



Academic opportunities and challenges associated with AI adoption in higher education and its influence on student learning performance

Dr. A Sudhanraj¹, S LakshmiPriya²

¹ Associate Professor, School of Management, Takshashila University Tindivanam, Tamil Nadu, India

² Assistant Professor, School of Management, Takshashila University Tindivanam, Tamil Nadu, India

Abstract

Artificial Intelligence (AI) has emerged as an important technology in higher education, transforming traditional approaches to teaching and learning through intelligent tutoring, adaptive learning, personalized education, and generative AI applications. The development of AI in education can be traced to early intelligent tutoring systems, which aimed to provide individualized learning support to students (CARBONELL, 1970; SLEEMAN & Brown, 1982). Recent advancements have expanded the role of AI in higher education by supporting personalized learning, student engagement, immediate feedback, flexible learning, knowledge acquisition, and academic assistance (BRUSILOVSKY, 1996; Holmes *et al.*, 2019; ZAWACKI-Richter *et al.*, 2019). However, AI adoption also presents several challenges, including inadequate technological infrastructure, lack of faculty training, academic integrity concerns, data privacy, ethical issues, and excessive dependence on AI-generated information (FLORIDI *et al.*, 2018; ZAWACKI-Richter *et al.*, 2019; KASNECI *et al.*, 2023). This review-based study examines the opportunities and challenges associated with AI adoption in higher education and explores its potential influence on student learning performance. The study further reviews the roles of personalized learning and student engagement as important mechanisms through which AI may improve learning outcomes, while AI literacy is considered an important student competency for the effective and responsible use of AI technologies (Long & MAGERKO, 2020). Overall, the review highlights that AI can contribute to improved student learning performance when it is integrated with effective pedagogy, appropriate institutional support, digital infrastructure, AI literacy, and ethical guidelines. The study provides a conceptual foundation for future empirical research examining AI adoption and student learning performance in higher education.

Keywords: Artificial Intelligence, Higher Education, AI Adoption, Student Learning Performance, Personalized Learning, Student Engagement, AI Literacy.

Introduction

Artificial Intelligence (AI) is increasingly becoming an integral component of higher education, creating new possibilities for transforming conventional approaches to teaching, learning, assessment, and student support (Holmes *et al.*, 2019; ZAWACKI-Richter *et al.*, 2019) [8, 19]. The integration of AI into education has its foundations in early intelligent tutoring systems, which were developed to provide learners with individualized instructional assistance and responsive learning support (Carbonell, 1970; SLEEMAN & Brown, 1982) [3, 14]. In recent years, developments in machine learning, natural language processing, and generative AI have broadened the application of AI across higher education institutions, enabling adaptive instruction, personalized learning pathways, automated feedback, and academic assistance (Chen *et al.*, 2020; KASNECI *et al.*, 2023) [4, 9]. By analyzing learners' needs and learning patterns, AI-supported systems can facilitate customized educational experiences, allowing students to access relevant resources, progress at an appropriate pace, and receive timely feedback (BRUSILOVSKY, 1996; Holmes *et al.*, 2019) [2, 8]. AI-based educational applications may also strengthen student engagement by creating interactive learning environments and offering continuous academic assistance beyond traditional classroom settings (ZAWACKI-Richter *et al.*, 2019; Bond *et al.*, 2024) [1, 19]. Nevertheless, the implementation of AI is not without difficulties, as higher education institutions may face limitations related to

technological infrastructure, faculty readiness, ethical decision-making, privacy protection, algorithmic fairness, and organizational resistance (FLORIDI *et al.*, 2018 [6]; UNESCO, 2021). The widespread availability of generative AI has further intensified debates concerning academic honesty, inappropriate use of AI-generated content, misinformation, student dependence on automated tools, and the accuracy of AI-produced information (Cotton *et al.*, 2023; KASNECI *et al.*, 2023) [5]. Consequently, successful AI integration requires a comprehensive approach involving institutional support, faculty development, suitable digital infrastructure, ethical standards, and effective governance mechanisms (Holmes *et al.*, 2019 [8]; UNESCO, 2021). Alongside institutional preparedness, AI literacy is becoming increasingly important for enabling students and educators to use AI tools effectively, critically assess their outputs, and recognize the ethical implications of their application in academic environments (Long & MAGERKO, 2020 [10]; Ng *et al.*, 2021).

Review of Literature

Evolution and Development of AI in Higher Education

The development of Artificial Intelligence (AI) in higher education reflects a gradual shift from basic computer-assisted learning tools toward advanced intelligent, adaptive, and generative technologies. The early development of intelligent tutoring systems focused on replicating selected functions of human tutors to offer individualized academic guidance and learning support

(CARBONELL, 1970; SLEEMAN & Brown, 1982) ^[3, 14]. Subsequently, adaptive learning technologies enhanced the capacity of educational systems to accommodate variations in students' prior knowledge, learning abilities, and individual preferences (BRUSILOVSKY, 1996) ^[2]. The growth of machine learning, natural language processing, deep learning, and learning analytics has significantly broadened the application of AI in areas such as personalized instruction, automated evaluation, predictive analysis, intelligent tutoring, and student services (Chen *et al.*, 2020; ZAWACKI-Richter *et al.*, 2019) ^[4, 19]. In recent years, generative AI and large language models have further expanded the educational applications of AI by enabling automated content creation, interactive learning experiences, personalized feedback, and academic assistance (KASNECI *et al.*, 2023) ^[9].

Personalized Learning and Student Engagement

Personalized learning supported by AI has gained considerable attention in higher education due to its potential to customize educational materials, learning processes, and feedback based on the specific needs of individual learners (BRUSILOVSKY, 1996; Holmes *et al.*, 2019) ^[2, 8]. Technologies such as AI-based chatbots, intelligent tutoring systems, virtual learning assistants, and adaptive platforms can offer students continuous academic guidance and provide rapid responses to questions related to their learning activities (Holmes *et al.*, 2019; ZAWACKI-Richter *et al.*, 2019) ^[8, 19]. These technologies have the potential to strengthen student engagement by promoting interactive learning experiences and providing academic assistance beyond conventional classroom environments. However, effective engagement depends on students' active intellectual involvement, and excessive reliance on AI-based tools may negatively affect independent reasoning, critical thinking, and meaningful human interaction.

AI Adoption and Student Learning Performance

The existing body of research indicates that the implementation of AI in education may contribute to improved student learning outcomes by facilitating personalized instruction, adaptive learning experiences, timely feedback, and ongoing academic assistance (Chen *et al.*, 2020; Holmes *et al.*, 2019) ^[4, 8]. Intelligent tutoring systems can detect individual learning difficulties and deliver appropriate support, whereas adaptive learning technologies can adjust instructional resources based on students' learning progress and performance (CARBONELL, 1970; BRUSILOVSKY, 1996) ^[2, 3]. However, the relationship between AI adoption and student learning performance may not be straightforward or automatic. Its effectiveness can be influenced by several factors, including students' level of engagement, AI literacy, faculty capabilities, technological facilities, and the extent to which AI is appropriately integrated into teaching practices. Consequently, personalized learning and student engagement can be considered potential mechanisms through which the adoption of AI may positively affect student learning performance.

Challenges, Ethics, and AI Literacy

Although AI offers considerable benefits for higher education, its implementation is accompanied by several concerns involving technological infrastructure, institutional

readiness, faculty preparedness, data security, algorithmic discrimination, and academic integrity (Floridi *et al.*, 2018; ZAWACKI-Richter *et al.*, 2019) ^[6, 19]. The rapid growth of generative AI has further increased concerns related to inaccurate information, plagiarism, inappropriate academic assistance, and excessive dependence on AI-generated outputs (Cotton *et al.*, 2023; KASNECI *et al.*, 2023) ^[5]. In this context, AI literacy has become an essential competency for both students and educators, enabling them to understand AI systems, assess the reliability of AI-generated information, and use such technologies responsibly and critically (Long & MAGERKO, 2020 ^[10]; Ng *et al.*, 2021).

Opportunities of AI Adoption

The application of Artificial Intelligence (AI) in higher education offers diverse possibilities for strengthening instructional practices, student learning, institutional administration, and academic support services. AI-based technologies allow educational institutions to move away from standardized teaching approaches by promoting more individualized and student-focused learning experiences. Intelligent tutoring systems and adaptive learning applications can examine learners' progress, BEHAVIOURS, and academic needs to deliver suitable learning resources, feedback, and instructional assistance (Holmes *et al.*, 2019; Chen *et al.*, 2020) ^[4, 8]. These capabilities enable educators to recognize variations in students' learning requirements and provide appropriate academic support at the right time (ZAWACKI-Richter *et al.*, 2019) ^[19]. AI-based technologies also offer considerable potential for improving student involvement by creating more responsive, interactive, and easily accessible learning environments. Tools such as intelligent chatbots, virtual assistants, and generative AI applications can respond quickly to students' questions and extend learning support beyond conventional classroom schedules (ZAWACKI-Richter *et al.*, 2019; KASNECI *et al.*, 2023) ^[9, 19]. In addition, AI can facilitate active learning through virtual simulations, personalized feedback, collaborative activities, and tailored academic guidance (Holmes *et al.*, 2019) ^[8]. By providing flexible and continuous learning assistance, these applications may contribute to greater student motivation, participation, and involvement in the educational process (Chen *et al.*, 2020; KASNECI *et al.*, 2023) ^[4, 9].

Research Gap

The existing literature indicates that AI has considerable potential to support personalized learning, enhance student engagement, facilitate adaptive instruction, strengthen intelligent tutoring, and provide continuous academic assistance, while also presenting technological, organizational, ethical, and academic concerns (Holmes *et al.*, 2019; ZAWACKI-Richter *et al.*, 2019) ^[8, 19]. Nevertheless, there remains a need for a more integrated examination of the relationship between AI adoption and student learning performance, particularly by considering personalized learning and student engagement as potential mediating mechanisms and AI literacy as a significant student competency. In addition, relatively limited research has comprehensively examined how institutional support, faculty preparedness, and digital infrastructure influence the effectiveness of AI implementation in higher education. Therefore, further empirical investigation is necessary to

develop a clearer understanding of the mechanisms through which AI adoption contributes to student learning performance and the contextual factors that determine its successful implementation in higher education.

Methodology

This study employed a systematic review of existing literature to explore the adoption and application of Artificial Intelligence (AI) within the higher education sector. Relevant academic research was examined with particular attention to AI adoption, personalized learning, student engagement, AI literacy, and students' academic learning outcomes. The literature search was conducted using major keywords, including Artificial Intelligence in higher education, AI adoption, personalized learning, student engagement, AI literacy, and student learning performance. The review covered studies addressing various AI applications, such as intelligent tutoring systems, adaptive learning technologies, learning analytics, AI-based chatbots, virtual assistants, and generative AI (CARBONELL, 1970; BRUSILOVSKY, 1996; ZAWACKI-Richter *et al.*, 2019) ^[2, 3, 19]. A thematic review technique was applied to categorize and synthesize the major opportunities, outcomes, and challenges emerging from AI implementation in educational settings. Particular attention was given to understanding the possible influence of AI adoption on student learning performance through personalized learning and enhanced student engagement. In

addition, factors such as AI literacy, faculty preparedness, institutional support, technological infrastructure, and ethical governance were considered as essential conditions influencing successful AI implementation (Holmes *et al.*, 2019; Long & MAGERKO, 2020 ^[8, 10]; Ng *et al.*, 2021). The findings were subsequently synthesized to identify existing research gaps and establish a conceptual foundation for future empirical studies examining AI adoption and learning outcomes in higher education.

Thematic Analysis

The thematic synthesis of the reviewed literature identified five major themes related to AI adoption in higher education: (1) Personalized and Adaptive Learning, (2) Student Engagement and Learning Support, (3) Academic Opportunities and Learning Enhancement, (4) Challenges and Risks of AI Adoption, and (5) AI Literacy, Ethical Use, and Institutional Support. The findings indicate that AI is reshaping higher education through individualized instruction, intelligent tutoring, automated feedback, academic assistance, and flexible access to learning resources (ZAWACKI-Richter *et al.*, 2019; Holmes *et al.*, 2019; Chen *et al.*, 2020; KASNECI *et al.*, 2023) ^[4, 8, 9, 19]. At the same time, concerns related to academic integrity, privacy, algorithmic bias, misinformation, unequal access, and inappropriate dependence on AI remain significant (FLORIDI *et al.*, 2018; Cotton *et al.*, 2023; TLILI *et al.*, 2023; UNESCO, 2023) ^[5, 6].

Table 1: Major Themes Identified from the Literature

Theme	Key Areas	Major Supporting Literature	Influence on Student Learning Performance
1. Personalized and Adaptive Learning	Individual learning pathways, adaptive content, intelligent tutoring, customized feedback	CARBONELL (1970); BRUSILOVSKY (1996); Holmes <i>et al.</i> (2019); Chen <i>et al.</i> (2020) ^[2, 3, 4, 8]	Supports individualized learning, knowledge development, and academic achievement
2. Student Engagement and Learning Support	Interactive learning, immediate feedback, academic assistance, conversational AI	ZAWACKI-Richter <i>et al.</i> (2019); Okonkwo and Ade-IBIJOLA (2021); KASNECI <i>et al.</i> (2023) ^[9, 13, 19]	Encourages participation, motivation, interaction, and active learning
3. Academic Opportunities and Learning Enhancement	Flexible learning, accessibility, knowledge development, research assistance, generative AI	Holmes <i>et al.</i> (2019); TLILI <i>et al.</i> (2023); KASNECI <i>et al.</i> (2023) ^[8, 9, 15]	Promotes independent learning, academic efficiency, and learning opportunities
4. Challenges and Risks of AI Adoption	Academic integrity, misinformation, privacy, bias, overdependence, digital inequality	FLORIDI <i>et al.</i> (2018); ZAWACKI-Richter <i>et al.</i> (2019); Cotton <i>et al.</i> (2023); UNESCO (2023) ^[5, 6, 19]	May affect critical thinking, authentic learning, academic integrity, and educational quality
5. AI Literacy, Ethical Use, and Institutional Support	AI competencies, faculty development, infrastructure, governance, responsible AI	Long and MAGERKO (2020) ^[10] ; Ng <i>et al.</i> (2021); UNESCO (2023); Miao and Holmes (2023) ^[11]	Enables responsible AI use and supports effective integration into education

Personalized and Adaptive Learning

The first major theme is the use of AI to support personalized and adaptive learning. Early intelligent tutoring systems were developed to provide individualized instruction and feedback based on learner requirements (CARBONELL, 1970; SLEEMAN & Brown, 1982) ^[3, 14]. The subsequent development of adaptive hypermedia enabled educational systems to modify learning content according to individual learner characteristics (BRUSILOVSKY, 1996) ^[2]. In contemporary higher education, AI systems can analyze students' learning progress, performance patterns, interactions, and knowledge gaps to recommend suitable learning materials and activities (Holmes *et al.*, 2019; Chen *et al.*, 2020) ^[4, 8]. This approach enables students to receive learning support that is better aligned with their individual pace and academic needs. Research indicates that AI-supported personalization can

improve learning experiences through targeted feedback, customized resources, and timely academic interventions (ZAWACKI-Richter *et al.*, 2019; Chen *et al.*, 2020) ^[4, 19]. It may also assist educators in identifying students who require additional support (Holmes *et al.*, 2019) ^[8]. However, the effectiveness of adaptive learning depends on the quality of student data, algorithmic accuracy, and appropriate pedagogical design (Williamson & EYNON, 2020) ^[18]. Therefore, AI-based personalization should complement teacher expertise and human interaction rather than replace them.

Student Engagement and Learning Support

The second theme concerns the role of AI in strengthening student engagement and providing continuous academic assistance. Student engagement, reflected through participation, motivation, interaction, and involvement in

learning activities, is closely associated with successful educational experiences (Fredricks *et al.*, 2004) ^[7]. AI technologies such as intelligent tutoring systems, chatbots, virtual assistants, and generative AI can provide students with immediate responses and learning assistance beyond regular classroom hours (ZAWACKI-Richter *et al.*, 2019; Okonkwo & Ade-IBIJOLA, 2021) ^[13, 19]. These technologies can support explanations, academic queries, interactive discussions, and personalized assistance (KASNECI *et al.*, 2023) ^[9]. The literature suggests that immediate feedback and continuous access to academic support can encourage active participation and self-directed learning (Holmes *et al.*, 2019; KASNECI *et al.*, 2023) ^[8, 9]. However, excessive reliance on automated systems may reduce meaningful teacher–student interaction and weaken the social dimension of learning (ZAWACKI-Richter *et al.*, 2019) ^[19]. Effective implementation therefore requires AI to enhance, rather than substitute, human interaction.

Academic Opportunities and Learning Enhancement

The third theme highlights the academic opportunities created by AI adoption. AI technologies provide students with access to personalized explanations, automated feedback, information resources, and flexible learning support (Holmes *et al.*, 2019; Chen *et al.*, 2020) ^[4, 8]. Generative AI has expanded these opportunities by assisting with brainstorming, summarization, writing, translation, programming, problem-solving, and knowledge exploration (KASNECI *et al.*, 2023; TLILI *et al.*, 2023) ^[9, 15]. These applications can help students approach complex academic tasks more efficiently and support independent learning. AI may also contribute to more inclusive learning by providing alternative forms of academic assistance for students with diverse educational and linguistic needs (Holmes *et al.*, 2019; KASNECI *et al.*, 2023) ^[9, 19]. The literature indicates that such opportunities may contribute to knowledge development, academic productivity, and learning efficiency (ZAWACKI-Richter *et al.*, 2019; Chen *et al.*, 2020) ^[4, 19]. However, the educational value of AI depends on how students use it. When AI supports inquiry, reflection, and understanding, it may contribute to learning; when it replaces students' own cognitive effort, it may limit the development of academic knowledge and skills (Cotton *et al.*, 2023; UNESCO, 2023) ^[5].

Challenges and Risks of AI Adoption

The fourth theme focuses on the major challenges associated with AI adoption in higher education. The literature identifies concerns involving technological infrastructure, faculty preparedness, AI competencies, privacy, algorithmic bias, academic misconduct, and unequal access to digital technologies (ZAWACKI-Richter *et al.*, 2019; Williamson & EYNON, 2020 ^[18, 19]; UNESCO, 2023).

Academic integrity has become a major concern following the expansion of generative AI. AI-generated content can create difficulties related to plagiarism, authorship, assessment validity, and unauthorized academic assistance (Cotton *et al.*, 2023) ^[5]. As a result, universities may need to adopt assessment approaches that emphasize critical thinking, creativity, application, and authentic demonstration of learning (KASNECI *et al.*, 2023) ^[9]. The reliability of AI-generated information is another important issue. Generative AI systems may produce convincing but

factually incorrect responses. If students do not verify AI-generated information, inaccurate knowledge may affect their academic development and learning performance (KASNECI *et al.*, 2023; UNESCO, 2023) ^[9]. Privacy and data security are also relevant concerns because AI-based educational systems may process large volumes of student data. Issues involving data ownership, surveillance, information security, and algorithmic decision-making require appropriate institutional attention (FLORIDI *et al.*, 2018; Williamson & EYNON, 2020) ^[6, 18]. Thus, AI adoption presents both opportunities and risks. Its contribution to learning performance depends substantially on responsible use, appropriate assessment practices, information verification, and effective institutional safeguards.

AI Literacy, Ethical Use, and Institutional Support

The fifth theme emphasizes the importance of AI literacy and institutional preparedness in achieving effective AI adoption. Students and educators require the ability to understand AI technologies, recognize their limitations, evaluate their outputs, and use them responsibly (Long & MAGERKO, 2020 ^[10]; Ng *et al.*, 2021). AI literacy extends beyond technical operation and includes the capacity to critically assess AI-generated information and make responsible decisions regarding its use (Long & MAGERKO, 2020) ^[10]. For students, this competency can influence whether AI is used to support genuine learning or merely to complete academic tasks. Faculty readiness is equally important. Educators require professional development to integrate AI into curriculum design, teaching practices, and assessment in pedagogically meaningful ways (ZAWACKI-Richter *et al.*, 2019 ^[19]; Ng *et al.*, 2021). At the institutional level, effective AI adoption requires appropriate infrastructure, faculty development, ethical guidelines, data governance, and academic integrity policies (UNESCO, 2023; Miao & Holmes, 2023) ^[11]. These mechanisms can establish a responsible environment for AI use while maintaining academic standards and protecting student interests.

Policy Implications

Higher education institutions should formulate clear policies that guide students toward the responsible and ethical use of Artificial Intelligence (AI) in academic activities. Students should receive systematic AI literacy training to understand the capabilities, limitations, and potential risks associated with AI technologies. AI should be promoted as a supportive learning resource that strengthens students' understanding rather than replacing their independent thinking and intellectual effort. Students should be encouraged to verify AI-generated information using reliable academic sources before incorporating it into assignments or research. Institutional policies should clearly define acceptable AI use in academic work while addressing plagiarism, unauthorized assistance, and academic integrity. Assessment practices should increasingly focus on critical thinking, creativity, problem-solving, and practical application of knowledge. Universities should ensure equitable access to AI-enabled learning facilities so that technological differences do not create educational disadvantages. Appropriate measures should be implemented to safeguard student data, maintain privacy, and ensure transparency in AI-supported educational

systems. Faculty members should provide appropriate guidance to help students integrate AI tools into their learning activities in meaningful and academically appropriate ways. Overall, student-centered AI policies should promote technological innovation while protecting academic integrity, learner autonomy, privacy, and the quality of higher education.

Conclusion

Artificial Intelligence is significantly influencing higher education by introducing new approaches to personalized learning, student engagement, academic support, and knowledge development. The thematic review identified five important dimensions of AI adoption, namely personalized and adaptive learning, student engagement, academic opportunities, adoption challenges, and AI literacy with institutional support. The findings suggest that AI can provide students with customized learning resources, timely feedback, and continuous academic assistance that may contribute to improved learning experiences. AI-based tools can also encourage independent learning by enabling students to explore knowledge and obtain academic support beyond traditional classroom environments. However, the adoption of AI also creates concerns related to academic integrity, inaccurate information, privacy, algorithmic bias, digital inequality, and excessive dependence on technology. The positive contribution of AI to student learning performance therefore depends on responsible use, appropriate pedagogical integration, and effective academic guidance. AI literacy is essential for enabling students to critically evaluate AI-generated outputs and make informed decisions regarding their academic use. Faculty preparedness, institutional infrastructure, ethical governance, and appropriate policies are equally important for ensuring sustainable AI adoption. The review concludes that AI should complement teachers and human interaction rather than replace the essential cognitive and social dimensions of education. Future research should empirically examine how AI adoption, student engagement, personalized learning, and AI literacy interact to influence student learning performance in higher education.

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