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Trends in the Use of Artificial Intelligence (AI) in Education: A Systematic Literature Review

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ABSTRACT

This study aimed to provide a systematic review of the trends in AI utilisation in education over the past decade (2015–2025). The Systematic Literature Review (SLR) method was employed following the PRISMA protocol, with data sources drawn from four major databases: IEEE Xplore, Scopus, Web of Science, and Google Scholar. The total number of selected and analysed articles offered in-depth insights into various forms of AI implementation, such as intelligent tutoring systems, adaptive learning, educational chatbots, automated assessment, and learning analytics. The findings of the review indicated that AI significantly contributed to personalised learning, educational management efficiency, and early detection of potential academic failure. However, notable challenges also emerged, particularly concerning ethics, data privacy, and algorithmic bias. In addition, technical and social barriers such as the digital divide and resistance from educators continued to hinder the equitable adoption of AI. This review concluded that strategic and ethical approaches were required in the development and implementation of AI in order to ensure greater inclusivity and sustainability. These findings were expected to serve as a foundation for educational policy and future research directions.

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1. INTRODUCTION

The development of digital technology has brought about significant changes across various sectors of human life. Among the most affected sectors, education stands out as one of those most profoundly influenced by the wave of digital transformation. This change not only touches technical aspects, such as the provision of infrastructure or the use of hardware and software, but also affects learning paradigms, the interaction between teachers and learners, and the overall strategies for managing educational institutions. Within this landscape, Artificial Intelligence (AI) has emerged as one of the key technologies exerting a major and rapidly evolving influence over the past decade. AI refers to the capability of computer systems to emulate human cognitive functions, such as logical reasoning, learning from data, decision-making, and autonomous problem-solving [1]. In the educational context, AI is positioned not merely as an assistive tool, but as a transformative catalyst promising various revolutionary innovations in

learning processes, educational management, and academic evaluation that are adaptive to the dynamics of the times.

Various forms of AI applications have been successfully adopted in both formal and informal educational domains, and across multiple educational levels—from primary schools to higher education and lifelong learning. Among the most prominent implementations are intelligent tutoring systems (ITS), adaptive learning systems, educational chatbots, automated assessment systems based on natural language processing (NLP), and AI-based learning analytics [2], [3]. Intelligent tutoring systems offer learning experiences akin to human tutors, with the ability to adapt content, difficulty levels, and delivery styles according to the unique characteristics and needs of each learner [4]. Meanwhile, adaptive learning systems provide more personalised learning experiences through real-time analysis of learners' performance and behaviour, enabling the delivery of targeted content suited to individual learning paces [5]. Moreover, AI facilitates automated academic evaluations, such as essay marking and online quizzes, at high speed with high consistency and minimal human bias [6]. Beyond the learning process, AI is also implemented in the managerial aspects of educational institutions. The technology has contributed to the optimisation of curriculum planning, student needs mapping, prediction of academic success, and efficient management of human and educational resources [7].

The digital transformation in education has become increasingly inevitable, particularly with the onset of global crises such as the COVID-19 pandemic, which accelerated the adoption of technology in remote learning. In such circumstances, AI has played a crucial role in providing online learning systems that not only deliver information but also interactively and responsively adapt to the highly diverse needs of learners [8]. AI's capability to process and analyse big data enables educational institutions to gain deeper insights into students' learning behaviour patterns. These data can be utilised to facilitate early interventions in potential academic failures, develop more effective teaching strategies, and strengthen student engagement in the learning process [9]. Hence, the presence of AI within the educational ecosystem is no longer merely a technological innovation, but a strategic necessity that determines the success of educational transformation in an ever-evolving digital era.

Despite these positive potentials, the application of AI in education also brings forth various critical challenges and issues that warrant serious attention. One major issue concerns ethics and data privacy, especially when highly sensitive student data are used to train AI models [10]. The data collected may include learning preferences, academic performance records, and other personal information, which, if not properly managed, can lead to breaches of privacy rights. Algorithmic bias also poses a significant problem, where AI models trained on unrepresentative or historically biased data may produce unfair and discriminatory decisions or recommendations toward certain groups [11]. Other challenges include technological infrastructure readiness, particularly in regions still experiencing a digital divide. Inequitable access to technology and internet connectivity may exacerbate educational inequality, allowing only a fraction of learners to optimally access AI-based learning [12]. Resistance from educators and institutions toward technological change is also a notable barrier. Factors such as low digital literacy, fear of human roles being replaced by machines, and limited access to professional training can slow the adoption of AI in education [13]. All these challenges underscore the importance of comprehensive and systematic academic reviews to understand not only the opportunities but also the risks and obstacles associated with AI implementation in the education sector.

Over the past decade, the number of academic publications discussing AI in education has increased significantly, reflecting the growing interest and academic focus on this topic. However, these studies remain scattered across various disciplines, with diverse focuses and approaches—ranging from technological and pedagogical perspectives to education policy and technological ethics. Many of these studies are fragmented or focused on specific contexts, such as higher education only, particular geographic regions, or specific types of AI technology. Furthermore, most existing reviews have not yet integrated the most recent data comprehensively, given the rapid pace of technological development [14]–[16]. Therefore, there is an urgent need for a broad and comprehensive systematic review that not only synthesises existing empirical evidence but also

provides a holistic picture of the directions, patterns, and dynamics of AI utilisation in education across various dimensions and contexts.

This study adopts the systematic literature review (SLR) approach using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework. This approach is chosen for its systematic, transparent, and standardised method for identifying, selecting, and analysing relevant literature. Data collection was conducted using several major academic databases, namely IEEE Xplore, Scopus, Web of Science, and Google Scholar, all recognised for their extensive coverage and high-quality publications in the fields of technology and education. The articles selected were limited to publications in English between 2015 and 2025, with an explicit focus on the use or impact of AI in formal and informal educational contexts. This review aims to provide an up-to-date and relevant synthesis of knowledge that not only benefits the academic community but also serves as a strategic reference for policymakers, technology developers, and educational practitioners in ethically and effectively integrating AI into learning practices.

This study has four main objectives: first, to identify various forms of AI technology implementation in educational contexts, both in formal classroom learning and informal settings; second, to analyse the impact of AI use on the effectiveness of learning processes in terms of learning outcomes, motivation, learner engagement, and teaching efficiency; third, to describe key challenges and ethical issues that arise in the practical implementation of AI, including data privacy concerns, algorithmic bias, and access inequality; and fourth, to formulate strategic recommendations to foster more inclusive, sustainable, and socially just development and utilisation of AI in educational systems. Accordingly, the findings of this review are expected to serve as a crucial foundation for more focused future research and to support a smarter, fairer, and more responsive educational transformation in the face of future challenges.

2. METHOD

This research employs a Systematic Literature Review (SLR) approach to gain a comprehensive understanding of AI implementation in education between 2015 and 2025. The SLR approach was selected for its ability to systematically and structurally summarise and synthesise scientific evidence from various sources, thereby producing an objective and replicable mapping of knowledge [17]. SLR is also useful for identifying research trends, gaps in the literature, and data-driven policy recommendations [18].

The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol serves as the primary guide for conducting this SLR, as it is a globally recognised framework for carrying out systematic reviews with transparency and standardisation [19]. PRISMA provides a structured framework from identification to reporting of studies selected based on stringent inclusion and exclusion criteria [20].

A comprehensive literature search was carried out across four leading academic databases: IEEE Xplore, Scopus, Web of Science, and Google Scholar. These databases were chosen for their extensive coverage and high-quality publications in the fields of technology and education. Keywords used included “Artificial Intelligence”, “AI in Education”, “Intelligent Tutoring System”, “Adaptive Learning”, “Learning Analytics”, and “Machine Learning in Education”. These terms were combined using Boolean operators such as AND, OR, and NOT to maximise the relevance of search results [21].

Literature included in this review had to meet several inclusion criteria: (1) published between 2015 and 2025; (2) written in English; (3) available in full text; and (4) explicitly addressing the use or impact of AI in formal or informal educational contexts. Accepted publications had to be peer-reviewed and could include qualitative, quantitative, or mixed-methods studies [22]. Articles such as opinions, editorials, or reports lacking empirical results, as well as documents unrelated to education, were excluded from the review [23].

The literature selection process involved three main steps: initial screening by removing duplicates, title and abstract screening to ensure relevance, and full-text reading to assess compliance with inclusion criteria. Two researchers conducted the selection independently to

minimise individual bias. Disagreements were resolved through discussion, and if necessary, a third party acted as a mediator [24].

Data from the selected articles were systematically extracted into a predefined format. Collected information included publication details (title, author, year), research aims and methodologies, educational context, type of AI technology used, key findings, as well as identified challenges and recommendations. This process was performed manually to ensure accuracy and consistency across articles [25].

Analysis was conducted using a thematic approach to identify common patterns and themes emerging from the reviewed studies. This approach enabled in-depth exploration of conceptual aspects, practical issues, and ethical concerns in the implementation of AI in education [26]. The main themes identified included: personalised learning through AI, use of learning analytics for student performance prediction, efficiency in automated assessment, use of chatbots as learning assistants, and concerns about privacy and algorithmic bias [27].

Although this study does not involve direct human subjects, ethical standards were upheld through the use of legally obtained references and proper academic citation practices. All documents analysed were either open-access or accessed via legitimate institutional subscriptions. Citations were formatted using the IEEE style to maintain academic integrity and acknowledge the contributions of previous scholars [28]. Through this SLR approach, the study is expected to provide a comprehensive literature map, illustrate the dynamics of AI development in education, and present evidence-based recommendations for future policy and practice in technology-enhanced learning.

3. RESULTS AND DISCUSSION

Based on a review of 82 scientific articles that met the inclusion criteria, this study reveals that the application of Artificial Intelligence (AI) in education has undergone significant development, both in terms of geographical reach and functional diversity. The studies analysed encompass a wide range of institutions and countries, reflecting a global adoption of AI that is no longer limited to developed nations alone. This indicates that AI has become a catalyst for educational transformation on a universal scale, with varying degrees of adaptation depending on the social, economic, and policy context of each region.

One of the main and most frequently highlighted findings in the literature is how AI is used to support personalised learning. The implementation of machine learning, natural language processing (NLP), and data analytics enables learning systems to understand students' learning preferences, cognitive abilities, and individual progress, and subsequently tailor the learning materials and approaches in real time. This approach is consistently reported to enhance student engagement, the effectiveness of the learning process, and in many cases, also contributes to improved academic outcomes.

Adaptive learning technologies such as Knewton and Smart Sparrow enable platforms to adjust content based on students' interaction patterns. These systems not only deliver content suited to students' comprehension levels but also provide relevant exercises, adjust material difficulty, and recommend alternative learning pathways. Studies show that students learning through such systems grasp concepts more quickly and demonstrate greater persistence in completing learning tasks.

The presence of Intelligent Tutoring Systems (ITS) is another critical highlight in the analysis. ITS such as Carnegie Learning and Squirrel AI simulate the role of human tutors capable of offering personalised and in-depth feedback on students' mistakes. These systems are designed not only to answer questions but also to guide students towards critical thinking, identify misconceptions, and rebuild understanding through AI-driven interactive dialogues. The effectiveness of ITS in enhancing conceptual understanding, especially in STEM fields, has been demonstrated in numerous experimental and longitudinal studies.

Another key category is automated assessment. Technologies such as Gradescope and Turnitin utilise AI to mark essay assignments, quizzes, and text-based examinations. This greatly helps in reducing lecturers' workloads, speeding up feedback cycles, and ensuring consistency in assessment. However, studies also note that the accuracy of automated assessment systems still

varies, particularly in evaluating argumentation nuance or logical structure in essays. Therefore, most experts recommend that such technologies be used as supportive tools, not as complete replacements for human assessment.

Educational chatbots have also started to gain prominence across various learning platforms. Chatbots such as Duolingo Bots and Watson Tutor have been used to provide responsive, text- or voice-based learning assistance. They are designed to answer students' questions instantly, provide brief explanations of specific concepts, and guide structured practice processes. The effectiveness of chatbots in increasing student engagement largely depends on the quality of interaction and the relevance of the responses given. Studies examining chatbot use have found them highly beneficial in self-directed learning and material review contexts.

Table 1. Five main categories of AI use in education based on the reviewed literature:

AI Use Category	Brief Description	Example Technologies
Adaptive Learning	Tailors content based on student performance and learning style	Knewton, Smart Sparrow
Intelligent Tutoring System	Mimics human tutors to provide personalised, interactive instruction	Carnegie Learning, Squirrel AI
Automated Assessment	Automatically grades essays, quizzes, and text-based exams	Gradescope, Turnitin
Educational Chatbots	Offers responsive, text/voice-based learning support	Duolingo Bots, Watson Tutor
AI-Based Learning Analytics	Analyses learning data to improve instructional decision-making	Tableau, Power BI + AI add-ons

In addition to supporting personalised learning, another key finding from this review is the use of AI to support decision-making at the institutional level. AI's ability to process and analyse large-scale data rapidly provides significant benefits to educational management. Institutions use AI to predict students' academic success, identify potential dropout risks, and evaluate curriculum and teaching method effectiveness. In many studies, AI-based predictive systems have proven effective in improving operational efficiency, providing a basis for more targeted interventions, and supporting long-term, data-driven planning.

A study conducted at a major university in East Asia used AI to map students' academic pathways and offer course recommendations based on previous performance. As a result, the institution succeeded in reducing dropout rates by 20% over two years. Another study in Europe revealed that AI systems analysing student engagement in LMS platforms could accurately predict students at risk of failing particular courses, enabling lecturers to take a personalised approach early on.

However, the successful implementation of AI in education has not always been smooth. Several significant challenges were also identified in the literature. The first is the issue of data privacy. Many AI systems rely on the collection and processing of large volumes of student data to train predictive models. Unfortunately, not all institutions have adequate regulatory frameworks to safeguard this sensitive information. Cases of data breaches and unauthorised data use have raised major concerns among educators, students, and parents.

Second, algorithmic bias poses a serious challenge. AI trained on non-representative data can yield discriminatory decisions or recommendations, such as in predicting academic performance or career path suggestions. Studies show that students from minority backgrounds, whether ethnic or economic, are more vulnerable to negative predictions if AI systems are not developed inclusively. Therefore, ethical evaluations and algorithmic audits are highlighted in many articles as essential components of responsible AI development practices.

Third, there remains a digital divide that hampers equitable AI implementation. Institutions in remote areas or developing countries often face limitations in infrastructure, internet access, and adequate digital literacy. This creates disparities in access to AI-based educational innovations, potentially deepening global educational inequality. Several studies propose collaborative

approaches among governments, the private sector, and international organisations to address this issue by providing basic infrastructure and digital skills training.

The literature also discusses resistance among some educators towards AI integration. Concerns over technology replacing the teacher's role, and a lack of understanding of AI's potential, are primary causes of this resistance. However, many studies emphasise that AI is not a replacement but a support for teachers. In an ideal scenario, teachers utilise AI to gain data-driven instructional insights, devise more personalised teaching strategies, and provide more effective interventions for struggling students.

Studies assert that the teacher's role actually becomes more strategic and reflective in the AI era. With the availability of real-time analysis and AI-based recommendations, teachers can allocate more time to building interpersonal relationships with students, fostering empathy, and nurturing social skills that machines cannot replicate. Therefore, enhancing teachers' capacity to understand and utilise AI is crucial and frequently recommended in the literature as part of long-term implementation strategies.

The review also found that the success rate of AI implementation is heavily influenced by educational policy frameworks and institutional readiness. Countries with clear national strategies for technology integration in education generally report more positive outcomes. Factors such as teacher training, availability of digital infrastructure, and robust data protection policies are key indicators of success.

Countries such as Singapore, South Korea, and Finland are cited in several studies as positive examples of developing inclusive AI-based education ecosystems. Governments in these countries not only provide technological tools but also promote curriculum transformation, continuous professional development for educators, and ensure public participation in the development of AI-related regulations. In this context, collaboration between the public and private sectors is vital to ensure sustainability and scalability of the systems.

Another notable aspect of the findings is the expanding role of AI in non-formal education and lifelong learning. Platforms such as Coursera, edX, and Udacity have integrated AI to provide personalised learning pathways, from course recommendations and study reminders to automated evaluations. These systems enable users from diverse backgrounds to learn flexibly according to their individual needs and schedules. In a global context that is increasingly dynamic, AI's capacity to support lifelong learning is essential to address future employment challenges.

Studies note that AI in non-formal learning has the potential to enhance social inclusion, particularly for adults without access to formal education. However, challenges such as limited digital literacy and dependence on specific languages still need to be addressed for this potential to be widely and equitably accessed.

Based on all of the above findings, this review proposes several relevant practical implications. First, it is essential for educational institutions to develop comprehensive AI integration strategies, including systematic training for educators, upgrades to digital infrastructure, and internal policies that support technological innovation. Second, data protection policies and algorithmic transparency must be enforced to safeguard user rights and security. Third, further research is necessary to explore the long-term impact of AI use on the social, psychological, and cultural dimensions of education, including how the roles of teachers and students evolve in increasingly digital learning ecosystems.

The findings of this systematic review illustrate that AI implementation in education holds tremendous transformational potential, but also presents serious challenges requiring multidisciplinary attention. Ethical, fair, and sustainable AI implementation can only be achieved through collaboration among technology developers, educators, policymakers, and the wider community. The future of AI-based education is not solely about technological sophistication, but also about how such technologies are used to reinforce human values, inclusion, and social justice in the teaching and learning process.

4. CONCLUSION

The application of Artificial Intelligence (AI) in education, as revealed from the review of 82 scholarly articles, demonstrates a strong global trend in supporting the transformation of

teaching and learning processes. AI has been widely utilised to enhance personalised learning through technologies such as adaptive learning, intelligent tutoring systems, and educational chatbots. Beyond its impact on individual learning experiences, AI also assists educational institutions in making strategic, data-driven decisions. In other words, AI is not merely a technical tool, but also plays a structural role in shaping a more responsive and efficient educational ecosystem.

Despite its considerable potential, the implementation of AI in education faces significant challenges. Issues such as data privacy, algorithmic bias, and disparities in technological access are major concerns frequently highlighted in the literature. Furthermore, resistance from educators—stemming from fears of being replaced by technology and a lack of digital literacy—also hinders progress. This review shows that the success of AI integration is highly dependent on institutional readiness and governmental policies, including support for training, data protection regulations, and adequate infrastructure. A cautious and ethical approach is key to optimising the use of AI so that it does not exacerbate existing inequalities.

AI in education can deliver a significant transformational impact if implemented in an inclusive, ethical manner that strengthens the human role in learning processes. Collaboration between educators, technology developers, and policymakers is essential to ensure that AI serves as a supportive tool that broadens access to and enhances the quality of education, rather than replacing it. The findings of this review emphasise that the future of education will not be shaped solely by technological advancements, but also by how such technologies are interpreted and applied within complex and ever-evolving social contexts.

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