

Chapter-6

TRANSFORMING EDUCATION SYSTEM THROUGH ARTIFICIAL INTELLIGENCE IN 21ST CENTURY: A REVIEW

Abstract

As we navigate the complexities of the 21st century, the integration of Artificial Intelligence (AI) into education systems has emerged as a promising avenue for enhancing learning outcomes and reshaping traditional pedagogical approaches. This meta-analysis explores the transformative potential of AI in education by synthesizing findings from a wide array of studies, encompassing various educational settings and AI applications. The study is aimed to review and analyse the role of Artificial intelligence in transforming the education system and evaluating its opportunities and challenges associated with it. This study is based on a related literature review. The data has been taken from different databases like Google Scholar, the publication database, Research Gate, and from other publications starting from 2018 to 2023 etc. The review documents were critically evaluated based on their ability to achieve the objectives of study. Results shows us that there are various number of applications of Artificial Intelligence like Personalized learning, Deep learning, Chatbots, Robotics and much more in order to raise the standard and quality of education throughout the world. But at the same time, there are various challenges related to its usage, which needs to be resolved for the complete success of education system in 21st century.

Keywords: Artificial intelligence in Education, AIED, Robotics, AI Challenges, AI Opportunities, Automated learning.

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I. INTRODUCTION

Artificial intelligence (AI), aims to enable computers to perform tasks by simulating intelligent human behaviours, and has rapidly advanced due to the information processing techniques (Duan et al. & Topol, 2019). Artificial intelligence (AI) has been widely used in educational practices, thanks to its fully developed techniques and practices which give birth to human-computer interactions, learning analytics dashboards, intelligent tutoring systems, teaching robots, adaptive learning systems, and much more (Chen et al. 2020). Even throughout the COVID-19 pandemic, AI tools and advanced technologies have played a pivotal role in enabling continuous learning for students and teachers worldwide (Dar and Khursheed, 2024). Ever since the introduction of AIED almost thirty years ago, artificial intelligence (AI) has been viewed as a potent instrument that can help create new paradigms in technology development, instructional design, and education research that would not be possible to create in conventional learning environments (Holmes & Hwang). AIED has specifically created new possibilities, obstacles, and opportunities for educational innovations, such as the shift to personalized learning, the difficulty of the instructor's role, and the creation of intricate educational systems (Baker et al., 2019; Holmes et al., 2018). In addition to this, different AIED methods have been used to build intelligent learning environments for behaviour detection, prediction model building, learning recommendation, etc. (Chen et al. 2020; Rowe, 2019). These methods include natural language processing, artificial neural networks, and much more. AIED is increasingly being used in education field, due to its good potential to transform the system (Hwang et al., 2020).

Artificial intelligence is the term used to describe the intelligence exhibited by machines as opposed to humans. Animal intelligence lacks consciousness and emotions, whereas intelligence displayed by humans and other species possesses these qualities. John McCarthy used the term artificial intelligence (AI) for the first time in 1955, defining it as 'making a machine behave in ways that would be called intelligent if a human were so behaving' In the sections that follow, we offer a framework for elucidating the functions of artificial intelligence (AI) in education, in addition to delineating its characteristics. These studies generally fall into one of four categories:

1. **Cognitive Coach:** This AIED application category has various applications which includes recommendation systems, adaptive/personalized learning systems, and intelligent tutoring systems. The usefulness of intelligent tutoring systems in fostering learning outcomes has been shown in a number of meta-analytic studies (Liu, et al. 2014; Steenbergen & Cooper 2014; VanLehn, 2011).
2. **Smart Learner Companion:** Research in this area are uncommon because the majority of AI-based learning environments prioritize student assistance over chances to foster student tutoring or advising. However, putting students in situations where they have to assist others AI tutees in understanding difficult ideas could be a great way to advance their higher order thinking skills and knowledge. While research on purposeful and explicit development of intelligent tutees has not yet been conducted, a number of AI models and techniques are able to acquire knowledge and experience through human interaction.

3. ***Enlightened Collaborator:*** From the standpoint of constructivism, having a partner or intelligent learning tool is crucial. Rather than concentrating on simple tasks like editing and calculation, certain tools can even do ‘smart’ data analysis and presentation, which encourages learners to think critically and identify important implications hidden in the data.
4. ***Policy Analyst:*** In recent years, AI techniques have been used to inform and guide the development of laws or policies (Gasser & Almeida, 2017). As a result, creating a policy-making advisor for the purpose of developing educational policies is both feasible and possible.

II. ARTIFICIAL INTELLIGENCE IN EDUCATION

AI-enhanced digital technology has become indispensable in our day-to-day lives because of its immense ability to alter our thoughts, behaviours, and social interactions. In actuality, while the idea of artificial intelligence (AI) and intelligent machines dates back to the 14th century (Tatar et al. 2003), the concept of AIED is relatively new, having emerged only 25 years ago. AI has been incorporated in education through a various methods and forms (Heffernan & Heffernan, 2014; Koedinger & Corbett, 2006). The advancements and achievements emerging from various disciplines, particularly computer science, have profoundly influenced the methods and approaches we use in education and how to teach learners. (Humble 2019; Botrel & Bayne 2015). In both K–12 and university settings, educators and students are using more and more AI-powered applications and tools. According to Della Ventura (2017), artificial intelligence (AI) technologies offer the possibility of implementing personalized learning for students based on their unique requirements. But, at the same time, its challenging to meet the needs of each individual learner using conventional teaching techniques since each learner has different learning skills, and needs. But thanks to AI, teachers can now individually adjust their instruction to each student’s needs (Della Ventura, 2017). As a result, students are able to learn with greater independence, motivation, and engagement (Della Ventura, 2018; Wang, 2017). AI technologies also present opportunities to enhance the participation of students with learning disabilities. As AI technologies are used more widely in education, teachers have the opportunity to eliminate time-consuming and repetitive tasks and respond to students promptly, which enhances the process of adaptive and customized learning (Chan & Zary, 2019).

III. ARTIFICIAL INTELLIGENCE AND SIGNIFICANCE

Education could be revolutionized in a number of ways by artificial intelligence (AI), which has great promise. The automation of academic and administrative work, tailored learning, intelligent material, and constant accessibility are the primary functions of artificial intelligence in education. Some noteworthy implications are as follows:

1. ***Personalized Learning:*** AI is able to provide personalized learning experiences by adjusting to each student's unique learning style and pace. This maximizes learning results by ensuring that every student receives instruction that is specific to their requirements, strengths, and weaknesses.

2. ***Enhanced Teaching:*** AI-driven resources can help educators produce and deliver superior instructional materials. Teachers can devote more of their time to teaching and mentoring students by using these tools, which can automate administrative work, give insights into student performance, and promote instructional tactics.
3. ***Augmented Reality and Virtual Reality:*** When AI is integrated with AR and VR technology, it may produce immersive learning environments that let students perform experiments, explore virtual worlds, and interact more interactively and engagingly with difficult subjects.
4. ***Intelligent Tutoring Systems:*** AI-driven tutoring programs can give students immediate feedback and direction, assisting them in understanding complex ideas and overcoming obstacles to learning. Based on the answers from the students, these systems can modify their instruction and offer focused assistance where it is required.
5. ***Automated Grading and Assessment:*** By automating grading and evaluation, AI algorithms can free up teachers' time and give students feedback more quickly. This frees up teachers to concentrate on other important facets of teaching, such guiding class discussions and giving specific comments.
6. ***Lifelong Learning and Skill Development:*** Through the provision of individualized learning routes catered to each person's interests and professional goals, AI-powered adaptive learning platforms can promote lifelong learning and skill development. This allows students to pick up new information and abilities at their own convenience and speed.
7. ***Data Analysis and Predictive Analytics:*** Large-scale educational data can be analyzed by AI to find trends, patterns, and insights that can guide instructional decision-making. By identifying kids who are at danger of falling behind or who require more support, educators can use predictive analytics to provide individualized intervention tactics and early intervention.
8. ***Language Translation and Accessibility:*** Students from different linguistic backgrounds can have greater access to educational resources thanks to AI-powered language translation technologies that can overcome language barriers. In a similar vein, AI can help disabled students by offering customized learning support and alternate content delivery forms.

In general, artificial intelligence (AI) has great potential to improve learning outcomes, increase the effectiveness of teachers, and make education more individualized, accessible, and interesting for students of all ages and backgrounds. While AI presents difficulties that demand careful thought and responsible development, it also has the potential to generate substantial improvements across a variety of domains. Its revolutionary ability to change industries, boost productivity, and tackle difficult societal issues is what gives it relevance.

IV. CHALLENGES IN AI

Following a critical evaluation of AIED, a number of challenges have surfaced. These are addressed below and will serve as a guide for researchers conducting additional research in the future.

- 1. *Insufficient Resources for Personalised Learning:*** Teachers have expressed dissatisfaction with the excessive homogeneity of the teaching strategies and learning materials suggested by personalized and adaptive learning platforms. Artificial intelligence (AI) agents suggest learning objects, which are any standardized, reusable digital educational resources that are easily modified to meet learning objectives in a range of situations (Cao et al., 2021). More research is required to determine the best ways to design learning objects for personalized and adaptive learning, as well as how to use them in this context.
- 2. *AI-Teaching Disjunction:*** New AI technologies aim to support teachers in their pedagogical decision-making by offering instructional support (e.g., through chatbots and robots) and by giving them rich information (e.g., learning analytics; Kim et al., 2022). Nonetheless, educators may encounter difficulties deciphering learning analytics data, be ignorant of the educational benefits of AI technologies, and be unclear about the pedagogical ramifications of utilizing AI in the classroom.
- 3. *Digital Divide and Educational Inequality:*** The majority of the AIED studies that were reviewed made clear how AI technologies could encourage student participation and develop 21st century skills. Nonetheless, the most capable and driven students frequently reaped the greatest rewards. However, this finding has two reasonable explanations: AI tools are not well developed for learners, and teachers lack the pedagogical expertise to effectively use the tools.
- 4. *AI Pedagogical Disparity:*** The majority of educators have been operating with a ‘black box’ in their classrooms because they are unaware of the principles underlying AI technologies, such as the algorithms that recommend resources. They consequently are unable to fully utilize the technologies for learning, teaching, and assessment, and are unable to respond to inquiries from students about AIED (such as why the AI platforms suggested specific learning resources). Therefore, future research should take into account the necessity of teachers having a working knowledge of AI and how it can be applied to pedagogy.
- 5. *AI Skepticism among Students and Teachers:*** When learning with AI, some educators and students have expressed feeling uneasy and less confident. Students may start to worry about their futures because AI technologies have the potential to render their desired careers obsolete. In the meantime, low self-efficacy can result from teachers ignorance of the systems (Wang et al., 2020). These ambiguities may lead to unfavourable perceptions of AIED, which could impact behavioural 2020; Qin et al., 2020). Research on AIED for students outside of the engineering context, such as K–12 and art students, as well as teacher professional development on AI subjects are both in need of further investigation (Chiu, 2021; Chiu et al., 2022; Xia et al., 2022; Chai et al., 2022).

6. ***Education Blind-spot in AIED Research:*** The goal of this review is to better convey the viewpoint of educational research on AIED. Nonetheless, because the majority of AIED researchers have a strong background in engineering, they frequently adopt an engineering perspective when conducting AIED research and concentrate on technological design and development. The viewpoints of educators and educational researchers are not adequately represented by this methodology.
7. ***Rudimentary Evaluation:*** It's possible that the most popular evaluation techniques won't work well for AIED research. The majority of the studies that were reviewed employed current techniques to assess new technologies that employ big data such as massive student populations and poorly organized data in novel ways (Renz & Hilbig, 2020). Consequently, new techniques for assessing the effectiveness of AI systems must be developed for the study of AIED.

V. OBJECTIVES

Education is a continuous process, which is needed for everyone and Artificial Intelligence in education has exposed it to new heights. Following are the objectives of this review type of study:

- To review and analyse the role of Artificial intelligence in transforming the education system of present century.
- To review and analyse the new opportunities of artificial intelligence in education and challenges associated with it.

VI. METHODOLOGY AND DATA

The study is based on a related literature review. This review systematically synthesizes and evaluates the role of Artificial Intelligence in transforming the education and its opportunities and challenges that are associated with it. The search strategy included academic databases, websites and other sources. The data has been taken from different databases like Google Scholar, the publication database, Research Gate, Eric and Wiley. The information and data sources have been appropriately acknowledged and referenced. The study also maintain some other criteria for selecting the appropriate literature such as publications starting from 2018 to 2023, peer reviewed journals etc. The review documents were critically evaluated based on their ability to achieve the objectives of study. Finally, the content has been carefully studied in order to give systematic look to study and ensure its quality and relevance.

VII. REVIEW OF LITERATURE

Chassignol et al. (2018) explored that, the artificial intelligence tools are already being used in many aspects of education, such as content creation, instructional strategies, student evaluation, and much more. This study adds to the body of knowledge in this area and will be of interest to academics, students, lecturers, and professionals working in the field of technology-enhanced learning as well as anyone interested in the cutting edge of education. Tao et al. (2019) explored that, the extreme robotics and artificial intelligence present risks and difficulties that need to be taken into account in all fields where they are used, especially in education. Students and instructors claim that a robot is not replicable since it is

emotionless, which highlights the potential for emotional disconnection resulting from the use of robots and artificial intelligence tools. Chen et al. (2020) explored that, the AI in education first appeared in the form of computer systems, and then it moved on to become web-based and online learning environments, which resulted in Robots and Chatbots. As a result, richer or higher-quality instruction has been produced by these technologies, which ultimately resulted in teacher effectiveness. Vincent & Vander (2020) explored that, the AI has the potential to enhance learning outcomes and procedures both within and outside of the classroom, as well as contribute to the achievement of SDG 4. At the system level, artificial intelligence (AI) in education is still being used sparingly. Borenstein & Howard (2021) explored that, AI is being incorporated into many facets of human life, and the complicated ethical issues that have arisen from its development, application, and use serve as a reminder that it is time to review the AI-related lessons that professionals and upcoming developers and designers are learning. So, it's important to prepare stakeholders in order to minimize its possible drawbacks. Ahmad et al. (2021) explored that, the education is one of the many fields that artificial intelligence (AI) has affected. AI is a modern approach to teaching and learning that can address and resolve a variety of learning-related problems so its adoption and implementation is inevitable. There are many other intelligent technologies, such as virtual facilitators, online learning environments, and social robots, that also make significant contributions to the field of artificial intelligence.

Zhai et al. (2021) explored that, by the AI's explosive growth, it is critical to comprehend how educators can best apply AI techniques to student's academic success. The difficulties posed by AI in education were also clearly visible in terms of the technique viewpoint, the roles of instructors and students, and social and ethical concerns and in order to bridge the gaps between technique and pedagogy, educators must collaborate with AI engineers. Majid & Lakshmi (2022) explored that, the future of AIED is unknown, it is predicted that nearly all fields of education, technical, professional, and non-technical will rely more on tools and technologies to provide a comprehensive learning environment for teachers and students. Though AI has started to show its advantages and promise in a variety of educational contexts, it is still unclear how the technology will empower students and enhance their overall learning outcomes.

VIII. CONCLUSION

As we stand at the cusp of unprecedented technological advancements, the integration of Artificial Intelligence (AI) into the education system promises a transformative impact on the landscape of learning in the 21st century. This chapter has provided an extensive review of how AI is reshaping education, highlighting the opportunities, challenges, and potential future directions. AI technologies have demonstrated remarkable potential in personalizing learning experiences, enhancing administrative efficiency, and enabling data-driven decision-making. Personalized learning, one of the most significant contributions of AI, tailors educational content to meet the unique needs of each student. Adaptive learning systems can analyze students' strengths and weaknesses, providing customized resources and feedback that enhance the learning process. This individualization not only promotes a deeper understanding of subject matter but also fosters greater engagement and motivation among students. Moreover, AI-powered tools can facilitate the development of intelligent tutoring systems that offer real-time assistance and support. These systems can simulate one-on-one

tutoring experiences, providing explanations, answering questions, and offering feedback that helps students navigate complex concepts. This capability is particularly beneficial in large classrooms where teachers may struggle to provide personalized attention to each student. Administrative tasks, often time-consuming and mundane, can be significantly streamlined through AI. From automating grading and attendance tracking to managing student records and scheduling, AI applications reduce the administrative burden on educators, allowing them to focus more on teaching and mentoring. Additionally, predictive analytics can help educational institutions identify at-risk students and implement timely interventions to improve retention rates and academic performance.

Data-driven decision-making, another critical advantage of AI in education, empowers educators and administrators with insights derived from vast amounts of data. By analyzing patterns and trends, AI can inform curriculum design, teaching strategies, and policy-making, ensuring that educational practices are aligned with the evolving needs of students and society. For instance, AI can identify gaps in learning and recommend targeted interventions to address them, leading to more effective and efficient education systems. Despite the numerous benefits, the integration of AI in education is not without challenges. Privacy and ethical concerns regarding data collection and usage must be addressed to protect students' rights and ensure responsible AI deployment. Ensuring equitable access to AI technologies is also crucial to prevent widening the digital divide. As AI continues to evolve, there is a risk that disparities in access to advanced technologies could exacerbate existing inequalities in education. Furthermore, the implementation of AI requires significant investments in infrastructure, training, and support. Educators need to be equipped with the skills and knowledge to effectively utilize AI tools in their teaching practices. Professional development programs and ongoing support are essential to help teachers navigate the transition to AI-enhanced education. Looking ahead, the future of AI in education is promising, with continuous advancements expected to bring about even more sophisticated and effective applications. Emerging technologies such as natural language processing, machine learning, and robotics have the potential to further revolutionize education, making learning more accessible, engaging, and inclusive. For example, AI-driven language translation tools can bridge linguistic barriers, enabling students from diverse backgrounds to access educational content in their native languages. Collaborative efforts between policymakers, educators, technologists, and researchers are essential to maximize the benefits of AI in education. Policies and frameworks that promote responsible AI usage, address ethical considerations, and ensure equitable access must be developed and implemented. Additionally, ongoing research and evaluation are necessary to assess the impact of AI on educational outcomes and identify best practices. In conclusion, the transformative potential of AI in the education system is immense, offering opportunities to enhance personalized learning, streamline administrative processes, and enable data-driven decision-making. However, realizing this potential requires addressing challenges related to privacy, equity, and implementation. As we navigate this evolving landscape, a collaborative and informed approach will be key to harnessing the power of AI to create a more effective, inclusive, and future-ready education system. By embracing AI responsibly and strategically, we can pave the way for an educational revolution that prepares students for the demands and opportunities of the 21st century.

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