Review Article

Application of Artificial Intelligence in Higher Education: A Systematic Review

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Abstract

Artificial Intelligence (AI) is a state-of-the-art technology that enhances communication and operational processes across various domains, including education. Current AI applications provide numerous advantages, such as creating personalized learning environments, promoting inclusivity and flexibility, generating smart educational content, and improving the efficiency of administrative processes. This study employed a qualitative research approach combined with a systematic literature review to examine the impact of AI in higher education. To ensure rigor and reduce bias, the PRISMA protocol guided the literature review, with relevant studies identified through searches in Scopus, Web of Science, and IEEE Xplore databases. The findings indicate that AI positively influences higher education by enhancing teaching methodologies and administrative processes. Educators are able to manage tasks more efficiently, which strengthens the reliability of teaching, while students benefit from improved learning outcomes. Additionally, AI applications help mitigate potential challenges in the learning process, contributing to an overall enhancement in the quality of education. The study highlights the dual role of AI in both improving learning outcomes and addressing its own limitations, marking a significant contribution to the field.

Keywords: Artificial Intelligence, Higher Education, Learning Effectiveness, PRISMA

1. Introduction

Technologies have the potential to transform the life style in all aspects. The integration of technology like artificial intelligence in higher education indeed has the potential to revolutionize various aspects of academic and administrative processes. Artificial Intelligence (AI) holds significant potential to tackle key challenges in education, transform teaching and learning practices, and ultimately accelerate progress toward achieving Sustainable Development Goal 4

(SDG 4) (UNESCO, 2021). AI is increasingly being integrated into current higher education systems to enhance the learning experience for both instructors and students and improve the effectiveness of teaching methods (Crompton & Burke, 2023). Some common applications of AI in education include: personalized learning, adaptive learning, visual assistants, grading and assessment, data analysis and many more (Tan et al., 2022; Chen et al., 2020). Researcher (Gašević et al., 2023) explores into the impact of AI in education on both learners and instructors. It discusses how AI technologies, such as ChatGPT, have sparked public interest and influenced teaching and learning practices.

The review highlights the importance of empowering learners for the age of AI through innovative educational approaches. For instructors, the review emphasizes the need for understanding and trust in AI systems, as well as the development of new theories of learning to enhance teaching effectiveness. It also covers challenges and opportunities related to using AI for assessment, designing AI-driven systems, and using AI applications in the classroom for improving educational outcomes for both students and teachers. The integration of AI has helped in improving the quality of education, making it more efficient, and creating personalized learning experiences for higher educational students (Zawacki-Richter et al., 2019). Therefore, with the help of AI technology, educational institutions can become more efficient.

1.1. Artificial Intelligence in Higher Education

The implications of artificial intelligence (AI), a technology designed to create intelligent machines capable of tasks typically requiring human intelligence, such as learning, reasoning, problem-solving, and decision-making, are profound for higher education institutions. AI encompasses diverse areas, including machine learning, algorithms, and natural language processing. Its integration into education has already led to significant advancements in educational tools and practices.

These applications include personalized learning platforms for improving the learning experience of students, automated assessment for assisting teachers and providing insights through facial recognition about the behaviors of learners. The interest in utilizing AI in higher education has encouraged researchers to find ways of utilizing AI in educational settings. Various researchers have carried out studies in different subjects, including (Zawacki-Richter et al., 2019; Tan et al., 2022; Han et al., 2023; Agrawal et al., 2021; Butler et al., 2018; Fu, 2019;

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Chen et al., 2020), which offer valuable insights into the significance of AI and its broader application in higher education.

The study by (Ouyang et al., 2022) concentrated on the integrations of AI technology in online higher education. In their findings, the authors extensively reviewed the relevant literatures that was published from 2011 to 2020 within 10 years range. Therefore, some of the significant functionalities of AI tools in online higher education were identified by the research findings.

Another research study conducted by (Zawacki-Richter et al., 2019) focused on the research literature on the application of artificial intelligence in the context of higher education, with special focus on the views and involvement of educators in the application of AI technologies. This research literature review focused on the research studies on the application of AI technologies by educators, the views of educators on AI technologies in the context of learning and teaching, the challenges educators face in the application of AI technologies, and the support required by educators in the application of AI technologies.

Similarly, research highlights that web-based and online education has evolved beyond merely providing materials for students to download, study, and complete assignments for passing purposes. Modern systems now incorporate intelligent and adaptive technologies that monitor both instructor and learner behaviors, adjusting content and support to enrich the educational experience (Chassignol et al., 2018; Dong, 2022; Peredo et al., 2011). The integration of AI technologies in education aims to enhance learning outcomes, streamline administrative processes, and offer personalized experiences for both students and faculty. Given the rapid pace of technological and educational advancements, implementing AI in education is crucial for improving the overall effectiveness of learning platforms and fostering more inclusive and impactful learning environments (Li & Wang, 2020).

Several research works have highlighted the different modern advancements in Personalized Learning (Slimi, 2023; Fahd et al., 2021). With the help of AI, teachers may tailor recommendations and feedback to each student's unique learning needs and learning styles by analyzing their learning patterns. This illustrates how AI can be used to attain educational objectives such as improving student engagement (Xu & Ouyang, 2021; Zawacki-Richter et al., 2019). AI tools can help improve student engagement through engaging materials, personalized learning tools, and online tutoring tools. In addition, AI has vast potential for improving

administrative processes (Zawacki-Richter et al., 2019). AI can reduce costs and enhance operational efficiency through streamlining administrative processes such as scheduling, support services, and admissions. Another area where AI plays an important role is in predicting the success of students. To enhance the retention rate of students, as well as their success, AI algorithms are used to predict the performance of students.

Furthermore, through the provision of Enhanced Research Capabilities, it is safe to say that AI plays an important role in enhancing the level of academic performance. With the help of AI, researchers are able to analyze large amounts of data, identify trends, and accelerate scientific discoveries in different fields of study (Chen et al., 2020; Crompton & Burke, 2023). With the application of AI in higher education institutions, it is clear that the future of education will be more efficient.

1.2. Questions/Objectives

In this study, it was imperative to consider the relationship and implementation of AI tools and academic performance because this is an essential part of the education sector, as it will enable the determination of the effectiveness of AI tools in enhancing the process of teaching and learning. It is in this respect that this study aims to advance the systematic review of the existing literature in the field of AI tools and applications such as:

- What and How AI-enabled applications are being used by Higher education?
- What are the challenges and limitations of integrating AI tools in higher education settings?

2. Methods

The systematic review of the application of AI in higher education was conducted following the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) for selecting items, as suggested by Page et al. (2021). A four-phase flow diagram was used for the purpose of ensuring the quality of reporting for this systematic review. PRISMA was chosen because it is widely endorsed and adopted as guidelines for systematic reviews of AI application in HE, as suggested by Page et al. (2021). This section provides an overview of literature search strategy, the selection criteria for inclusion and exclusion, and outlines the methodology for data coding specifically related to the application of AI in higher education.

2.1. Data sources and Search Strategy

For the purpose of conducting a systematic review of the existing literature on the application of artificial intelligence in education, the current study will follow the guidelines proposed in the PRISMA statement. The PRISMA principles, as proposed by Page et al. (2021), will be followed to answer the three major research questions, and a systematic approach will be followed to conduct a qualitative systematic literature review. Considering the nature of the current study and the objective of conducting an evaluation of the application of artificial intelligence in education, a qualitative research approach will be followed by using qualitative content and thematic analysis methodologies.

For conducting the literature search, reliable online academic databases like IEEE Xplore, PubMed, Scopus, and Web of Science are used because of their reliability and comprehensive collection of literature regarding education. A set of keywords like "artificial intelligence," "higher education," "AI in education," "AI-based education," "collaborative learning," "personalized learning," "machine learning," "AI-enhanced learning," "AI in ethical issues," "machine learning for student success," and "student learning" is used to fetch relevant literature that specifically deals with the application of AI in educational settings. This particular method is used to ensure a comprehensive study of existing literature regarding the application of AI in higher education settings, which offers valuable insights regarding various strategies and aspects of AI application in educational settings.
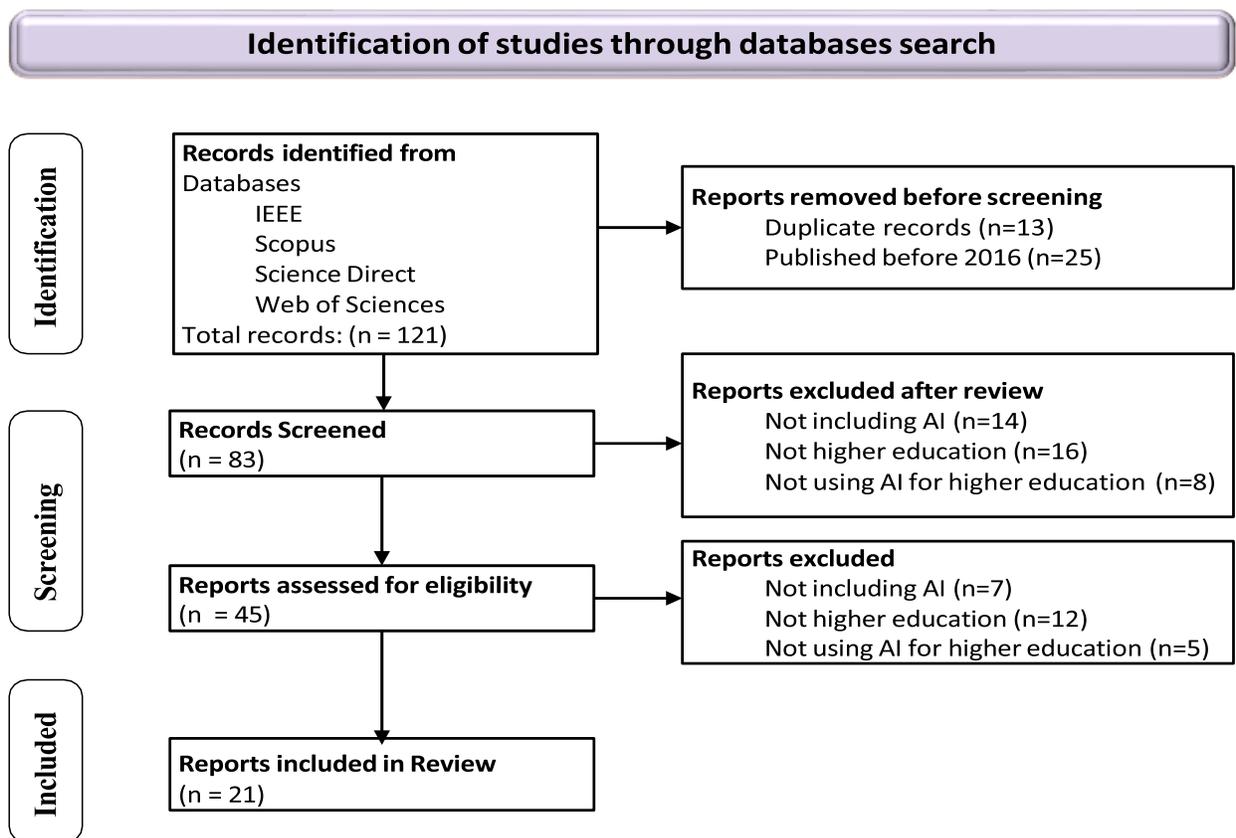
2.2. Selection Inclusion and Exclusion Criteria

The inclusion and exclusion criteria also played an important role in the selection process to find the most relevant and significant studies for the review. To make the inclusion criteria relevant and up-to-date, the publication date of the articles has been restricted to the past 7 years, i.e., from January 2016 to February 2024. This is to find the most recent developments in the field of artificial intelligence in education.

Table 1: Inclusion and exclusion criteria

	Inclusion Criteria	Exclusion Criteria
Publication year Source	Paper published after 2016 Peer-reviewed journal papers	Paper published before 2016 Non-peer-reviewed journal papers, editorials, books, Conference proceedings and review articles. Other languages
Language	English Language	
Context	Higher education	
Source type	Academic and Scopus or web of science indexed databases	Non-education Non-academic, non-Scopus or Web of Science indexed articles
Topic	Application of AI in higher education education	Application of AI in another sectors (e.g. health…)

In the subsequent phase, there was an emphasis laid on using reliable academic databases for literature search. In particular, there was an emphasis laid on using databases like IEEE Xplore, Scopus, and Web of Science.

Identification of studies through databases search

Identification

Records identified from Databases
IEEE
Scopus
Science Direct
Web of Sciences
Total records: (n = 121)

Reports removed before screening
Duplicate records (n=13)
Published before 2016 (n=25)

Screening

Records Screened (n = 83)

Reports excluded after review
Not including AI (n=14)
Not higher education (n=16)
Not using AI for higher education (n=8)

Reports assessed for eligibility (n = 45)

Reports excluded
Not including AI (n=7)
Not higher education (n=12)
Not using AI for higher education (n=5)

Included

Reports included in Review (n = 21)

Figure 1. PRISM flow chart of article identification and Screening

By utilizing these databases, which are well known for their quality assurance and comprehensive coverage of scholarly works, the study attempted to access a wide array of high-quality research

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articles related to the application of artificial intelligence in the field of education. Such a meticulous approach towards the selection of the database was undertaken in order to improve the quality and robustness of the literature review process in such a way that the research articles included would significantly contribute towards the overall analysis and findings of the study.

In the initial phase of the study, a comprehensive search was undertaken through which a total of 121 articles were obtained from the respective databases. However, 25 articles were eliminated from the list because they were published prior to 2016. Further, 13 duplicate articles were also eliminated from the list. As a result, the initial sample size was refined to 83 articles. The titles and abstracts of the articles were meticulously examined during the screening phase in such a way that the articles which are not relevant to the application of AI in the context of higher education are eliminated from the list.

Out of these, 45 articles were identified as meeting the initial criteria and were selected for the next stage of assessment. A more detailed assessment of these articles in relation to the criteria for inclusion was carried out, which identified that only 21 articles fully met the criteria for inclusion in this study. Therefore, it can be identified that the final criteria for selecting articles for this review were met by 21 articles that were selected for this study. To identify the criteria for selecting articles for this review, a PRISMA chart (Figure 1) has been developed to identify the criteria for selecting the articles for this review.

2.3. Applications

The primary objective of this study is to examine the application of Artificial Intelligence (AI) in higher education. Evaluating AI's role in education is crucial, particularly in relation to teaching, learning, and administrative processes. As noted by Igbokwe (2023), Willis (2024), and Sharma et al., AI presents a significant opportunity to drive transformative changes across these educational domains. By analyzing how AI is applied, this study seeks to shed light on its impacts and potential benefits. This section presents a synthesis of findings from reviewed articles, highlighting the effects of AI on instruction, learning, and administration, while also addressing ethical considerations associated with its use in education.

2.3.1. *Key Applications of AI*

AI has a vital role to play in revolutionizing teaching learning and administrative processes in higher educational institutions. These technologies can facilitate personalized learning experiences through AI-powered platforms, adaptive instructions – to provide learning materials, instructions, and feedback for students, and automated and real-time assessments, which can lead to improved student outcomes.

It also enables data analytics for data-driven decisions related to academic program development; it simplifies administrative processes through AI technologies such as student services, financial processes, etc.; it also improves efficiency in general; it also enhances innovation as it enables researchers to utilize AI tools and platforms to analyze complex data, develop predictive models, automate experiments, etc., which ultimately leads to inventions; furthermore, it also enables AI chatbots and virtual assistants for student support services, etc. In general, AI technologies enable higher educational institutions to offer high-quality education, innovation, etc., as well as prepare students for a rapidly changing digital world.

2.3.2. *Instructional, Learning, and Ethical Considerations*

Examining the use of AI applications and their integrations requires instructional learning and administrative considerations. The analysis of various articles highlights the rapid adoption and utilization of AI in different forms by instructors for instructional purposes and as pedagogical tools. The implementation of AI has significantly improved the effectiveness, efficiency, and quality of instructional work, as evidenced by the reviewed and analyzed publications (Chen et al., 2020; Zawacki-Richter et al., 2019; Crompton & Burke, 2023).

In this context, efficiency and quality are defined as the delivery of curriculum-relevant content tailored to learners' specific needs and capabilities, whereas effectiveness is evaluated based on students' uptake, retention, and achievement of learning outcomes. Based on these operational definitions, the study's findings suggest that AI has significantly contributed to enhancing the quality, effectiveness, and efficiency of instruction (Tan et al., 2022; Xu & Ouyang, 2021).

The implementation of AI applications can have a significant impact on instructional quality. The analysis of relevant studies identified several important themes in which AI has affected the work of instructors. A major theme is using technology, especially, AI, to promote academic integrity. Plagiarism checkers and proctoring systems (e.g. annual checking system, Grading Tutor; Turnitin has been cited). A second theme is using AI for learning, which has been shown to be

quite beneficial in improving the quality of education (Sutton, 2019; Gasparyan et al., 2017; Foltýnek et al.,2019; Sabeeh & Khaled,2021). These humanoid robots learned to speak and converse with students so that their appearance as well as capability can be utilized in understanding more about the subjects.

Apart from the academic benefits of AI, the technology is also changing the way the administration of a university is run. In the modern era, AI technologies are used to efficiently manage tasks such as the enrollment and registration of students, which makes the job easier for the administration (Igbokwe, 2023; Chen et al., 2020). AI technologies also assist in the improvement of the decision-making processes of the administration by efficiently analyzing data and identifying patterns and trends.

The above study findings show that the application of AI technologies improves the quality of instruction in a university and the efficiency of the administration. In other words, AI technologies can improve instruction and the administration of a university simultaneously.

3. Results and Discussions

AI technologies comprise a variety of tools and applications. These tools and applications of AI technology include machine learning algorithms, natural language processing, and predictive analytics. This systematic literature review comprises 21 studies related to the application of AI technology in higher education. The analysis of the research studies in line with the research questions provides an insight into the application of AI technology.

Research Question 1: What and How AI-enabled applications are being used by Higher education?

AI-enabled application is transforming the field of higher education by providing unique and innovative ways of solving challenges facing the field. One of the ways AI is being used in higher education is through personalized learning. AI is being used to analyze data and provide personalized learning experiences for students (Tan et al., 2022). AI-enabled applications in higher education include adaptive learning platforms, virtual teaching assistants, personalized learning pathways, Intelligent Tutoring Systems, and smart content recommendation tools, all of which provide tailored learning experiences for individual students. Another key application is predictive analytics, which helps identify underperforming students and informs interventions to improve outcomes. Additionally, AI is transforming higher education through virtual reality simulations, automated grading, and smart campus management systems.

The findings revealed that the majority of the research points out the fact that AI has been embraced and utilized in the field of learning, especially in learning institutions. Initially, AI was in the form of computer technology. However, the technology has grown and developed into web-based intelligent education systems. The study also indicates that AI is being integrated into learning through embedded computer systems, humanoid robots, and web-based chatbots within educational contexts. These technologies are used independently or in combination with the instructors in the learning context. By using the AI platforms in the learning context, instructors have been able to empower themselves in enhancing their administrative capabilities, such as the review and grading of the assignments undertaken by the students. AI's machine learning capacity has also been used in the personalization of the curriculum in accordance with the needs of the students. The use of AI in the personalization of the curriculum has been effective in enhancing the quality of learning and the engagement of the students (Gašević et al., 2023).

There are various users of AI applications in the context of higher education, including learners, educators, administrators, researchers, parents, and many more, each having their roles and obligations in effectively utilizing AI applications to improve the process of education and learning in institutions of learning. Therefore, there is a need to collaborate with one another in order to fully exploit the benefits of using AI technologies while at the same time addressing any issues that may come up. As a result, there is a potential for transforming traditional education by using AI technologies in education.

Research Question 2: What are the challenges and limitations of integrating AI tools in higher

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education settings?

The use of AI in the decision-making processes in the higher learning sector also raises ethical considerations. For instance, AI is prone to bias in its decision-making processes. This raises ethical considerations in terms of the fairness of the outcomes in processes such as admission, grading, and student support. Therefore, the use of AI in the higher learning sector raises ethical considerations in terms of the need for transparency in the processes used in the decision-making processes. Consequently, it is imperative to prioritize ethical considerations when implementing AI in higher education.

Despite the positive implications of the use of AI in the higher learning sector, the application of AI in the sector also presents a number of challenges. For instance, data privacy is a major challenge in the use of AI in the higher learning sector. AI is used in the handling of a lot of data in the sector. As a result, the use of AI in the sector raises ethical considerations in terms of the need for the protection of the data from breaches. There is also the challenge of the reliability of AI in the sector. In addition, the fact that AI is still in its infancy in the sector also raises ethical considerations in terms of the need for the development of a framework for the use of AI in the sector. There is also the challenge of the non-interoperability of different AI technologies in the sector.

Another significant thing that can be learned from this study is that trustworthiness and reliability in AI technologies would always be an open challenge. Marcus & Davis (2019) argue against the notion that AI would reach a stage of intelligence equal to that of humans, highlighting the limitation of AI systems and how to bridge this gap between a controlled environment and the real world. They emphasize that a move towards common sense and understanding in AI is necessary. This is also a significant factor for higher education, promoting the use of AI in a responsible manner and encouraging higher education institutions to develop AI programs with a realistic understanding of AI's capabilities and limitations, as well as ethical issues.

In education, the use of AI would also have positive as well as negative aspects to consider. There are certain issues that would have to be addressed when AI is integrated in education (Luckin et al., 2022). Some of the key factors that would have to be considered for AI to be effectively integrated in education include promoting active participation in AI, as education systems are interconnected; developing AI programs for educators; developing a relationship

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between AI researchers and educators; ethics should be a prime concern, investing in AI in education; developing a mindset of experimentation and evaluation in teachers; developing a relationship with policymakers to develop AI guidelines in education; etc. By following these recommendations, it would be possible to tap into the potential of AI in education effectively.

4. Conclusion, recommendations, and future work

As seen in the findings and dialogue above, it is clear that AI has tremendous potential to change higher education for the better. AI has tremendous potential to change how we teach, how we learn, and how we work. If AI is integrated with our current system for e.g., through personalized learning tools, analytics, or a smart campus approach then we're seeing some exciting possibilities: more personalized education, more engaged students, and more efficient administration. However, this also brings us challenges that should be carefully considered.

There are a number of obstacles that need to be cleared before an institution can effectively introduce AI in education, including the possibility of algorithmic bias, data privacy and security, teacher training, interoperability, and developing guidelines on ethics. The trust and reliability of AI remain debatable.

For an effective introduction of AI in education, the author of this particular study recommends the following:

- Develop teacher training programs that focus on teachers: Educational institutions should provide professional development opportunities that enhance teachers' knowledge of using AI effectively in education.

- Promote collaboration between AI researchers and educators: This would encourage the development of AI tools that address real-world education needs and solve actual education challenges.

- Place ethics at the forefront: Educational institutions should develop guidelines that govern AI-based decision-making processes. Emphasize ethics such as transparency, fairness, equity, integrity, as well as issues of bias, privacy, consent, and how AI would affect teachers.

- Invest in AI in education R&D: There is a need to fund education research and

development to advance AI technologies that are education-specific, including how to overcome current AI challenges, such as common sense and comprehension.

- Encourage a culture of experimentation and evaluation. Schools and departments should foster an environment that makes teachers feel comfortable experimenting with AI tools and evaluating their effectiveness. Teachers should benefit from ongoing professional development that allows them to incorporate AI into teaching that suits their needs.

In the future, new teaching methods such as adaptive learning environments and intelligent tutoring systems should be explored. The development of lifelong learning systems should be taken further. These include research into these technologies and AI-based tools for curriculum design and evaluation. By embracing these technologies, teachers can provide a more personalized, inclusive, and effective learning experience for their students.

Disclosure of Conflicts of Interest

This paper is free of conflict of interest.

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