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Artificial Intelligence in Education: A Comprehensive Review

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Abstract

The rapid advancement of artificial intelligence has brought about changes in several sectors, including the education sector, where it has a significant role in developing learning outcomes, assigning educational experiences, and alleviating administrative work for teachers. AI systems, including machine learning and virtual reality, have been employed in educational practices, helping to provide innovative alternative solutions to traditional teaching and learning challenges. Despite the great opportunities presented by AI, both teachers and learners face many challenges, such as teachers' readiness to adopt these technologies, their need for professional development, and moral concerns. This paper examines AI in education, exploring how it can improve curricula, support teachers, and enhance student outcomes. The research also highlights key barriers, including technological limitations, privacy issues, and biases in AI algorithms. Based on extensive literature reviews, the study explores new trends and research gaps, as well as guiding prospects for future research in AI-enabled education, with a great deal of attention focused on teacher training, long-term outcomes, ethical issues, and the effects of AI on student-teacher interactions in the educational environment. The Previous studies in the literature review suggest strategies to integrate AI into education effectively, helping students benefit from this technology without negatively impacting human values and the importance of personal interaction. This paper also addresses issues related to privacy and biases in AI algorithms.

Keywords: Artificial intelligence; Education; machine learning; enhance student outcomes.

1. Introduction

Today, technology has become an essential element in our daily lives, and the effects of technology are not limited to our lifestyles only but have also brought about changes and affected the processes of work, learning, and the means of our interaction with others (Rani et al., 2024). The rate of advanced innovations is constantly increasing, making our work and daily lives highly efficient and effective. One of the most important of these developments is the advanced and modern technology known as artificial intelligence, a vital and highly effective tool that can masterwork in a very sophisticated way that resembles humans or mimics human behaviour (Fitria, 2021).

Artificial intelligence this tool can be defined as a technology found inside computers that can perform tasks and imitate human behavior through programming in specialized systems that reflect human thought processes by designing systems compatible with human thought processes (Mao et al., 2024). In this context, AI can be known as an innovative capability, similar to human mental processes, through modern programs and devices (Alier et al., 2024).

Moreover, (AI) reduces the amount of administrative work for teachers to allow them to focus on the different aspects of the teaching and learning process. For example, devices such as grading devices and smart lectures provide direct feedback to improve the quality of the educational process. Also, AI in education sectors is defined as the adoption and use of algorithms and machine learning techniques to design compelling educational experiences; by interpreting information related to student performance, artificial intelligence can design lessons according to student levels and individual needs and know the learning outcomes. Thus, this technology improves student engagement, which helps raise and improve learning outcomes (Krstic et al., 2022).

In addition, during the last ten years, an increasing number of scientific research papers Related to AI fields in education have been observed. Therefore, the researcher conducted statistics to determine the percentage and number of scientific papers and research papers between the following years, 2014 and 2024, as shown in Figure 1.

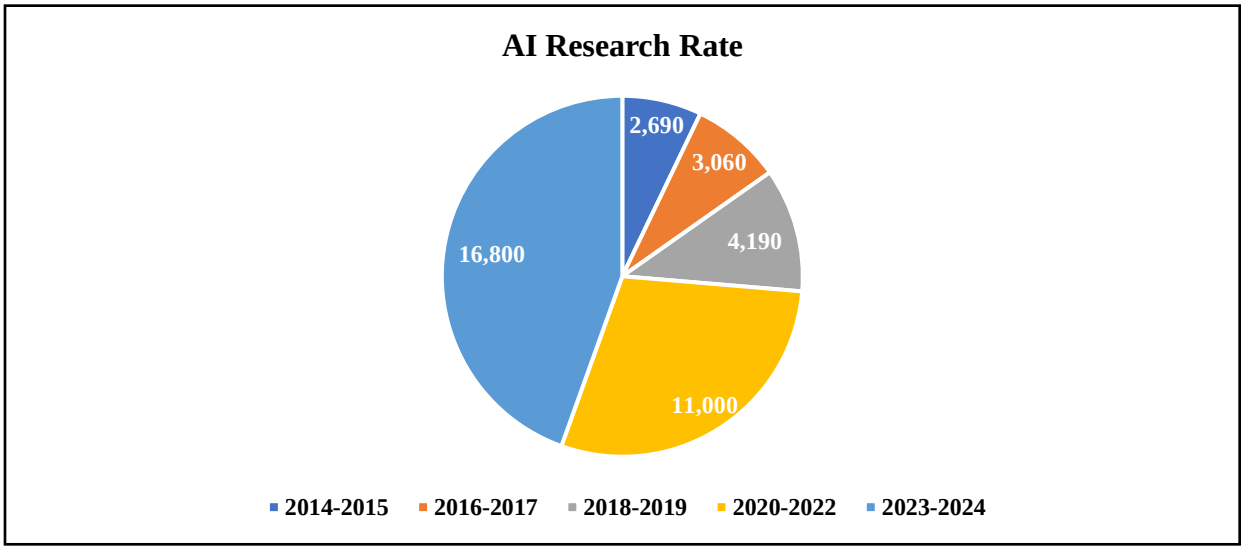

Figure 1. Number of scientific research Within the framework in scope of artificial intelligence

The rapid growth of AI technology can transform education, enhance learning outcomes, and support teachers in enabling self-directed learning. However, despite its effective capabilities, using AI in the learning procedures creates some challenges. Therefore, professional development and training must be activated to use high quality artificial intelligence and have positive and effective interactions between students and teachers. This is due to the existence of

a gap in how to apply and activate artificial intelligence in adequate quality and how to implement the distance education system at the levels of education, starting from early childhood and finishing in higher education, and how to manage and activate it in an integrated manner in the best way to ensure that all beneficiary groups, including administrators, students, and teachers, benefit.

This paper aims to study the impacts and trends of using artificial intelligence in education in the future to verify its ability and efficiency in bringing about a digital revolution in curricula, developing learning environments, and developing teaching practices. Moreover, the research seeks to study the challenges and difficulties facing teachers in using artificial intelligence technologies, understand how artificial intelligence can support the learning process or hinder educational outcomes, and identify the practical steps necessary to successfully and effectively integrate and introduce artificial intelligence into educational systems.

2. Literature Survey

The study (Xu, 2024) indicated the effective role of artificial intelligence in developing and improving educational outcomes by testing various artificial intelligence tools, such as machine learning and virtual reality, using qualitative methods (Yousif M, 2022).). Researchers focused on mathematics curricula, emphasizing the ability of these effective technologies to support and develop learning experiences by providing personal support to students, stimulating participation, and improving academic performance in general. However, this study did not study the effects of artificial intelligence on student outcomes. Among the recommendations that it made was to focus on research that focuses on intensive training for teachers on ways to use AI in classrooms. Moreover, the study by (Samarescu et al., 2024) aimed to identify the factors influencing the use of artificial intelligence in learning processes using the quantitative approach. Among the most important results achieved by the study is the presence of personal ability to use artificial intelligence and the emergence of many advantages that have significant and effective positive effects on the use of artificial intelligence in the teaching process.

Similarly, a study by (Dominguez et al., 2023) surveyed 445 teachers from primary to higher education using a qualitative approach to ascertain how AI tools and software are being integrated and employed in classrooms. The results indicate that although AI is adding new momentum and significant development, special programs must be developed and designed to train teachers with digital and smart skills to use artificial intelligence. Furthermore, a study by (Al Darayseh, 2023) also explores through his study the AI application in science curricula using the descriptive approach; the results showed no statistical significance. Between teachers' responses according to the variables of gender, qualification, and teaching experience on the use of AI in teaching, results also showed a high level of teachers' acceptance of the use of artificial intelligence in education, the percentage of self-competencies and ease of using this digital technology reached 71.4%, The most important recommendations reached by the study is to increase the sample percentage in future research.

In addition, the researcher (Baidoo-Anu et al., 2023) exploratory study aimed to investigate the effectiveness of ChatGPT, which is considered an artificial intelligence tool, and its impact on the teaching and self-learning process, one of the most important results reached by the study is that ChatGPT has a high-efficiency capacity that helps in collaboration with great potential and high efficiency and helps in engaging students and also helps in formative

assessment, this study indicated the need to research evaluating the classroom that contains the use of artificial intelligence technology. On the other side, the study carried out by (Nguyen et al., 2023) aimed at the potential ethical risks of using (AI) in education by using a qualitative approach, and the results indicated the establishment of a comprehensive set of ethical principles that aim to guide stakeholders in the education sector, including data privacy in the use of artificial intelligence, including transparency and fairness.

In a similar study conducted by (Chounta, 2022), the research shed light on exploring teachers' views on artificial intelligence and how this tool supports educational practices in the learning environment from kindergarten to twelfth grade in Estonia by using survey research. The results showed that teachers' knowledge of artificial intelligence applications was minimal. One of the most important suggestions of the study was to involve teachers in the design processes of artificial intelligence. The researcher (Uygun, 2024) conducted a study that included 74 teachers to take their views on the impact of artificial intelligence technology in education by using the method in education Opinion Scale approach; the results showed a positive view of the role of artificial intelligence in creating wealth in the educational process, and one of the most important gaps is that the study did not measure the effects of artificial intelligence on learning environment.

Furthermore, research conducted by (Chassignol et al., 2018) provides a general vision of the direction and future of AI technology in education, where expected impacts were classified using the literature review approach in several key areas, including curricula, teaching methods, assessment techniques, and developing communication between learners and teachers. This literature review confirms that artificial intelligence technology contributes to shaping and designing the learning process, activating specialized educational experiences, and transforming traditional educational structures into digital ones through AI, which is suitable for all levels of students. The researcher (Farahani, 2024) conducted a study that aimed to conduct a comprehensive study of (AI) technology in education by relying on the document review method. The end study concluded the necessity of using AI in teaching and learning. Enables teachers to gain deep insights into student learning patterns through data-driven analytics.

A study by (Kistyantoet et al., 2022) also discusses how AI tools can enhance and improve learning experiences and how faculty can adapt to teaching settings using AI technology. The findings indicate that AI plays a pivotal and significant role in designing teaching and learning in higher education (Yousif et al., 2011). According to the study (Jung, 2022), the qualitative approach was used to highlight the extent of teachers' interest in using artificial intelligence in teaching and to examine the factors influencing the use of artificial intelligence in education. This study concluded that teachers' most important concerns are information, evaluation, and management. Also, one of the important gaps is that the study included only 38 teachers, which makes it difficult to generalize the results well. Therefore, the study confirmed that attention should be paid to other scientific research to increase the sample percentage.

In the context of younger learners, (Yang, 2022) uses a theoretical framework to study the mechanisms of AI in early childhood learning and examines the challenges of integrating artificial intelligence technology and tools into learning for young children. The study proposes a new pedagogical model for young learners in teaching artificial intelligence and emphasizes the need to develop age-appropriate curricula for teaching AI concepts to young learners (AlKishri & Al-Bahri, 2021). In addition to classroom applications, (Gocen's et al., 2020), the study aimed to explore

and investigate the effects of artificial intelligence on the future roles of teachers, school administrators, and educational institutions using a qualitative approach. The study offers diverse perspectives on how AI will change educational practices. Among the most notable findings, teachers expressed concerns about AI's ability to redesign and reshape effective roles and limit teachers' work and responsibilities.

Also, the study (Al-Dosari, 2020) aimed to study the effective effects of artificial intelligence on higher education institutions in Saudi universities. The qualitative research methodology was used by asking some questions to a sample of academics. One of the important results of the study is that there are low levels of awareness and a lack of comprehensive understanding of the method of applying artificial intelligence. The study recommends increasing Saudi society's culture and awareness of the methods and mechanisms of applying artificial intelligence technologies in teaching. Furthermore, this scientific study conducted by (Rahman, 2023) aims to improve the evaluation process using AI and improve the learning experience. The researcher used the sampling method, and the most important results of the study were obtained to obtain a comprehensive view of teachers' views on the process of employing AI in the educational process. However, it will not consider students' perceptions of artificial intelligence in education.

In a broader sense, (Ng et al., 2023) explore the digital competence of AI for teachers and twenty-first-century skills using a qualitative approach, and one of the most important results reached by the study is that AI is adopted as a major driver of innovation in education. One of the important gaps in this study is that it reached a complete analysis of perceptions without considering the cultural differences regarding AI technology tools in education. Similar to the study the researcher made (Chiu et al., 2023), through a systematic review used to identify the nature of AI tools in education, with a broad focus on how it is applied to learning, teaching, management, and student assessment, the study reached several conclusions, including that artificial intelligence plays various roles, including assisting in personalized learning, the study emphasizes the need for further studies on how artificial intelligence affects learning areas. In addition, the study (Hu, 2021) aims to use artificial intelligence technology to evaluate teachers' teaching, and the study was conducted using a machine learning algorithm. Through these algorithms, the study reached important results, including the algorithm's accuracy in evaluating teaching, and the study suggested that other research should focus on using (AI) in teacher evaluation (Kazem et al., 2016).

As well as studying by (Leiker et al., 2023) to highlight the effectiveness of (AI) technology in designing great content that can effectively improve students' understanding of educational materials. The study was conducted using a mixed-methods approach. Among the results reached by the researcher is that the video clips designed using artificial intelligence have great effectiveness and positive effects on the educational process. Future studies must focus on educational values, especially for media produced by AI and its practical effects on education. Moreover, this study was carried out by a researcher (Crawford et al., 2024) and aimed to discover the rate of interaction between people, namely teachers and learners in educational environments, and the method of using artificial intelligence in universities by using the structural equation modelling approach, one of the most important results reached by the study is that the use of artificial intelligence is associated with a decrease in social outcomes, including a decrease in human social support, therefore, one of the study's recommendations is that the study calls on educational universities to develop strategic plans to improve the academic outcomes of artificial intelligence while strengthening social ties (Yousif et al., 2021). Also, a study by the researcher (Perrotta, 2019) studied the impact of using artificial intelligence

in educational environments, especially in online learning environments, by using the qualitative approach, and the study concluded that artificial intelligence systems rely on limited educational knowledge and, therefore, do not rely on it entirely.

Finally, (Gidiotis et al., 2024) the study aimed to identify the use of social science imagination to envision the future of AI in education by using the qualitative method, and one of the results reached by the researcher is that AI is a tool to support teachers and not replace them. One of the important gaps is that the study only focused on general topics and did not study how artificial intelligence in education affects different cultures to know the percentage of cognitive culture towards this technology.

This review discusses the role of AI in education, focusing on its applications, benefits, and challenges. Various studies were reviewed that applied AI tools, including machine learning, virtual reality, and ChatGPT, to show how effective it is in enhancing learning experiences, engagement, and assessment. Key challenges identified in research included teacher training, ethical concerns, and cultural differences. Some studies highlighted the role of AI in shaping curricula, improving instructional methods, and fostering personalized learning. Still, there are gaps, such as limited research on the long-term impact of AI on student performance. Future research should be done on teacher training, ethical considerations, and the role of AI in digital education.

3. Research Methodology

3.1. Research Approach

The research adopts a qualitative research approach, wherein, through an extensive literature review, an attempt is made to trace the role of AI in education. This research synthesizes various studies on AI applications, benefits, and challenges, and its impact on teaching-learning. Analyzing past research, this study tries to identify the main themes, trends, and gaps in AI-enabled education.

3.2. Data Collection Method

These data are secondary, sourced from various relevant peer-reviewed journal articles, conference papers, and academic reports. Studies to be included must involve AI applications in education, be published in reputable journals between 2018 and 2024, and discuss machine learning, virtual reality, ChatGPT, and other AI-powered educational technologies. The papers should discuss ethical concerns, teacher training, and privacy issues in AI adoptions. A literature search was conducted via the following databases and search engines: Google Scholar, IEEE Xplore, Scopus, and Web of Science.

3.3. Data Analysis Method

The reviewed literature is grouped into the following key themes; all are based on a thematic analysis approach, as follows:

- AI Applications in Education - Machine learning, virtual reality, ChatGPT.
- Benefits of AI in Learning - Personalized learning, engagement, curriculum development.
- Challenges and Barriers: Teacher readiness, ethical issues, and bias in AI algorithms.

- Research Gaps and Future Directions: Need for teacher training, long-term outcomes, and ethical considerations. In this systematic review, these themes will be examined to ensure the best strategies of integrating AI into education while reducing risks.

3.4. Validity and Reliability of the Research

The validity and reliability of the research are established by the fact that:

- Findings cross-checked from multiple sources.
- The studies are chosen based on different educational settings.
- Identifies common patterns and discrepancies in AI research

This approach ensures a comprehensive and unbiased assessment of AI's role in education.

4. Results and Discussion

Therefore, the literature review does an in-depth analysis of AI in education, its applications, benefits, and challenges, besides emerging trends. The discussion establishes gaps in research, new directions that future studies can take, methodologies used, and statements of key findings. The following themes summarize the insights obtained from the reviewed studies:

4.1. The Need for Teacher Training in AI Integration

Other studies call for teacher training and development of digital competencies to effectively integrate AI into education. Further research has been suggested in the area of training needs and vocational training for teachers to acquire skills related to AI.

- Xu (2024) and Samarescu et al. (2024) reported positive impacts of AI tools on student learning but did not discuss how teacher preparedness influences such outcomes.
- Dominguez et al. (2023) showed that teacher training programs are generic, not tailored for specific levels of education, which therefore means lacking AI-specific pedagogical training.
- Ng et al. (2023) pointed out that training programs for teachers should focus on AI, since AI is a driver of innovation in education.

These gaps suggest that future research should focus on the design of AI training programs at different educational levels to ensure effective AI implementation in classrooms.

4.2. Ethical, Privacy, and Data Security Concerns

Another important concern in AI-driven education is ethics, privacy, and security of data. Many studies insist on the necessity of guidelines for keeping student data and AI algorithms transparent:

- Nguyen et al. (2023) created rules of ethics concerning AI in education, taking care of transparency and students' privacy.
- For sure, Chassignol et al. (2018) say, AI provides personalized learning, but difficulties still lie in aligning AI with traditional models of education.
- Crawford et al. (2024) suggest that AI involvement minimizes human interaction, which may be harmful because essential social sides of learning will be lost.

It hints at an urgent need for investigation into responsible AI deployment, with a balance in AI-driven efficiencies, ethical considerations, and the well-being of students.

4.3. The Role of AI in Student Assessment and Learning Analytics

Artificial intelligence these days is more and more infused into automated assessment and learning analytics.

- Rahiman et al. (2023) revealed that AI will enhance student assessment to make it more data-driven and effective learning.
- According to Leiker et al. (2023), AI-generated educational videos enhance the understanding and learning of students.
- Chiu et al. (2023) stressed that AI is currently playing its role in assessment and administrative tasks, although studies regarding its long-term effect are scanty.

These findings indicate that AI-based methods for student assessment have to be studied further in regard to fairness, accuracy, and adaptability across different learning contexts.

Figure 2 displays the number of research areas that were among the recommendations of the studies discussed in the paper. The (X-axis) constitutes the topics of studies, and the (Y-axis) illustrates the numbers of recommended studies in each field. Overall, the chart shows that AI teacher training is the area most in need of highlighting and future studies should focus on this area.

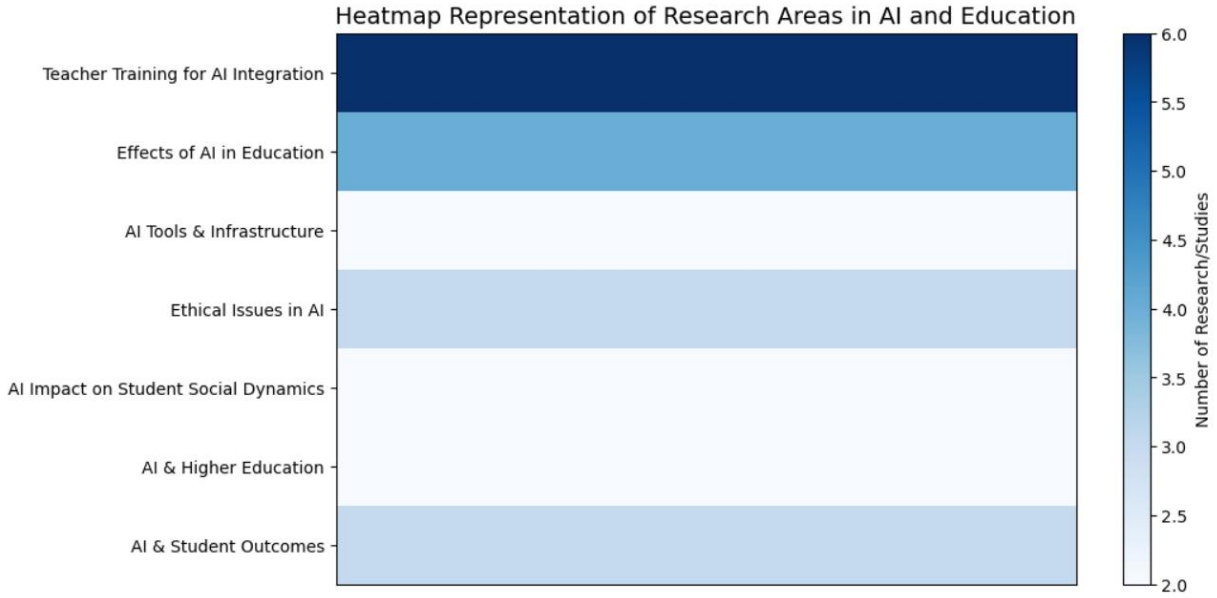

Figure 2. number of research areas among the recommendations

4.4. The research methodologies in AI education

The review of the research methodologies in AI education studies provides a mixed bag of approaches, reflecting different lines of investigation into the role of AI in education. Table 1 shows that a large part of AI education studies is qualitatively oriented, focusing on teacher perceptions, ethical issues, and the challenges of integrating AI. However, quantitative and machine-learning-based methodologies are emerging, highlighting the measurable effect of AI on

learning outcomes. Future research might benefit from more empirical, data-driven studies that could validate the long-term effects of AI on education.

Table 1. Research methodologies in AI education

Methodology	Number of Studies
Quantitative methods	3
Qualitative methods	7
Descriptive methodology	1
Exploratory study	1
Theoretical framework	1
Systematic literature review	1
Machine learning algorithm	1
Mixed-methods approach	1
Structural equation modeling (SEM)	1
Sampling method	1
Library method & document review	1
Survey research	1
Opinion scale	1
Thematic analysis qualitative	1

4.5. A comparative analysis and Limitations

AI applications in education have shown great potential, but there are many challenges and opportunities for improvement as presented in Table 2.

Personalized learning supports collaboration, engagement, and effective delivery of results by tailoring content to individual needs but is based on high-quality data, which can be biased.

Data diversity can mitigate this problem. AI teachers complement traditional teaching by providing quick feedback but often rely on technology, which can reduce critical thinking; balance and equality in use between AI and human interaction is important.

Automated grading systems can make assessments quicker and minimize administrative work and pressure, although they can increase bias without data diversity. In addition, learning analytics can help identify students at academic risk and track performance but raise privacy and ethical concerns, which can be addressed by following ethical standards to achieve AI efficiency and knowledge in the educational process. (U.S. Department of Education, 2021).

Table 3. summarizes some of the main ethical issues related to AI in education, together with challenges and suggested solutions for reducing risks.

- Privacy and Data Security

Challenge: AI use in education increases the chances of students' private data being compromised since sensitive information is prone to leakage or other forms of abuse.

Suggestion: Institutions should set up sound data protection and adhere to privacy laws so that student information is handled securely.

- Impact on Teaching Roles

Challenge: AI can change the traditional roles of teaching; whether teachers will be replaced or not is scary for some teachers.

Suggestion: This technique should not replace the teachers but rather assist and support teachers' effectiveness in teaching by providing them with personalized support, as well as students.

- Bias and Fairness

Challenge: AI can further exacerbate biases found within the training data, and these biases result in inequities in learning opportunities.

Suggestion: Identification of biases in AI-driven learning tools and mitigation efforts should be sought to create equity and inclusion within learning environments.

- Teacher Role Independence

Challenge: Over-reliance on AI might erode teachers' instructional skills due to automated tools gradually taking over teachers' instructional activities.

Suggestion: AI should be positioned as a complementary support tool, not a replacement for educators, and must allow teachers to retain active engagement in the learning process.

Table 2. A comparative analysis of different AI applications:

AI Application	Effectiveness	Limitations	Areas for Improvement
Personalized Learning	Improves engagement and results.	It relies on high-quality data, which exposes it to bias.	Promote transparency and data diversity.
AI Tutors and Assistants	Complementary to traditional education.	Over-reliance can be detrimental to critical thinking.	Balance between artificial intelligence and human interactions.
Automated Grading Systems	Speed up the classification and evaluation process.	Risks that reinforce biases.	Use of diverse training data.
Learning Analytics	Identifying students at risk.	Ethical and Privacy threat.	Commitment to ethical standards.

Table 3. Perspectives on the ethical considerations and challenges

Ethical Consideration	Challenges	suggestions
Privacy and Data Security	Sensitive student data is at risk of being breached and misused.	Ensure strong data protection and compliance with privacy laws.
Impact on Teaching Roles	Artificial intelligence could change traditional teaching roles, potentially displacing teachers.	Use AI to empower teachers.
Bias and Fairness	AI could reinforce biases, leading to unfair treatment of some students.	Identify biases in AI systems

Teacher role independence	The risk of losing teachers' skills when AI takes over certain tasks.	AI is a support tool, not a replacement.

5. Conclusion

In conclusion, this paper focused on the impacts of using artificial intelligence in the educational environment and on the benefits and challenges of AI. There are many advantages of AI mentioned in this study, which are as follows: Artificial intelligence is distinguished by its distinct ability to develop learning outcomes, helps in developing and innovating curricula, reduces the percentage of administrative work for teachers, and creates new educational experiences. On the other hand, there are some challenges to using artificial intelligence in teaching, such as teachers' readiness and acceptance to use artificial intelligence, the need for more professional development for teachers, and concerns about privacy, ethics, and biases in artificial intelligence algorithms that constitute significant obstacles to the development and applications of this technology in a safe and effective manner. Previous studies emphasized the need to address these issues to use artificial intelligence technology in education in a highly ethical and effective manner. Future recommendations for references in this paper include conducting more research on training teachers in the areas of application and use of this technology in the educational process and conducting scientific research on topics with ethical considerations. In general, previous studies emphasize the importance of following comprehensive plans to use artificial intelligence in the learning process to achieve maximum benefit from it in the educational process.

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