. Author Contributions

Anderson Ferreira da Silva: conceptualization, methodology, investigation, data curation, writing—original draft, writing—review and editing. *Rosimeire Rozendo*: conceptualization, investigation, data curation, writing—original draft, writing—review and editing. *Cristiane Aparecida Simão Silverio*: conceptualization, methodology, supervision, validation, writing—review and editing, and approval of the final version. All authors read and approved the final version of the manuscript.

7. Conflicts of Interest

No conflicts of interest.

8. Ethics Approval

Not applicable.

9. Artificial Intelligence Statement: Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

The authors declare that artificial intelligence tools were used only to support the organization of the manuscript revision process, language review, structural refinement, and overall organization of the content and references (OpenAI ChatGPT GPT-5.6 Sol; OpenAI, accessed August 2026). All scientific writing, interpretation of the evidence, methodological decisions, and conclusions were developed and approved by the human authors, who assume full responsibility for the manuscript.

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