IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, October 2026
Impact Factor: 8.2

The Evolving Landscape of Artificial Intelligence in Education: A Systematic Review of Technologies, Applications, Ethics, and Future Directions

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Abstract: *Artificial Intelligence (AI) is transforming education by enabling personalized learning, intelligent tutoring, automated assessment, and learning analytics. Recent advancements in Generative AI (GenAI), Large Language Models (LLMs), and Agentic AI have enhanced educational systems through adaptive learning, content generation, and AI-assisted teaching. However, challenges such as data privacy, algorithmic bias, explainability, academic integrity, and ethical concerns continue to hinder their widespread adoption. This systematic review analyzes fifteen recent studies published between 2024 and 2026 to examine the latest developments in AI-driven education. The selected studies cover key areas including Generative AI, Agentic AI, Learning Analytics, Educational Data Mining, Intelligent Tutoring Systems, AI-assisted teacher education, and ethical AI implementation. The review identifies major applications, compares existing approaches, highlights current limitations, and discusses emerging research trends. The findings reveal that while AI has significant potential to improve teaching and learning, greater emphasis is needed on explainable AI, human–AI collaboration, standardized evaluation frameworks, and long-term classroom validation. This review provides valuable insights and future research directions for developing responsible, transparent, and learner-centered AI-enabled educational systems.*

Keywords: Artificial Intelligence, AI in Education, Generative AI, Agentic AI, Personalized Learning, Intelligent Tutoring Systems, Learning Analytics, Educational Technology

I. INTRODUCTION

Artificial Intelligence (AI) is transforming education by enhancing teaching, learning, and educational management. Recent advances in Machine Learning (ML), Deep Learning (DL), Large Language Models (LLMs), and Generative Artificial Intelligence (GenAI) have enabled personalized learning, intelligent tutoring, automated assessment, adaptive learning, and data-driven decision-making. AI-powered tools such as ChatGPT, Google Gemini, and GitHub Copilot are increasingly used to support content creation, lesson planning, programming assistance, and student learning. More recently, Agentic AI has emerged as a new generation of educational technology capable of autonomous reasoning, planning, and continuous learner support. In addition, Educational Data Mining (EDM) and Learning Analytics (LA) help institutions analyze learner behavior, predict academic performance, and improve instructional strategies.

Despite these benefits, AI adoption in education faces challenges such as data privacy, algorithmic bias, explainability, academic integrity, and the need for responsible AI governance. Moreover, many AI-based educational systems lack standardized evaluation frameworks and long-term classroom validation. This review systematically analyzes 15 recent

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studies (2024–2026) on AI in education, covering Generative AI, Agentic AI, Intelligent Tutoring Systems, Learning Analytics, Educational Data Mining, AI-assisted teacher education, and ethical AI implementation. The review compares existing approaches, highlights key applications, identifies current challenges and research gaps, and discusses future research directions.

II. RESEARCH METHODOLOGY

This review follows a Systematic Literature Review (SLR) approach to analyze recent developments in Artificial Intelligence in education. The objective is to identify major AI technologies, applications, challenges, and future research directions through a structured analysis of recent literature.

A. Literature Search Strategy

A systematic search was conducted for peer-reviewed studies published between 2024 and 2026 using IEEE Xplore, ACM Digital Library, Journal of Web Engineering, and other reputable journals. Search keywords included Artificial Intelligence in Education, Generative AI, Agentic AI, Large Language Models, Intelligent Tutoring Systems, Personalized Learning, Learning Analytics, Educational Data Mining, Explainable AI, and AI Ethics.

B. Selection Criteria

Studies were selected based on the following criteria:

- Published between 2024–2026
- Peer-reviewed journal or conference papers

C. Study Selection and Data Analysis

After screening, 15 research papers were selected covering Generative AI, Agentic AI, Intelligent Tutoring Systems, Learning Analytics, Educational Data Mining, AI Ethics, Teacher Education, Personalized Learning, and AI-based educational platforms. Key information—including research objectives, AI technologies, methodologies, findings, limitations, and future directions—was extracted from each study. A qualitative comparative analysis was then performed to identify research trends, applications, challenges, ethical issues, research gaps, and future opportunities in AI-driven education.

D. Research Workflow

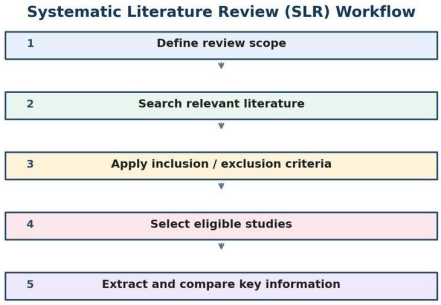


Fig. 1. Systematic literature review research workflow.

III. LITERATURE REVIEW

Artificial Intelligence (AI) has significantly transformed education through personalized learning, intelligent tutoring, automated assessment, adaptive content generation, and data-driven decision-making. Recent advances in Generative AI, Large Language Models (LLMs), Agentic AI, Educational Data Mining (EDM), and Learning Analytics (LA) have

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expanded the capabilities of AI-enabled educational systems. This section reviews 15 recent studies (2024–2026), highlighting their objectives, methodologies, key contributions, and limitations.

The selected literature mainly focuses on five research areas: (1) Generative AI for teaching and learning, (2) Agentic AI and autonomous educational systems, (3) Personalized and adaptive learning, (4) Ethical and responsible AI, and (5) Learning Analytics and Educational Data Mining. Although these studies demonstrate AI's potential to improve educational outcomes, challenges such as limited classroom validation, explainability, privacy, and long-term evaluation remain.

Table I summarizes the selected research papers and their main contributions, AI technologies, and reported limitations.

TABLE I. SUMMARY OF SELECTED RESEARCH PAPERS

Paper	Year	Main Focus	AI Technology	Key Contribution	Limitation
Paper 1	2024	Generative AI in Education	Generative AI, GANs	Comprehensive review of GenAI applications, adaptive learning, and educational content generation	Limited practical implementation and classroom validation
Paper 2	2025	Agentic AI in Education	Agentic AI, LLMs	Taxonomy of autonomous educational agents and future research directions	Mostly conceptual with limited empirical evaluation
Paper 3	2025	AI Adoption in Higher Education	Technology Acceptance Model (TAM)	Identified factors affecting AI adoption for collaborative and inclusive learning	Based on a single university survey
Paper 4	2025	AI in Teacher Education	ChatGPT, Gemini, Perplexity	Proposed a six-phase framework for critical AI integration in teacher education	Limited participant population
Paper 5	2024	AI-Generated Code Detection	ChatGPT, AI Detectors	Evaluated AI detectors for identifying AI-generated programming code	Existing detectors
Paper 6	2026	Human–AI Synergy	Intelligent Tutoring Systems, GenAI	Proposed AI–Human Synergy Framework for collaborative education	Framework requires real-world validation
Paper 7	2025	Educational Data Mining	Neural ODE, Neural CDE, Learning Analytics	Reviewed continuous-time learning analytics and ethical AI trends	Limited empirical implementation
Paper 8	2025	Ethical AI in Education	Adaptive AI Systems	Identified ethical challenges and mitigation strategies using the Pythia platform	Based on a single case study
Paper 9	2026	Agentic AI Review	Multi-Agent Systems	Systematic review of autonomous educational agents and pedagogical alignment	Few long-term classroom studies
		GenAI in Engineering	ChatGPT, GitHub	Scoping review of AI-	Focused primarily on

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Paper 10	2025	Education	Copilot, Gemini	supported engineering and computing education	engineering discipline
Paper 11	*2025*	Robotics Education	Robotics, Simulation	Surveyed robotics laboratories and practical learning approaches	Limited focus on AI-driven personalization
Paper 12	*2024*	AI, Mobile Learning, and Social Media	AI-based Learning Systems	Investigated relationships among AI, mobile learning, and academic performance	Conducted within a single institution
Paper 13	*2025*	Mathematics Teacher Education	Generative AI, MATH41	Demonstrated AI-assisted lesson planning and teacher competency development	Small sample size
Paper 14	*2024*	AI-Based Educational Platform	Generative AI, Big Data	Proposed a big data-driven educational platform integrating web engineering and AI	Lacked experimental validation
Paper 15	*2025*	Personalized Music Education	Generative AI	Reviewed AI-based personalized music education methods	Limited AI applications for instrumental practice

Table I. Summary of the 15 selected research papers.

IV. COMPARATIVE ANALYSIS OF AI TECHNOLOGIES IN EDUCATION

The selected studies demonstrate the rapid evolution of AI in education from Generative AI to Agentic AI, with increasing emphasis on personalization, human–AI collaboration, and ethical AI. This section compares the reviewed studies based on AI technologies, educational applications, research methodologies, advantages, limitations, and emerging trends.

A. Comparison of AI Technologies

The reviewed studies employ various AI technologies to address different educational challenges. Generative AI is the most widely adopted technology for content generation and personalized learning, while Agentic AI represents an emerging direction for autonomous educational support.

TABLE II. COMPARISON OF AI TECHNOLOGIES

AI Technology	Purpose	Representative Papers	Advantages	Limitations
Generative AI	Content creation, tutoring, lesson planning	P1, P10, P13, P14, P15	Personalized learning; rapid content generation	Hallucination, bias, academic misuse
Agentic AI	Autonomous learning assistants	P2, P9	Goal-oriented learning; adaptive support	Limited classroom deployment
Large Language Models (LLMs)	Question answering, educational assistance	P1, P2, P10	Natural interaction; scalable learning	Reliability and factual accuracy
Learning Analytics	Student performance prediction	P7	Early identification of at-risk learners	Privacy concerns

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Educational Data Mining	Learning behavior analysis	P7	Data-driven decision making	Requires high-quality educational data
Intelligent Tutoring Systems	Personalized instruction	P6	Adaptive feedback and learner support	Limited human collaboration
AI Detection Systems	Detection of AI-generated work	P5	Supports academic integrity	Low detection accuracy
AI-Assisted Teacher Education	Lesson planning and teacher support	P4, P13	Improves teaching competency	Requires pedagogical training

Table II. Comparison of major AI technologies identified in the reviewed studies.

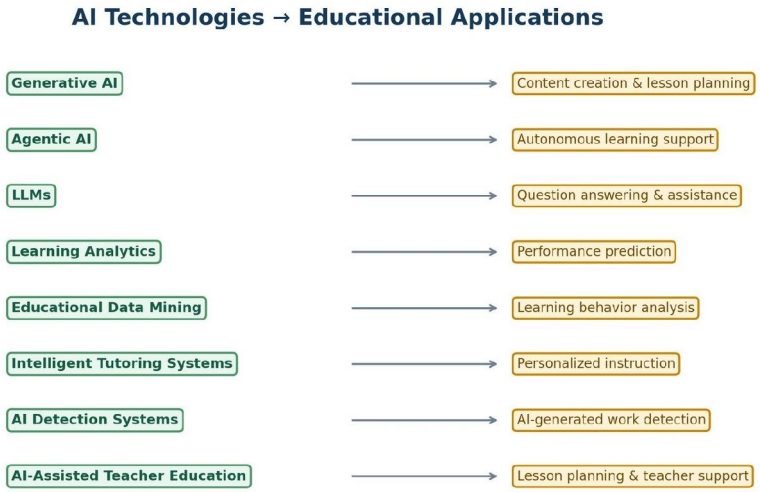


Fig. 2. AI technologies and educational applications framework.

Technology representation model

$$R_t = (N_t / N) \times 100$$

where N = 15 selected papers and N_t = number of representative papers for technology t. Because papers may represent more than one technology, percentages need not sum to 100%.

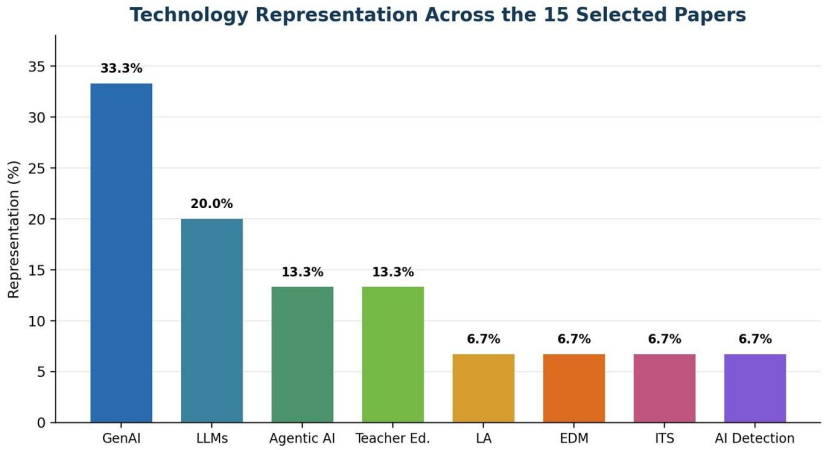


Fig. 3. Technology representation across the 15 selected papers.

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B. COMPARISON OF EDUCATIONAL APPLICATIONS

The selected papers cover diverse educational applications, including personalized learning, intelligent tutoring, teacher education, engineering, mathematics, robotics, music education, learning analytics, and AI-based educational platforms.

These applications demonstrate the broad impact of AI across modern education.

Educational Application	Papers
Personalized Learning	P1, P2, P6, P10, P12, P15
Intelligent Tutoring	P1, P2, P6, P9
Teacher Education	P4, P13
Engineering & Computing Education	P5, P10
Mathematics Education	P13
Robotics Education	P11
Music Education	P15
Learning Analytics	P7
Mobile Learning	P12
Educational Platforms	P14
AI Ethics	P8

Table III. Educational applications represented across the selected papers.

C. ADVANTAGES AND LIMITATIONS

The reviewed studies consistently report benefits such as personalized learning, intelligent tutoring, automated content generation, improved student engagement, learning analytics, and AI-assisted teaching. However, common limitations include limited classroom validation, privacy and security concerns, algorithmic bias, lack of explainability, academic integrity issues, and insufficient long-term evaluation.

D. EMERGING RESEARCH TRENDS

- Transition from Generative AI to Agentic AI.
- Increased focus on human–AI collaboration.
- Growth of explainable and trustworthy AI.
- Expansion of personalized adaptive learning.
- Integration of AI with Learning Analytics and Educational Data Mining.
- Stronger emphasis on ethical AI governance.

Overall, educational AI is evolving toward more collaborative, adaptive, and learner-centered systems. Future research should focus on real-world validation, standardized evaluation, and responsible AI implementation.

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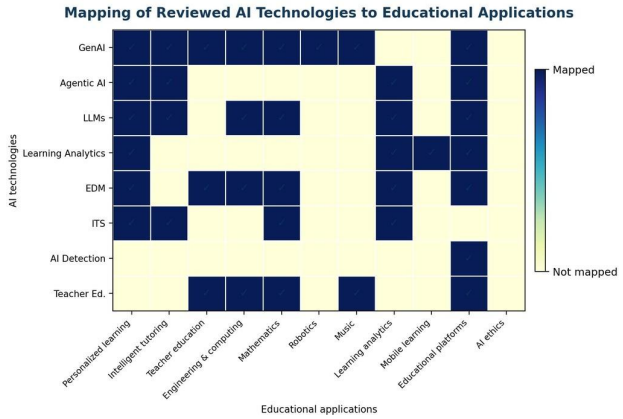


Fig. 4. Mapping of reviewed AI technologies to educational applications.

V. APPLICATIONS OF ARTIFICIAL INTELLIGENCE IN EDUCATION

Artificial Intelligence (AI) has significantly enhanced education by supporting personalized learning, intelligent tutoring, automated assessment, and data-driven decision-making. AI systems analyze learner performance to provide adaptive content, personalized feedback, and customized learning pathways.

Generative AI and Intelligent Tutoring Systems assist educators in lesson planning, content creation, grading, and student support, reducing workload while improving learning experiences. Learning Analytics and Educational Data Mining help predict student performance, identify at-risk learners, and support evidence-based educational decisions.

The reviewed studies also demonstrate AI applications in teacher education, engineering, mathematics, robotics, music education, and AI-powered educational platforms. Despite these benefits, responsible implementation remains essential to address privacy, fairness, transparency, and academic integrity. Overall, AI has become a key technology for improving educational quality, accessibility, and efficiency, while emphasizing the need for ethical and human-centered adoption.

VI. CHALLENGES AND ETHICAL ISSUES

Data Privacy and Security

AI systems collect large amounts of student data, creating risks related to privacy, security, and unauthorized access. Secure data management and privacy regulations are essential.

Bias and Explainability

AI models may produce biased decisions due to biased training data. In addition, many AI systems lack transparency, making Explainable AI (XAI) important for building trust.

Hallucinations and Academic Integrity

Generative AI can generate inaccurate information and enable plagiarism or AI-assisted assignments. Human verification and improved assessment methods are needed.

AI Dependency and Human Oversight

Excessive dependence on AI may reduce students' critical thinking skills. AI should support teachers and learners rather than replace human judgment.

Ethical Governance

Educational institutions should establish policies that ensure fairness, transparency, accountability, privacy protection, and responsible AI use.

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VII. RESEARCH GAPS AND FUTURE RESEARCH DIRECTIONS

Although AI has significantly improved education through personalized learning, intelligent tutoring, and learning analytics, several research gaps remain.

A. Research Gaps

- Limited integration of Generative AI, Agentic AI, and Explainable AI into unified educational systems.
- Insufficient Human–AI collaboration, with AI often replacing rather than assisting educators.
- Lack of explainable and transparent AI models.
- Limited real-world classroom validation and long-term evaluation.
- Inadequate ethical frameworks addressing privacy, bias, and fairness.
- Absence of standardized benchmarks for evaluating AI-based educational systems.

B. Future Research Directions

- Developing integrated and human-centered AI learning platforms.
- Improving Explainable AI (XAI) and ethical AI frameworks.
- Conducting large-scale classroom validation studies.
- Establishing standardized evaluation methods.
- Enhancing personalized learning using multimodal learner data.
- Strengthening AI governance and responsible AI literacy.

VIII. CONCLUSION

Artificial Intelligence (AI) has become a transformative technology in education by enabling personalized learning, intelligent tutoring, automated assessment, learning analytics, and adaptive educational systems. This review analyzed 15 recent studies (2024–2026) to examine recent advancements, applications, challenges, research gaps, and future directions of AI in education.

The reviewed literature shows that technologies such as Generative AI, Agentic AI, Large Language Models (LLMs), and Learning Analytics have significantly improved teaching and learning through personalized instruction, intelligent feedback, and enhanced educational support. However, several challenges remain, including data privacy, algorithmic bias, explainability, hallucinations, academic integrity, and excessive dependence on AI.

The review also identifies important research gaps, such as limited real-world validation, lack of standardized evaluation frameworks, and insufficient Human–AI collaboration. Future research should focus on developing ethical, explainable, and human-centered AI systems while strengthening collaboration between educators and intelligent technologies. Overall, AI has the potential to reshape education by improving learning outcomes and accessibility. Responsible implementation, supported by transparency, ethical governance, and continuous human oversight, will be essential for building trustworthy and sustainable AI-enabled educational environments.

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