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Agentic AI in Education: Opportunities, Challenges, and Future Research Agenda

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Abstract

Agentic artificial intelligence (AI) is emerging as a new generation of intelligent systems capable of reasoning, planning, decision-making, and autonomous action. In the field of education, these capabilities can enable personalized learning, intelligent tutoring, adaptive feedback, educational analytics, collaborative learning, and teacher support. Concurrently, the greater autonomy of AI raises issues of transparency, accountability, privacy, bias, pedagogical shift, learning process, infrastructure, job loss, academic dishonesty, and sustainability. This editorial examines the opportunities and challenges associated with Agentic AI in education and highlights areas in which existing educational practices and governance arrangements may need to evolve. The paper outlines a future research agenda for autonomy and transparency, ethics and governance, pedagogy and instruction, learner development, infrastructure and accessibility, human–AI collaboration and role transformation, academic integrity and misuse, scalability and sustainability, and cross-cultural and institutional contexts based on these challenges. The agenda focuses on the importance of empirical, comparative, interdisciplinary and longitudinal research to inform the understanding of the potential of autonomous AI to improve learning outcomes while maintaining human oversight, academic values, equity, and responsible use. The proposed agenda is designed to be used as a reference for researchers, educators and institutions to design effective, inclusive, trustable and sustainable educational ecosystems with Agentic AI.

1. Overview of Agentic AI in Education

Artificial intelligence (AI) has evolved rapidly over the last few years, moving from traditional rule-based and predictive systems toward more advanced intelligent systems capable of autonomous reasoning, planning, and decision making. Recently, Agentic AI has emerged as a new paradigm that extends the capabilities of Generative AI by enabling AI systems to act autonomously, pursue goals, make decisions, interact with environments, and collaborate with humans and other intelligent agents (Hughes et al., 2025). Unlike conventional AI systems that mainly respond to user prompts, Agentic AI systems are designed to perform tasks proactively, adapt to changing contexts, and execute multi step actions with minimal

human intervention (Bandi et al., 2025). The rise of Agentic AI represents a shift from passive AI assistance toward autonomous and collaborative intelligence. Agentic AI has the potential to transform many sectors, including healthcare, business, manufacturing, transportation, and education, by improving efficiency, adaptability, personalization, and intelligent decision support.

Education is one of the sectors that can be significantly transformed through Agentic AI technologies. Educational systems continuously evolve to respond to technological advancements, labor market demands, and societal changes. Traditional digital learning environments focused mainly on delivering educational content and automating administrative tasks. However, Agentic AI introduces a more intelligent, adaptive, and autonomous educational ecosystem that supports both learners and educators. In the context of education, Agentic AI refers to intelligent autonomous systems capable of assisting students, supporting educators, personalizing learning experiences, managing educational processes, and facilitating collaborative learning activities. These systems can interact dynamically with learners, monitor progress, provide personalized feedback, recommend learning pathways, and autonomously adapt instructional strategies based on students' needs and performance (Kostopoulos et al., 2025). As a result, Agentic AI can contribute to creating more flexible, learner centered, and intelligent educational environments.

Educational technologies have long played an essential role in enhancing teaching and learning by improving accessibility, engagement, collaboration, and learning effectiveness. The emergence of Agentic AI further extends the capabilities of educational technologies by introducing autonomous reasoning and adaptive decision making into learning environments (Ubaydullaevna et al., 2025). One major application of Agentic AI in education is the development of intelligent tutoring systems capable of acting as autonomous learning companions that guide students throughout their educational journey. These systems can analyze learner behavior, identify strengths and weaknesses, recommend personalized resources, and provide continuous adaptive feedback. Another application is the use of Agentic AI powered virtual teaching assistants that can support educators in preparing learning materials, grading assignments, answering students' questions, and monitoring student engagement. Agentic AI can also support personalized learning by dynamically adjusting learning content, pacing, and instructional strategies according to individual learner characteristics and preferences.

In addition, Agentic AI can facilitate collaborative and experiential learning environments through intelligent simulations, virtual laboratories, and immersive educational experiences. For example, autonomous AI agents can support students during problem solving activities, project-based learning, and group discussions by providing guidance, generating suggestions, and coordinating collaborative tasks. Agentic AI can also improve educational analytics through continuous monitoring of learner interactions and performance data (Lai et al., 2025), enabling educators and institutions to identify at risk students and provide timely interventions. Furthermore, the integration of Agentic AI with technologies such as virtual reality, augmented reality, wearable devices, and learning analytics can create highly interactive and adaptive learning environments that enhance student engagement, motivation, and learning outcomes. As Agentic AI technologies continue to evolve, they are expected to play an increasingly important role in reshaping educational practices, institutional operations, and the future of teaching and learning.

2. CHALLENGES OF AGENTIC AI IN EDUCATION

While Agentic AI offers significant opportunities for transforming education, its implementation also introduces several important challenges that need to be carefully addressed. One of the major challenges is the autonomous nature of Agentic AI systems. Unlike conventional AI systems that mainly respond to predefined user inputs, Agentic AI systems are capable of making decisions, initiating actions, and executing tasks independently (Raheem & Hossain, 2025). This raises concerns regarding control, accountability, and transparency within educational environments. Educators and institutions may face difficulties understanding how autonomous agents make decisions, recommend learning pathways, or generate educational content. The lack of transparency in decision making processes may reduce trust in Agentic AI systems and create concerns regarding the reliability of educational outcomes.

Another major challenge lies in ethical governance, bias, and fairness, which remain among the most consistently reported concerns in recent reviews of AI in education (Alfiras et al., 2025). Agentic AI systems rely heavily on large volumes of student data to provide adaptive and personalized learning experiences. This raises concerns regarding data privacy, data

ownership, consent, surveillance, and cybersecurity. Educational institutions must ensure that sensitive learner information is protected against misuse, unauthorized access, and potential security breaches. In addition, there is a risk that Agentic AI systems may inherit or amplify biases embedded in training data or algorithms, which can lead to unfair treatment, discrimination, or unequal learning opportunities for certain groups of students. Ensuring fairness, inclusivity, and ethical decision making therefore becomes a critical issue in the adoption of Agentic AI in education.

The integration of Agentic AI also presents pedagogical and instructional challenges. Traditional teaching approaches may no longer be sufficient in highly autonomous and intelligent learning environments. Educators may need to redesign curricula, assessment methods, and instructional strategies to effectively integrate Agentic AI into teaching and learning processes. At the same time, the increasing reliance on autonomous systems may alter the role of educators from knowledge providers to facilitators, mentors, and supervisors of AI supported learning environments. This transition requires significant investments in teacher training and professional development to ensure that educators possess the technical, pedagogical, and ethical competencies needed to work effectively with Agentic AI technologies.

Another challenge concerns students' cognitive, social, and emotional development. While Agentic AI can provide highly personalized learning experiences, excessive dependence on autonomous AI systems may reduce opportunities for human interaction, collaborative learning, and interpersonal communication. Students may become overly reliant on AI generated assistance, potentially weakening critical thinking, creativity, problem solving, and independent learning skills (Al-Emran, 2024). In addition, continuous interaction with autonomous intelligent agents may influence students' emotional well-being, motivation, sense of identity, and social development. There is therefore a need to carefully balance AI supported learning with meaningful human engagement and social interaction.

Infrastructure and accessibility issues also remain significant barriers to the successful implementation of Agentic AI in education. The deployment of advanced Agentic AI systems requires substantial technological infrastructure, computational resources, reliable internet connectivity, and continuous technical support. Several educational institutions, particularly in underserved regions, may lack the financial and technological capacity needed to adopt such technologies effectively. This may widen existing digital inequalities between students and institutions with access to advanced technologies and those without access. The high cost of implementation, maintenance, and system integration may further limit the scalability and accessibility of Agentic AI in education.

The growing integration of AI in education also raises concerns regarding employment, academic integrity, and the future role of humans in educational processes. Autonomous AI agents may automate several academic and administrative tasks traditionally performed by educators and support staff, creating uncertainty regarding future job roles and professional responsibilities. In addition, the use of highly autonomous AI systems may increase concerns regarding plagiarism, misinformation, fabricated content, and unethical academic practices. Educational institutions therefore need to establish clear policies, governance frameworks, and ethical guidelines to regulate the responsible use of Agentic AI technologies in teaching, learning, assessment, and institutional management.

3. FUTURE RESEARCH AGENDA

The challenges discussed above indicate that the educational use of Agentic AI requires research that extends beyond technical capability and technology adoption. The research priorities listed in Table 1 are directly related to the autonomy, governance, pedagogical, learner, infrastructure, employment and academic-integrity challenges listed above. The agenda then extends these priorities to longer-term questions of scalability and sustainability and to cross-cultural and institutional contexts, where the effects and governance of Agentic AI may vary. Future studies should not only explore the feasibility of implementing Agentic AI in education but also how it needs to be designed, managed, utilized, and assessed in various educational contexts, given its potential to impact learning activities, educational decisions, and institutional processes.

Themes	Research questions
Autonomy, Control, and Transparency	• How can explainable and transparent mechanisms be integrated into Agentic AI systems to improve trust in educational decision making? • How can accountability frameworks be designed to clarify responsibility for AI driven decisions and outcomes in education? • What methods can be used to evaluate the transparency and interpretability of Agentic AI systems across different educational contexts?

	• How do varying levels of AI autonomy influence educators' and students' trust, acceptance, and reliance on Agentic systems?
Ethical and Governance Issues	• What ethical guidelines are required to regulate the responsible use of Agentic AI in education? • What governance models are most effective for monitoring and auditing Agentic AI systems in educational institutions?
Pedagogical and Instructional Challenges	• What instructional strategies are most effective for integrating autonomous AI agents into teaching and learning processes? • How does the use of Agentic AI influence curriculum design, assessment methods, and classroom interaction? • What are the long-term effects of Agentic AI supported learning environments on teaching effectiveness and educational quality?
Impact on Learners' Development	• How does prolonged interaction with Agentic AI affect students' critical thinking, creativity, and problem-solving skills? • What impact does Agentic AI have on students' motivation, engagement, and self-regulated learning behaviors? • What psychological and social implications emerge from students' continuous reliance on autonomous educational agents?
Infrastructure and Accessibility	• What technological infrastructures are required to support scalable deployment of Agentic AI in educational institutions? • How can Agentic AI systems be optimized for low resource and developing educational environments? • What strategies can improve accessibility and usability of Agentic AI for students with diverse learning needs? • What are the energy consumption and computational implications of large-scale deployment of Agentic AI in education?
Employment and Role Uncertainty	• How will Agentic AI reshape the roles and responsibilities of educators and academic staff? • What new competencies and professional skills will educators require in AI augmented educational environments? • How can collaborative human-AI teaching models be designed to complement rather than replace educators?
Academic Integrity and Misuse Risks	• How does Agentic AI affect academic integrity, assessment validity, and responsible student use of AI? • How can institutions distinguish legitimate AI-supported learning from inappropriate AI dependence or misuse? • What assessment designs are most resilient to autonomous AI assistance while preserving meaningful measurement of student learning? • How can misinformation, fabricated content, plagiarism, and other AI-enabled academic misconduct be detected and addressed?
Scalability and Sustainability	• What organizational, financial, and technical factors determine the long-term scalability of Agentic AI in educational institutions? • How can institutions evaluate the cost-effectiveness and long-term sustainability of Agentic AI adoption? • What environmental implications arise from the computational resources required for large-scale Agentic AI deployment? • How can sustainable and resource-efficient Agentic AI solutions be developed for institutions with limited technological capacity?
Cross-Cultural and Institutional Contexts	• How do cultural, institutional, and policy differences influence the adoption and governance of Agentic AI across countries? • How do Agentic AI opportunities and risks differ between well-resourced and low-resource educational settings? • What institutional conditions and national policies support responsible and equitable Agentic AI implementation? • How can cross-country comparative studies improve understanding of context-specific Agentic AI adoption, governance, and educational outcomes?

Table 1. Proposed research agenda.

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