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The Use of Artificial Intelligence in Higher Education Learning: A Systematic Review of Its Effectiveness and Challenges in Implementation

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A B S T R A C T

This study aims to map trends in the use of artificial intelligence (AI) in higher education learning, examine its effectiveness, and identify key implementation challenges. A qualitative approach was employed using the Systematic Literature Review (SLR) method. Literature was collected from academic databases and platforms, including Google Scholar, Sinta, and DOAJ, covering publications from 2020 to 2025. Relevant national and international journal articles were selected using keywords related to AI, higher education, learning, effectiveness, and challenges. The selected studies were systematically analyzed through an SLR table and synthesized as primary data for the results and discussion. The findings reveal a significant increase in AI adoption, particularly generative AI, in higher education learning. AI is commonly used as a learning assistant, discussion facilitator, and support tool for assessment and academic administration. Its effectiveness is reflected in enhanced student engagement, learning autonomy, and institutional efficiency. Nevertheless, challenges persist, including ethical issues, limited AI literacy, infrastructure constraints, and the lack of adaptive regulatory frameworks. These results indicate that AI integration can improve educational quality when supported by clear policies and ethical governance.

1. Introduction

The transformation of education in Era 4.0, which aligns with the concept of Society 5.0, marks a fundamental paradigm shift in the academic world. This era is not simply about technology adoption, but rather about the intensive integration of digital developments centered on human needs and well-being (Rahmadani et al., 2024; Amara et al., 2025). The idea of a "super-smart, human-centered society," first popularized by the Japanese government in 2016, serves as the philosophical

foundation for this change. Society 5.0 envisions a society where the cyber and physical worlds are seamlessly integrated, creating an ecosystem capable of solving complex social problems through artificial intelligence and data. Within this framework, the education system is required to play a key role in producing a generation of citizens who are not only technologically literate but also capable of utilizing technology such as the Internet of Things (IoT), big data, and artificial intelligence (AI) as tools to create innovative solutions and safeguard collective well-being.

This concept reinforces the urgency for educational institutions to no longer be passive recipients of technology, but rather to become active architects reimagining the purpose of education, shifting it from merely transmitting knowledge to developing socio-technical problem-solving capacity. Practically, this means curricula must be designed to holistically develop 21st-century skills: creativity to generate new ideas, critical thinking to evaluate information amidst a data storm, effective communication to collaborate in global networks, and collaborative skills to work in multidisciplinary teams. Building strong character traits, such as integrity and resilience, also lays the foundation for graduates to be not only technically savvy but also able to compete and thrive ethically in the challenging digital era (Pare & Sihotang, 2023; Al Farizy et al., 2025; Yusriani & Fithriani, 2025).

The emergence of artificial intelligence (AI) in the higher education landscape has sparked a revolution in the way learning is designed and delivered. Tools like ChatGPT, personalized AI tutors, Grock, and various adaptive learning systems have transformed classroom dynamics from one-way models to dynamic and responsive interactions. AI enables a highly personalized learning approach, where each student can pursue a learning path tailored to their specific learning style, pace, and needs. Adaptive learning systems, for example, analyze students' responses to material in real time; if students struggle, the system automatically provides additional resources such as explanatory videos, more fundamental practice problems, or remedial modules.

Conversely, if students demonstrate rapid mastery, the system offers more complex challenges to prevent boredom and stimulate maximum potential. AI also acts as an assistant, providing instant feedback, not only on multiple-choice questions but also on complex tasks like essay writing, where it can analyze argument structure, grammar, and coherence of ideas. More than just a tool, AI powers an ecosystem of self-paced and interactive learning, empowering students to take control of their learning while still receiving structured guidance. By automating basic administrative and assessment tasks, AI also frees up faculty time to focus on more valuable roles, such as mentoring, in-depth Socratic discussions, and research guidance (Safitri & Susilo, 2025; Islami et al., 2025).

At the operational level, universities naturally serve as prime laboratories for educational technology implementation. They have ample research and development (R&D) resources, academic staff relatively open to technological innovation, and a drive to continuously adapt curricula to meet rapidly changing industry needs. The COVID-19 pandemic (2020–2021) served as an unexpected

catalyst, forcing universities worldwide to undertake a massive "digital pivot." In a short time, they implemented learning management systems (LMS) such as Canvas, Moodle, or Blackboard; shifted to online classes via Zoom and Microsoft Teams; and adopted various collaboration tools and online assessment solutions. This period demonstrated the remarkable capacity of higher education institutions to adapt quickly when faced with external pressures. This adaptation was not merely a temporary solution; it left a legacy of renewed educational effectiveness, the introduction of innovative teaching methods such as hybrid and flipped classrooms, and ultimately improved the quality of graduates who are better prepared for the demands of the modern, digital and connected workforce.

However, amid this wave of implementation, significant knowledge gaps remain. Much research has been conducted on the use of AI in higher education, but these studies are often fragmented. They may focus on only one type of AI tool (e.g., the use of ChatGPT for writing assignments), a specific discipline (e.g., AI in medical education), or a specific institutional context. As a result, the overall picture of effectiveness, challenges, and necessary policy reforms remains unconsolidated. Therefore, a comprehensive and systematic review such as a systematic literature review to map the entire research landscape is essential. Such a review is crucial to provide a comprehensive, evidence-based picture for policy makers to create regulations that support innovation, for education practitioners (lecturers and university management) to adopt best practices, and for researchers to identify future research gaps. The goal is to responsibly optimize the potential of AI to support the holistic improvement of higher education quality.

To address this need, this study was designed with a clear focus. Three main research questions emerged as the basis for the investigation: (1) What forms of AI utilization in higher education learning have been reported in previous research? (2) How effective is the use of AI in learning in higher education according to empirical findings from previous research? and (3) What are the challenges, obstacles, and ethical considerations that arise in the implementation of AI in higher education environments? Based on these questions, the research objectives are formulated systematically: to identify, analyze, and synthesize scientific evidence regarding various forms of AI application, evaluate their impact on student learning outcomes, and map technical, pedagogical, and ethical obstacles that need to be overcome. Through this research, it is hoped that a framework will emerge that can provide clear direction for AI integration that is not only innovative, but also effective, inclusive, and humanity-centered.

2. Methodology

This qualitative research uses the Systematic Literature Review (SLR) method, which is useful for mapping the effectiveness and challenges of AI use in higher education. Data sources were obtained through previous studies with topics similar to the research title. These previous studies were in the form of articles/journals published between 2020 and 2025 with national or international research status. After that, the data sources that have been found were entered into an SLR matrix

table containing the author, year, title, objectives, methods, theories, and main results of the research. Articles were selected through the following stages: identification → title/abstract screening → full-text review → final article analysis. Data analysis was carried out using thematic coding to find patterns in three themes: AI use, effectiveness, and implementation challenges. After the data was processed and sorted, the results were then compiled into narrative and mapping forms to draw conclusions about the implications of AI development for learning in higher education (Zawacki-Richter et al., 2020; Mardhiah et al., 2025).

3. Results and Discussion

Forms of AI Utilization in Higher Education

Previous literature findings indicate that the use of AI in higher education is developing rapidly and is highly varied, particularly in 2023, when generative AI and ChatGPT rapidly developed and dominated the learning environment in education. Priandani et al. (2025), using their bibliometric analysis, demonstrated the surge in AI publications in higher education with the theme of ChatGPT/generative AI as a strong focus, indicating that AI is now an important part of the modern campus ecosystem. Aguado-García et al. (2025) and Ocen et al. (2025) also show that AI is not only used to assist learning but is also used for institutional innovation, including personalized learning.

At the practical level, AI is also used for learning assistants such as chatbots and LLMs for discussions, creating IDs, and assisting with assignments, as described by Agung & Lisana (2025). Research conducted by Widodo et al. (2024) also demonstrated that AI is beneficial for encouraging the development of active learning, such as providing feedback and learning recommendations for students. AI is also expanding into academic management and even evaluation, for example, in assessment automation to manage academic data, which is useful for simplifying the administrative burden on lecturers (Liang et al., 2025). Overall, findings on the use of AI in higher education fall into three broad patterns: (1) AI is used as a learning assistant, such as ChatGPT/LLM; (2) AI is used for interactive and adaptive learning systems; and (3) AI is used to support evaluation and academic administration to reduce the administrative burden on lecturers.

Effectiveness of AI Use in Higher Education Learning

Based on a synthesis of previous studies, the effectiveness of AI used in higher education learning tends to be positive. However, this still depends on the context of implementation and readiness for use. According to Widodo et al. (2024), AI integration can increase student engagement and strengthen teaching effectiveness, especially when AI is used to support active learning. A study by Portilla et al. (2025) also confirmed that AI contributes to improving the quality of teaching and learning processes in higher education institutions.

In terms of learning outcomes, Vieriu & Petrea (2025) demonstrated that AI has a positive impact on students' academic development, through the provision of adaptive materials and broader access to resources. Oktaviati (2025) also explained that AI increases learning effectiveness through conceptual understanding, practice, and support for independent learning. Research by Ouyang et al. (2023) also demonstrated that AI-driven learning analytics can support collaborative problem-solving and provide insights difficult to obtain using conventional evaluation alone, thus enabling more focused student learning. AI also has institutional effectiveness. According to Ashaari et al. (2021), AI-based big data analytics capabilities can improve performance in higher education institutions and support academic decision-making that is tailored to the needs of students and others.

Meanwhile, in the generative AI context, Bahroun et al. (2023) suggest that generative AI can transform the way students learn and help provide teaching methods for lecturers, including designing assignments, such as project-based assignments and being able to explore ideas creatively. Bates et al. (2020) also added that AI has great potential in campus learning, provided it can be adopted appropriately and with the right companion system, namely a pedagogical companion system. Therefore, the effectiveness of using AI for learning in higher education can be concluded to increase or enhance motivational engagement, support independent and personalized learning, efficiency in teaching for lecturers and even efficiency in the assessment process, and improve performance within the institution.

Challenges and Barriers to AI Implementation in Higher Education

Although the use of AI appears effective and widespread, several previous studies have also shown that its implementation faces several challenges and obstacles in higher education that require systematic addressing. Research by Ocen et al. (2025) identified major obstacles, including regulatory issues, constitutional readiness, and even ethics, which are crucial issues when AI begins to be widely used by students. Al-Zahrani & Alasmari (2024) also conducted in-depth research on this issue, emphasizing the social and ethical implications of AI use, such as bias in algorithms, inequity in technology access, and the risk of AI misuse in academic activities. Ethical issues most frequently arise in evaluation and academic integrity. Christyodetaputri & Marwa (2024) also believe that AI can improve unfairness in assessments, but only if accompanied by individual/human oversight, and there must be system transparency and clear ethical standards. This is in line with the opinion expressed by Liang et al. (2025) warn that automation in AI assessment and instruction has the potential to displace the role of lecturers if not balanced with an appropriate pedagogical framework.

Technical challenges are also evident in data requirements and infrastructure. Aldoseri et al. (2023) also show that AI integration in higher education requires a robust data strategy, as AI quality still depends on the availability of academic big data management. Research conducted by Petrychenko et al. (2023) also adds that changes in higher education technology can have adaptive consequences for institutions, including costs, human resource training, and shifts in learning culture.

Priandani et al. (2025) and Bahroun et al. (2023) also add and signal that the surge in generative AI must be closely followed by readiness in university regulations so that the use of AI technology can be directed and not simply a trend. In conclusion, the challenges and obstacles experienced by universities with the use of AI are: (1) ethics and integration into academics; (2) university regulations and policies; (3) AI literacy for lecturers and students; (4) and adequate data and infrastructure readiness.

Discussion

This research confirms that the use of AI technology in higher education has moved rapidly. It is no longer merely a supporting tool but has become a strategic part of learning design and academic governance. The variety of uses, from generative learning assistants and adaptive systems to personalized systems, to assisting with evaluation and administration, demonstrates that AI has become a supporter at the pedagogical and institutional levels. These findings indicate a shift in the learning paradigm toward a more flexible, data-driven, and responsive model tailored to the individual needs of lecturers and students. In this context, AI technology is not merely a substitute for individual roles, but also serves as a technology to strengthen academic decisions and facilitate enriching learning and work experiences, as long as the technology's use remains within a clear framework.

Regarding the effectiveness of this technology, patterns were also found that AI tends to make a positive contribution to the quality of learning, teaching, and administration. This effectiveness arises when AI technology aligns with the principles of active learning, problem-solving, collaboration systems, and support for independent learning. It can be argued that AI can work optimally if it becomes a structured and planned part of pedagogy, not merely an add-on or a trend used without strategy. This reinforces the notion that the success of AI technology use in higher education is determined by the design of learning, the readiness of lecturers, and the literacy level of students, rather than the sophistication of the technology itself. Universities need to ensure that AI integration is aligned to expand learning and teaching opportunities, strengthen competency outcomes, and measurably improve the efficiency of higher education's academic processes.

There is also complexity in the challenges and obstacles to implementing AI technology in higher education. Barriers in the form of ethics and integrity occupy a central position, as AI has the potential to blur the boundaries between legitimate learning assistance and actions that undermine the authenticity of academic work. Challenges in higher education regulations and policies indicate that universities have not yet fully developed adaptive governance for the rapid development of AI in today's era. Limited literacy among lecturers and students, as well as infrastructure needs, are also factors that can hinder the use of AI if not managed systematically. Therefore, the development of AI technology demands that universities combine technological innovation with strengthening the quality and capacity of individuals, as well as accountable policies.

Based on this discussion, this study concludes that AI technology can both present significant opportunities and pose a serious management burden for universities. Policy direction and development need to be directed, aligned, and focused on three main areas: (1) strengthening literacy for lecturers and students, encompassing the technical, pedagogical, and ethical aspects of AI use; (2) universities must develop policies that balance technological innovation and academic integrity; and (3) universities must also develop contextual AI-based learning and teaching models that are appropriate to the characteristics of lecturers, students, and academic disciplines.

4. Conclusion

This research concludes that the use of Artificial Intelligence (AI) technology for learning in higher education during the 2020-2025 period demonstrates diverse improvements. The role of AI includes its use as a learning and teaching assistant, providing an adaptive, systematic, and personalized learning system, and supporting evaluation and administration. A synthesis of previous literature also shows that AI integration is generally effective in increasing independence, lecturer/student engagement, and student learning outcomes. It can also help reduce the academic burden on lecturers and improve the work efficiency of lecturers and university staff.

This effectiveness can vary depending on the learning context, readiness for use, human resources, and pedagogical design. Significant challenges and obstacles to implementing AI in higher education include ethical and integrity issues, limited literacy among students, lecturers, and other campus staff, infrastructure readiness, and the lack of clear institutional regulations. Therefore, AI can potentially become a strategic instrument in binding the quality of education in higher education if it is integrated appropriately and directed, can be accounted for, and is accompanied by individual or human capacity, and the existence of adaptive higher education policies.

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