

Artificial intelligence in distance education: a systematic review of emerging pedagogical, cognitive and institutional dynamics

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Abstract

Purpose – The study aims to systematically review and synthesize findings from peer-reviewed empirical and conceptual studies published between 2020 and 2025 to examine how AI is presently conceptualized, designed and enacted within distance education learning environments.

Design/methodology/approach – This review employed a systematic synthesis approach to examine how AI is conceptualized, implemented and studied within distance education contexts. In total, 56 peer reviewed articles were included in the systematic review. The process proceeded in iterative phases. Each article was read in full, with analytic notes created to capture research purposes, AI functions, learning contexts, methodological approaches, findings and implications. Particular attention was given to how the studies conceptualized the role of AI, whether as a tutor, tool, assessor, collaborator, facilitator of self-regulation or institutional mechanism, and how these conceptualizations aligned with distance education delivery. Four interconnected themes that structure discourse on AI in distance education emerged from the review.

Findings – The review identifies four interrelated themes that capture the evolving role of AI in distance education: (1) AI-driven personalization, learner modeling and adaptive support; (2) AI-mediated assessment, feedback and learning facilitation; (3) human–AI interaction, learning processes and pedagogical transformation and (4) AI governance, fairness, integrity and equity.

Research limitations/implications – A primary limitation concerns the limited number of studies included in this synthesis. Because the 56 articles included in this review were preselected and provided in full text, the analysis does not claim to represent the entirety of global research on AI in distance education during the period under study. While this approach enabled deep examination in education, it may omit relevant studies published in adjacent fields or disciplinary contexts. Future research would benefit from systematic searches across broader databases and inclusion criteria that capture emerging work in related domains such as computational education research, human–computer interaction and learning sciences. A second limitation is the lack of longitudinal evidence. Most studies reviewed relied on short-term interventions or cross-sectional data, making it difficult to assess the sustained effects of AI on learning, motivation or institutional practices. Longitudinal research is needed to understand how learner’s relationships with AI evolve over time, how instructors adapt their pedagogical strategies in response to AI integration, and how institutional policies shift as AI becomes more entrenched in distance education environments.

Practical implications – In addition to the four themes used to guide discourse involving AI and distance education, what emerges from this systematic review is an understanding that the impacts of AI in distance education extend far beyond technological features. AI reorganizes relationships among learners, teachers and institutions, requiring new pedagogical competencies, new forms of collaboration and new frameworks for accountability. For distance education, long committed to principles of access, flexibility and learner empowerment, the challenge is to integrate AI in ways that uphold these values while leveraging the technology’s potential to support high-quality learning.

Social implications – Educators and institutions must adopt intentional, theory-informed and ethically grounded approaches to AI design and implementation. They must cultivate AI literacies among learners and instructors, develop governance structures that focus on fairness and transparency and invest in research that examines AI’s long-term effects on learning and teaching. Through such efforts, the field can move toward forms of AI integration that enhance rather than compromise the core mission of distance education.

Originality/value – The rapid expansion of AI in distance education presents both transformational opportunities and profound responsibilities. By synthesizing evidence across diverse contexts and methodological traditions, this review provides a foundation for navigating these complexities and for shaping the future of AI-enabled distance education in ways that are pedagogically sound, ethically responsible and attuned to the needs and agency of learners.

Keywords Artificial intelligence, Distance education, Distance learning, Online learning

Paper type Literature review



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Introduction

Artificial intelligence (AI) has moved rapidly from a novel idea to a defining feature of current-day distance education. Over the past decade, and particularly since the global expansion of online learning during the COVID-19 pandemic, AI has been integrated across a wide array of distance education environments, influencing how students engage with content, how instructors design and facilitate instruction and how institutions make strategic decisions. AI-supported tools now mediate processes as varied as personalized learning pathways, automated and formative feedback, early-warning analytics, conversational assistance and adaptive skill development. As such, AI has begun to reshape not only the mechanics of distance education but also the pedagogical, cognitive and ethical assumptions that underpin educational practice.

The acceleration of AI adoption within distance education has unfolded across diverse contexts. Studies have examined AI tools in higher education (Chang, Wang, & Ku, 2024), K–12 (Xu, Dugdale, Wei, & Mi, 2023), STEM education (Ngoveni, 2025; Shabalala, 2024), health sciences and professional education (Li *et al.*, 2023; Prinz, Bürklein, Schäfer, & Donnermeyer, 2024), language learning (Liu, Darvin, & Ma, 2025; Vijayakumar & Panwale, 2025) and informal digital learning environments (Nguyen, Dinh, Dao, & Tran, 2025). Across these settings, researchers have investigated how AI systems support learner engagement, self-regulation, motivation, collaboration and cognitive performance. Other studies have examined teacher's and designer's shifting roles as they interact with AI-supported tools (Kumar *et al.*, 2024; Marrhich, Lafram, Berbiche, & El Alami, 2021; Nagro, 2021; Stadelmann, Keuzenkamp, Grabner, & Würsch, 2021), while institutional studies have explored AI's implications for academic integrity, fairness and governance (Fidas *et al.*, 2023; Seo, Tang, Roll, Fels, & Yoon, 2021).

Despite the breadth of this work, the research landscape is fragmented. Many studies focus on highly specific AI applications or localized implementations, which limits broader conceptual integration and generalization. Moreover, technological advances have outpaced theoretical and ethical frameworks, leaving uncertainties about how AI should be used pedagogically and how it may alter longstanding relationships among learners, teachers and institutions. There is a growing need for systematic synthesis that not only summarizes existing findings but also illuminates the underlying dynamics shaping AI-mediated distance education environments.

This review addresses that need by synthesizing 56 peer-reviewed empirical and conceptual studies published between 2020 and 2025 that explicitly examine AI within distance education contexts. By analyzing the purposes, methods and findings across this body of literature, this review identifies four interconnected themes that structure contemporary discourse on AI in education: (1) AI-driven personalization, learner modeling and adaptative support; (2) AI-mediated assessment, feedback and learning facilitation; (3) Human–AI interaction, learning processes and pedagogical transformation and (4) AI governance, fairness, integrity and equity. These themes reveal how AI is simultaneously enhancing instructional capacity, altering the nature of human–machine relations in learning and raising complex ethical questions that institutions and stake holders must navigate.

For scholars, educators and policymakers, understanding AI's multifaceted influence on distance education is essential as AI technologies continue to evolve, particularly with the rapid rise of generative AI and increasingly autonomous systems. Through this systematic synthesis, this review seeks to clarify what current research is telling us about the pedagogical opportunities and risks associated with AI, deepen the understanding of AI's cognitive and institutional effects and provide a direction for future research and responsible practice in the field of distance education.

Methods

This review employed a systematic synthesis approach to examine how AI is conceptualized, implemented and studied within distance education contexts (Denner, Marsh, & Campe, 2017).

It draws on 56 peer-reviewed empirical and conceptual studies, each provided in full text and selected for direct relevance to AI-mediated distance education. This approach enabled a depth-oriented analysis sensitive to the nuances of AI integration across diverse educational settings.

The identification of the 56 peer-reviewed studies was initiated using two well-known and widely used databases that contain research related to the field of education. The two databases are Education Source and ERIC (EBESCO). Within both of these databases, an initial search was performed using keywords “artificial intelligence or ai or a.i.” and “online learning or e-learning or distance learning”. Additional search parameters included only peer-reviewed articles, in English, where the full text of the article was available and were published from 2020 to 2025.

This initial search resulted in the identification of 88 articles between the two databases. After a review of all 88 articles, 27 articles were found to be duplicates between the two databases. This resulted in 61 unique articles that matched the criteria. A second review of the articles resulted in the removal of three articles because they were literature reviews comprising dates outside the parameters of this research. Two additional articles were removed because they were conference papers that broadly outlined a project but did not include detailed findings. Once these articles were removed, 56 unique, topic-specific articles remained to be analyzed.

The studies ultimately selected represent a broad range of learning environments, including higher education (Chang *et al.*, 2024), K–12 (Xu *et al.*, 2023), professional training programs (Prinz *et al.*, 2024), and informal learning ecosystems (Lee & Cho, 2025; Nguyen *et al.*, 2025). Several studies derive from STEM distance education contexts (Ngoveni, 2025; Shabalala, 2024), while others examine AI-supported disciplinary domains such as health sciences (Li *et al.*, 2023), and language learning (Liu, Darvin *et al.*, 2025). This diversity enabled a synthesis that reflects the multifaceted ways AI is influencing distance education.

The systematic synthesis proceeded in iterative phases. Each article was read in full, with analytic notes created to capture research purposes, AI functions, learning contexts, methodological approaches, findings and implications. Particular attention was given to how the studies conceptualized the role of AI, whether as a tutor, tool, assessor, collaborator, facilitator of self-regulation or institutional mechanism, and how these conceptualizations aligned with distance education delivery.

Through analysis and comparison of the 56 studies, patterns began to emerge across studies describing how AI reshapes pedagogy, cognitive engagement, learner–system interaction, assessment practices, teacher roles and institutional policy. Early categories were refined into broader thematic constructs, ultimately integrating into four analytically robust themes. These themes captured the core dynamics of the research findings involving AI-mediated distance education: (1) AI-driven personalization, learner modeling and adaptive support; (2) AI-mediated assessment, feedback and learning facilitation; (3) Human–AI interaction, learning processes and pedagogical transformation and (4) AI governance, fairness, integrity and equity. Some studies intersected with more than one theme, a reflection of AI’s complex and multifaceted role, resulting in assignments to more than one theme in some circumstances. Table 1 provides a theme-study index with frequency counts.

Findings

Theme 1: AI-driven personalization, learner modeling and adaptive support

A prominent line of inquiry across the reviewed studies concerns AI’s increasing capacity to generate personalized learning pathways, construct nuanced learner models and provide adaptive support that aligns with student’s evolving needs in distance education environments. This personalization imperative is particularly noticeable in distance education where learner heterogeneity, limited instructor visibility and the challenges of self-paced instruction can impede student progress. AI-driven models respond to these challenges by analyzing patterns in learner behavior, predicting performance trajectories and tailoring content, feedback or learning strategies accordingly.

Table 1. Theme-study index with frequency counts

Theme	Studies (author, year)
1. AI-Driven Personalization, Learner Modeling, and Adaptive Support (24 studies)	Ahmed et al. (2025) , Almuqhim and Berri (2025) , Bootchuy and Amornrit (2025) , Bozkurt and Sharma (2023) , Harizan and Ally (2025) , Kaouni et al. (2023) , Kang et al. (2023) , Kar et al. (2024) , Kumar et al. (2024) , Lee and Cho (2025) , Li et al. (2021, 2023, 2024) , Marrhich et al. (2021) , Moghadam et al. (2024) , Nguyen et al. (2025) , Nuci (2025) , Ouyang et al. (2023) , Prinz et al. (2024) , Thakur and Bhavani (2025) , Vijayakumar and Panwale (2025) , Wang et al. (2025) , Xu et al. (2023) , Yang and Liu (2022)
2. AI-Mediated Assessment, Feedback, and Learning Facilitation (19 studies)	Bodea et al. (2020) , Chang et al. (2024) , Cheng et al. (2022) , Fidas et al. (2023) , Forkan et al. (2023) , Jin et al. (2025) , Kang et al. (2023) , Li et al. (2023) , Marrhich et al. (2021) , Moon et al. (2025) , Nagarkar et al. (2021) , Nagro (2021) , Ouyang et al. (2023) , Seo et al. (2021) , Stadelmann et al. (2021) , Wang et al. (2025) , Zheng et al. (2024) , Zheng, Fan et al. (2025) , Zheng, Huang et al. (2025)
3. Human–AI Interaction, Learning Processes and Pedagogical Transformation (17 studies)	Bootchuy and Amornrit (2025) , Cheng et al. (2022) , Correia et al. (2024) , Deep and Chen (2025) , Engeness et al. (2025) , Gyasi et al. (2025) , Jin et al. (2023, 2025) , Kaouni et al. (2023) , Kumar et al. (2024) , Liu, Darwin et al. (2025) , Liu, Zou, et al. (2025) , Marrhich et al. (2021) , Moon et al. (2025) , Rienties et al. (2025) , Sun (2025) , Xiao, Yi et al. (2024)
4. AI Governance, Fairness, Integrity, and Equity (19 studies)	Ahmed et al. (2025) , Borkovska et al. (2024) , Fidas et al. (2023) , Finkelstein and Soffer-Vital (2025) , Kar et al. (2024) , Li et al. (2021, 2024) , Morgado et al. (2025) , Ngoveni (2025) , Prinz et al. (2024) , Rienties et al. (2025) , Rokhayani et al. (2022) , Seo et al. (2021) , Shabalala (2024) , Stealea et al. (2025) , Sun (2025) , Wang et al. (2025) , Xiao, Alibakhshi, et al. (2024) , Xiao, Yi, et al. (2024)

Several studies examined adaptive systems designed to match instructional content with learner’s real-time understanding and engagement levels. [Almuqhim and Berri \(2025\)](#) and [Harizan and Ally \(2025\)](#), for example, propose AI-integrated microlearning frameworks that dynamically adjusted content modules based on student’s interaction patterns, enabling a more responsive and individualized learning experience. [Kar, Das, Chatterjee, and Mandal \(2024\)](#), identify critical learning parameters for students learning in AI-mediated distance education. Similar efforts were evident in the work of [Kaouni, Lakrami, and Laboudiya \(2023\)](#), who introduced an adaptive e-learning model that drew on AI techniques to refine instructional strategies and support teachers in managing diverse learner profiles in remote contexts. [Nuci \(2025\)](#) likewise advanced a cloud-based AI system that generated personalized learning paths by analyzing student’s competencies and progression, demonstrating improvements in learner satisfaction and perceived fit.

The potential of AI personalization in professional and health sciences education was evidenced in studies such as those by [Li et al. \(2023\)](#), who found that AI-assisted morphological training systems effectively adapted task difficulty to student’s skill development, thereby accelerating learning in medical education. [Prinz et al. \(2024\)](#) reported analogous outcomes in dental education, where an AI-supported training environment improved diagnostic accuracy by tailoring feedback to learner’s evolving competencies. [Marrhich et al. \(2021\)](#) further illustrated the role of AI-based recommendation

systems in supporting teacher's transition to online teaching, suggesting that adaptive support tools also carry value for teacher development.

Beyond content-level adaptation, several studies implemented predictive analytics to identify learners at risk of disengagement or failure. [Li, Xing, and Leite \(2021\)](#) and their subsequent study in 2024 demonstrated that fairness-aware predictive models could enhance early identification of students in need of support without exacerbating demographic inequities. [Xu et al. \(2023\)](#) extended this predictive capability to young learners in online environments, showing that AI models could reliably forecast engagement levels, thus enabling targeted interventions. [Ouyang, Wu, Zheng, Zhang, and Jiao \(2023\)](#) reported that performance prediction models embedded within engineering courses allowed instructors to refine instructional strategies in line with learner's predicted trajectories.

Other studies showcased AI's ability to support microlearning and modularized instruction. [Bootchuy and Amornrit \(2025\)](#) designed an AI-supported information and media literacy platform, where AI-mediated tracking enabled more accurate analysis to answer learner's questions. [Moghadam, Darejeh, Delaramifar, and Mashayekh \(2024\)](#) similarly demonstrated the benefits of integrating AI-driven decision making into virtual learning experiences, while [Wang, Zhou, Li, Cheung, and Tian \(2025\)](#) showed how AI-enhanced interactive scaffolding impacts language learning.

Across these diverse implementations, one consistent finding emerges: AI-driven personalization enables more precise alignment between instructional design and learner needs, promoting deeper engagement and more efficient learning. However, several studies also pointed to limitations and risks. The effectiveness of personalization depends heavily on the quality and representativeness of underlying data, an issue highlighted in studies employing learning platforms ([Li et al., 2021](#), [Li, Xing, & Leite, 2024](#); [Thakur & Bhavani, 2025](#); [Yang & Liu, 2022](#)). Additionally, while adaptive tools may reduce cognitive load and facilitate learning, there is also a strong need for cognitive awareness of the constraints associated with AI ([Bozkurt & Sharma, 2023](#); [Liu, Darvin, et al., 2025](#)). The studies collectively suggest that personalization technologies hold substantial promise but require careful design to avoid over-automation and to ensure that learners remain active agents in their educational processes.

Theme 2: AI-mediated assessment, feedback and learning facilitation

A portion of the reviewed literature examined how AI reshapes assessment practices and the provision of feedback in distance education environments. Assessment and feedback have sometimes been noted as areas of vulnerability in distance education due to delayed instructor response times, challenges in monitoring student progress and barriers to providing individualized guidance at scale. AI interventions address these gaps by automating formative assessment, generating personalized feedback and supporting learner's cognitive and metacognitive development through continuous monitoring and scaffolding.

Several studies illustrate how AI can enhance the immediacy, relevance and pedagogical value of feedback. [Zheng et al. \(2024\)](#) demonstrated that AI-enabled feedback mechanisms, particularly when integrated within online collaborative learning environments, improved learner's ability to collaborate on knowledge building and group performance. Their later study ([Zheng, Fan, et al., 2025](#)) further confirmed that AI-driven recommendations and performance diagnostics supported more effective collaborative knowledge building patterns. [Zheng, Huang, Gao, and Fan \(2025\)](#) extended this line of inquiry by developing an AI-based group cognitive diagnostic approach, thereby refining collaborative learning pathways in ways that would be difficult for human instructors to achieve in real time.

Automated formative assessment tools were also employed to support comprehension and content mastery. [Forkan et al. \(2023\)](#) developed an AI-augmented video-based learning system in which the algorithm automatically generated practice questions aligned with student's activity patterns. Their results indicated that AI-generated assessments enhanced

comprehension by increasing opportunities for formative evaluation. The benefits of automated or semi-automated feedback were also evident in studies such as [Chang et al. \(2024\)](#), where AI feedback supported learning in complex cognitive domains, and in [Cheng, Cheng, and Huang \(2022\)](#), which analyzed how AI-integrated platforms facilitated student's learning progress and cognitive load.

AI-mediated assessment is equally prominent in professional education settings. [Li et al. \(2023\)](#) found that automated feedback within an AI-enhanced system for blood cell morphology training improved student's diagnostic accuracy and deepened their understanding of the content. [Prinz et al. \(2024\)](#) similarly demonstrated the value of AI-supported evaluative feedback in dental education, where AI helped students identify errors in clinical reasoning that may not have been immediately evident through traditional instructional methods.

In addition to skill-based assessment, several studies explored how AI facilitates collaborative learning processes. [Jin et al. \(2025\)](#) investigated an AI-enabled online professional learning community in which AI tools supported knowledge co-construction among novices and experts. [Moon, Jung, Bae, Lee, and Kim \(2025\)](#) similarly observed that AI-driven conversational supports influenced group dynamics and the alignment of technology with pedagogy as well as the importance of structured guidance in AI-enhanced learning.

Despite the pedagogical affordances of AI-mediated assessment, the reviewed studies also surfaced concerns about reliability, transparency and learner trust. [Fidas et al. \(2023\)](#), for example, examined an AI-driven proctoring system and noted concerns regarding privacy. [Seo et al. \(2021\)](#) highlighted the importance of understanding the accuracy of AI generated material and the impacts on student and instructor trust.

At the same time, studies such as [Bodea, Mogoş, Müller, and Dascălu \(2020\)](#), [Kang et al. \(2023\)](#), [Marrhich et al. \(2021\)](#) and [Nagarkar, Kalamkar, and Parchure \(2021\)](#), show that AI can impact distance education learners, teachers and designers. Taken together, the body of research confirms that AI has transformative potential to enhance distance education, but its effectiveness depends on thoughtful instructional design, clear communication and the cultivation of learner trust.

Theme 3: human–AI interaction, learning processes and pedagogical transformation

A third major line of inquiry across the reviewed studies concerns the ways humans, including learners, teachers and designers, interact with AI systems, and how these interactions reshape pedagogical practices and learning processes in distance education. As AI becomes embedded in the communicative, cognitive and organizational structures of distance education learning environments, it no longer functions merely as a background tool but emerges as a participant in learning. This shift has consequences for relational dynamics, motivational and emotional processes, instructional design and the distribution of labor between humans and machines.

Numerous studies examined the role of AI-based conversational agents and chatbots in mediating learner engagement, affect and understanding. [Engeness, Nohr, and Fosslund \(2025\)](#) found that chatbots became interactive learning partners through dialogic engagement, which in turn supported the development of student's digital agency. [Moon et al. \(2025\)](#) extended this insight by showing that chatbots fostered ideation, structured argumentation and knowledge construction. [Bootchuy and Amornrit \(2025\)](#) similarly observed that AI conversational systems improved information and media literacy among distance learners by accurately analyzing questions and providing precise answers.

Other studies investigated the cognitive and affective dynamics of human–AI interaction. [Jin, Im, Yoo, Roll, and Seo \(2023\)](#) documented improvements in metacognitive, cognitive and behavioral regulation in distance education when using AI applications. [Xiao, Yi, and Akhter \(2024\)](#) found that AI-supported English language learning environments enhanced student's cognitive emotion regulation and academic enjoyment, suggesting that AI can shape not only cognitive development but also emotional resilience in distance education. Similar patterns appeared in [Liu, Zou, Soyoof, and Chiu \(2025\)](#), where AI-mediated language learning fostered

higher levels of motivation, enjoyment and commitment to learning. Studies in culturally diverse contexts, such as those reported by Gyasi, Lanqin, Love, and Boateng (2025) and Sun (2025), found that AI-supported learning enhanced cross-cultural understanding, personal development, collaborative knowledge building and cognitive engagement.

A parallel research thread examines how AI transforms the work of instructors and instructional designers. Several studies identified shifts in teacher roles as automation and intelligent analytics become embedded in teaching practice. Marrhich *et al.* (2021), described how AI-supported systems eased instructor's transition to online teaching by automating routine tasks, thereby allowing faculty to devote more time to pedagogical decision-making and individualized support. Kumar *et al.* (2024) argued that instructional designers increasingly leverage AI in their roles, but that it should be done with caution and care. This realignment of design and facilitation roles is further evidenced in studies such as Jin *et al.* (2025), which showed how AI tools supported the co-construction of knowledge within online professional learning communities.

Teacher perceptions of AI also emerged as a critical dimension. Seo *et al.* (2021) addressed the potential for increased personalized learner-instructor interaction through the use of AI in distance education. At the same time, they highlighted the risks associated with the violation of social boundaries. Morgado, Leonido, Pereira, and Gouveia (2025) traced the broader institutional implications of AI adoption, noting that educators need to optimize the benefits while addressing limitations. Rienties *et al.* (2025) raised concerns about the ethical and social issues associated with AI-mediated learning environments in distance education.

In addition to teacher roles, several studies addressed the emergence of human–AI collaboration models. Kang *et al.* (2023) described how AI-supported dance instruction required instructors to adjust their pedagogical approaches, blending automated guidance with human interaction. The study by Xiao, Alibakhshi, *et al.* (2024) further emphasized that learner's AI literacy strongly influenced their ability to benefit from these new collaborative arrangements.

Collectively, these studies portray a shifting landscape in which AI systems participate in, rather than simply support, pedagogical interactions. Human–AI relationships are redefining the boundaries of teaching and learning, reshaping cognitive, emotional and social processes, and requiring educators to adopt new literacies, ethical sensibilities and instructional strategies. While the potential benefits are considerable, these transformations also demand sustained critical inquiry into questions of agency, trust, cultural responsiveness and the evolving role of the teacher in AI-enhanced distance education environments.

Theme 4: AI governance, fairness, integrity and equity

A final theme emerging across the reviewed literature concerns the governance, fairness, integrity and equity-related implications of AI integration in distance education. As AI systems increasingly mediate processes of assessment, personalization, communication and institutional decision-making, critical questions about transparency, fairness, privacy, academic integrity and equitable access emerge. These concerns are especially salient in distance education, where learners interact with AI systems in environments characterized by physical separation, heightened reliance on digital platforms and varying levels of technological access and readiness.

One central thread across the studies involves the ethical and affective ramifications of AI-based monitoring and assessment systems. Fidas *et al.* (2023) conducted an investigation of an AI-driven proctoring system in distance education and found that it can be effective against impersonation attacks, usability and the user experience. Seo *et al.* (2021), observed that the introduction of AI surveillance technologies in online learning environments complicated the relational dynamic between instructors and students, often leading to concerns over the violation of boundaries. These findings illustrate how AI systems can inadvertently undermine the psychological safety and relational transparency necessary for productive learning in a distance education environment.

Related concerns arise in studies examining algorithmic fairness and bias. [Li et al. \(2021\)](#) discuss the importance of careful use of AI when related to issues of fairness. Their later work (2024) reinforced the need for fairness in distance education and presented an AI-enhanced algorithm to evaluate fairness. [Xu et al. \(2023\)](#), while focusing on younger online learners, highlighted similar issues, noting the importance of accurately measuring engagement in online learning through the use of AI. These studies collectively underscore the importance of AI development practices in distance education systems where algorithmic judgments may influence fairness, engagement, interventions, grading or learner support.

While studies noted the need for focus on a variety of equity related issues. [Ngoveni \(2025\)](#) argued that AI-enhanced mathematics instruction in distance education environments should be balanced with an eye on digital inequities, digital infrastructure and adequate training for teachers and learners. [Shabalala \(2024\)](#) extended this concern to STEM education more broadly, cautioning that AI integration must consider data privacy, security and equitable access. Studies addressing inclusion at the learner level, such as [Ahmed, Saleh, and Ahmed \(2025\)](#) and [Stelea, Robu, and Sandu \(2025\)](#), demonstrated that AI systems designed with accessibility and equity in mind can significantly improve learning opportunities for students with disabilities or children with special needs and promote inclusive education. [Borkovska, Kolosova, Kozubska, and Antonenko \(2024\)](#) similarly examined how AI tools may cultivate soft skills in distance education environments, offering pathways for more inclusive learning experiences. These studies affirm that AI has the capacity to promote equitable access when designed intentionally, but may also deepen inequities when access, literacy or cultural responsiveness is uneven.

Equity concerns also intersect with cultural and linguistic diversity. [Finkelstein and Soffer-Vital \(2025\)](#) found that cultural empathy plays an important role in AI-facilitated distance education learning experiences. [Sun \(2025\)](#) demonstrated that AI-supported virtual exchanges can enhance cross-cultural understanding and personal development among English majors in online learning. [Xiao, Yi, and Akhter \(2024\)](#) showed that AI-mediated language learning in online learning environments bolster academic enjoyment. Additionally, [Rokhayani, Rukmini, Hartono, and Mujiyanto \(2022\)](#) reported that online, AI-mediated English language learners reported increased feelings of autonomous and fun learning.

Institutional governance represents another dimension of this theme. Studies such as [Morgado et al. \(2025\)](#) examined the critical need for policies when introducing AI into distance learning environments. These policies will benefit learners, teachers and designers. [Rienties et al. \(2025\)](#) similarly identified the importance of governance related to AI-enhanced distance education issues.

Across these studies, a consistent message emerges: AI's role in distance education cannot be understood solely in terms of pedagogical effectiveness. Ethical and equity considerations must be central to any deployment of AI, particularly in environments where students operate with varying levels of autonomy, technological access and cultural familiarity. Effective AI governance requires not only technical safeguards but also institutional policies that foster trust, ensure transparency, protect privacy and expand equitable access to AI-supported learning experiences. Without such measures, the benefits of AI may be unevenly distributed, and the potential of AI to enrich distance education may remain unrealized.

Discussion

The findings across the 56 reviewed studies reveal a complex and evolving landscape in which AI is reshaping pedagogical, cognitive and institutional dimensions of distance education. Although the studies vary in purpose, design and disciplinary orientation, several cross-cutting patterns emerge that help clarify AI's current and potential contributions to distance education environments. These patterns point to an overarching shift in which AI is not merely supporting instructional processes but is increasingly embedded within the relational, epistemic and organizational structures of learning systems.

A first insight is highlighted by AI's role in intensifying personalization and learner modeling across diverse distance education contexts. Studies examining adaptive engines, predictive analytics and individualized recommendation systems (Almughim & Berri, 2025; Kaouni *et al.*, 2023; Prinz *et al.*, 2024) collectively illustrate that AI enables a more granular understanding of learner's knowledge states, behaviors and motivational profiles. This enhanced visibility supports adaptive pathways that may mitigate some of the longstanding challenges of distance education, particularly learner heterogeneity and reduced instructor presence. Yet, across the literature, personalization is both celebrated and discussed with cautions. While predictive models are shown to guide timely interventions (Li *et al.*, 2021, 2024), they also highlight the importance of fairness and reduced bias. This underscores the need for human-centered models of AI-supported personalization that treat adaptive insights as augmentations to, rather than replacements for, learner's agency and instructor's professional judgment.

A second major insight centers on AI's influence over assessment and feedback, which continues to represent one of the most transformative areas for AI integration in distance education. The reviewed studies demonstrate that automated or semi-automated feedback systems enhance immediacy and accuracy while reducing instructor workload (Forkan *et al.*, 2023; Li *et al.*, 2023; Zheng *et al.*, 2024). These developments have notable implications for learner performance, self-regulation and confidence, particularly in complex cognitive domains. In addition, group-level cognitive diagnostics (Zheng, Huang, *et al.*, 2025) and AI-mediated feedback in collaborative learning spaces (Jin *et al.*, 2025; Moon *et al.*, 2025) illustrate AI's emerging capacity to support not only individual learning but also collective knowledge building. However, AI-enhanced assessment also amplifies concerns about transparency, reliability and surveillance. Studies examining AI-enabled monitoring systems (Fidas *et al.*, 2023) reveal the psychological and ethical risks associated with automated judgments, especially when learners perceive these systems as intrusive or opaque. Thus, while AI expands the possibilities for personalized, scalable feedback, its adoption must be accompanied by ethical safeguards that preserve learner trust, ensure transparency and clarify the intended scope of automated assessment.

A third insight traces the pedagogical and relational implications of human–AI interaction. Across multiple studies, learners report that chatbots, conversational agents and intelligent assistants offer valuable scaffolding, generate motivation and shape the social and emotional contours of learning (Deep & Chen, 2025; Engeness *et al.*, 2025; Liu, Darwin, *et al.*, 2025; Xiao, Yi, *et al.*, 2024). These findings suggest that AI systems increasingly serve as co-constructors of meaning with learners rather than merely delivering information. This transformation has implications for learner's cognitive processing, sense of agency and emotional engagement. Simultaneously, studies involving teachers and instructional designers (Correia, Hickey, & Xu, 2024; Kumar *et al.*, 2024; Marrhich *et al.*, 2021; Morgado *et al.*, 2025) show that AI integration is restructuring professional roles, redistributing labor and demanding higher levels of AI literacy. While this does present opportunities for teachers to focus on high-level pedagogical work, concerns about overreliance on automated systems or institutional expectations that exceed their training should be addressed. Human–AI partnerships therefore emerge as both a pedagogical asset and requiring ongoing consideration of how responsibilities, expertise and authority are shared across humans and machines.

The fourth insight relates to governance, fairness, integrity and equity, which represent foundational concerns in AI-enabled online education. Some studies draw attention to potential algorithmic bias (Li *et al.*, 2021, 2024), differential access to AI resources (Ngoveni, 2025; Shabalala, 2024) and the cultural and linguistic factors that shape learner's experiences with AI tools (Finkelstein & Soffer-Vital, 2025; Sun, 2025). These findings suggest that the benefits of AI may not be evenly distributed across learner populations, institutions or regions. Instead, AI adoption can reproduce structural inequities unless accompanied by intentional design strategies and supportive institutional policies. Moreover, AI-enabled academic integrity systems reveal the psychological and ethical dilemmas inherent in automated

surveillance (Fidas *et al.*, 2023), highlighting the need for institutional governance frameworks that prioritize transparency, consent and proportionality. The literature indicates that ethical deployment is not ancillary to AI effectiveness but central to its pedagogical legitimacy and sustainability.

Across these themes, the reviewed studies collectively suggest that AI is reshaping distance education in ways that transcend technological enhancement. AI is recasting pedagogical relationships, redistributing labor, influencing learner's affective experiences and reconfiguring institutional norms and expectations. The field is therefore moving toward an understanding of AI not merely as a set of tools but as a complex socio-technical system embedded within distance education. Such a system demands holistic and careful approaches to design, implementation and governance, incorporating perspectives from pedagogy, ethics, data science and institutional policy.

At the same time, the literature points to several needs that warrant continued attention. The balance between automation and human judgment remains unsettled. Learner's and educator's trust in AI systems is uneven and paramount to learner success when involving AI-mediated distance education. The promises of personalization and efficiency often coexist with risks to autonomy, privacy and equity. Addressing these tensions requires frameworks that position AI as a collaborator rather than a controller, emphasizing human oversight, interpretability, transparency and inclusivity. It also requires a clearer articulation of the pedagogical theories underpinning AI integration, as many studies focus on technological affordances without sufficiently grounding interventions in established learning theories.

Overall, the studies reviewed reveal a field undergoing transformation, with AI reshaping how learning is structured, facilitated, assessed and governed in distance education. Understanding these dynamics is essential for developing the next generation of equitable, ethical and pedagogically sound AI-enabled learning environments.

Limitations

Although this review provides a systematic synthesis of AI integration in distance education, limitations must be acknowledged to contextualize its contributions. A primary limitation concerns the limited number of studies included in this synthesis. Because the 56 articles included in this review were preselected and provided in full text, the analysis does not claim to represent the entirety of global research on AI in distance education during the period under study. While this approach enabled deep examination in education, it may omit relevant studies published in adjacent fields or disciplinary contexts. Future research would benefit from systematic searches across broader databases and inclusion criteria that capture emerging work in related domains such as computational education research, human-computer interaction and learning sciences.

A second limitation is the lack of longitudinal evidence. Most studies reviewed relied on short-term interventions or cross-sectional data, making it difficult to assess the sustained effects of AI on learning, motivation or institutional practices. Longitudinal research is needed to understand how learner's relationships with AI evolve over time, how instructors adapt their pedagogical strategies in response to AI integration and how institutional policies shift as AI becomes more entrenched in distance education environments.

Conclusion and future research

AI is becoming a defining force in the evolution of distance education, shaping how learning is designed, facilitated, experienced and governed across a wide variety of digital contexts. The 56 studies synthesized in this review collectively illustrate that AI is no longer a peripheral supplement to instructional technology but a central actor within contemporary educational ecosystems. AI influences not only the mechanics of content delivery or assessment but also the relational, cognitive and institutional frameworks that sustain meaningful learning in distance education environments.

The review identified four broad themes through which AI's influence is most visible: (1) AI-driven personalization, learner modeling and adaptive support; (2) AI-mediated assessment, feedback and learning facilitation; (3) Human–AI interaction, learning processes and pedagogical transformation and (4) AI governance, fairness, integrity and equity. Within each theme, AI offers considerable promise. Adaptive systems enhance the precision of instructional support, predictive analytics enable timely intervention, automated feedback improves learning efficiency, conversational agents scaffold motivation and engagement and AI-assisted tools expand opportunities for inclusion and accessibility. These developments hold particular value in distance education, where the physical separation of learners and teachers often magnifies challenges of engagement, personalization and continuous support.

Yet the review also highlights potential risks and unresolved tensions. The same systems that personalize learning can diminish autonomy if overly prescriptive; the tools that enable efficient feedback can obscure the learning processes behind automated judgments; the agents that scaffold interaction can inadvertently reshape learner identity or foster dependency and the models that guide institutional decisions can reproduce inequities if not carefully designed and governed. Ethical, cultural and affective considerations therefore remain central to the responsible deployment of AI in distance education environments.

What emerges from the synthesis is an understanding that the impacts of AI in distance education extend far beyond technological features. AI reorganizes relationships among learners, teachers and institutions, requiring new pedagogical competencies, new forms of collaboration and new frameworks for accountability. For distance education, long committed to principles of access, flexibility and learner empowerment, the challenge is to integrate AI in ways that uphold these values while leveraging the technology's potential to support high-quality learning.

To meet this challenge, educators and institutions must adopt intentional, theory-informed and ethically grounded approaches to AI design and implementation. They must cultivate AI literacies among learners and instructors, develop governance structures that focus on fairness and transparency and invest in research that examines AI's long-term effects on learning and teaching. Through such efforts, the field can move toward forms of AI integration that enhance rather than compromise the core mission of distance education.

This illustrates the critical need for future research in AI-enhanced distance education as the rapid rise of AI presents significant new directions for inquiry. Future research could include an examination of how generative AI can support knowledge construction, how learners negotiate co-authorship with AI systems and how educators design assessments that cultivate human–AI co-creation while safeguarding academic rigor. In sum, the future points towards fertile opportunities for important research. Investigating AI through longitudinal, theoretically grounded and ethically engaged approaches will be essential for understanding and shaping the evolving role of AI in distance education.

In conclusion, the rapid expansion of AI in distance education presents both transformational opportunities and profound responsibilities. By synthesizing evidence across diverse contexts and methodological traditions, this review provides a foundation for navigating these complexities and for shaping the future of AI-enabled distance education in ways that are pedagogically sound, ethically responsible and attuned to the needs and agency of learners.

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