Transactions on Computer Science and Intelligent Systems Research
ISSN: 2960-1800, eISSN: 2960-2238 | Volume 5
AIDML 2024

The Application of Artificial Intelligence in Education

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Abstract. Artificial Intelligence has had a huge influence on various fields since its appearance. The main focus of this paper is on the revolutionary impact of artificial intelligence on education. The major applications in the field of education are personalized learning, adaptive learning, virtual reality technology and teaching assessment. Virtual reality mainly focuses on virtual classroom, virtual laboratory, and smart campus, while teaching assessment analyzes and exemplifies self-service grading as one of the key components. Artificial intelligence technology has changed the traditional teaching and learning system by providing new modes of operation, teaching methods, and grading systems. This paper addresses the drawbacks of artificial intelligence in education while also analyzing its benefits. Despite these challenges, Artificial intelligence plays an undeniable part in educational reform, it employ novel learning styles to satisfy students' preferences and address multiple questions. Finally, the paper anticipates the future trajectories of artificial intelligence applications in education, and offering a comprehensive summary of the entire discussion.

Keywords: artificial intelligence, educational reform, education, education application.

1. Introduction

The 1940s were when Artificial Intelligence first emerged.The short stories about robots written by American science fiction author Isaac Asimov introduced this idea initially [1,2,3]. At the Dartmouth Conference, the term "artificial intelligence" was coined, marking the beginning of AI as a distinct field of study. The development of AI did not go smoothly. In the two decades since Dartmouth, the field of AI has seen great successes. ELIZA, an early computer program that processed natural language and simulated human-computer dialogue, is a good example. But then came the winter of AI due to the high expenses associated with researching it. As times changed, the publication of artificial neural network research and machine learning, ushered in a renewed focus on AI. A program created by Google called AlphaGo defeated the world Go champion in 2016. The power of deep learning and neural networks, which are the basis of most artificial intelligence nowadays, was demonstrated by AlphaGo's victory against humans in this case.

Artificial intelligence has tremendous potential and is becoming more and more common in many industries as a result of the rapid development of science and technology. The advancement and implementation of AI within the educational areas have also demonstrated a diversified trend and have begun to penetrate the school education system gradually, extremely changing traditional teaching methods and learning experiences. AI education systems, through their active integration with traditional education methods, have demonstrated promising results and significant contributions to education reform.

Before the invention of computers and other associated technologies, teaching and learning were purely mechanical processes or relying on human effort and engagement [1]. However, as technology continues to advance, the promise and application of artificial intelligence make it more adaptable in handling situations and solving problems. In the education area, AI is used more for supportive reasons, such as intelligence or process automation. AI and education research is increasingly focused on using AI technology to aid teaching, construct a smart campus, and achieve intelligent learning, teaching, and management. The education field utilizes image recognition technology, face recognition technology, adaptive learning, and other AI technologies [4]. These reforms have brought new changes and experiences to the education system. Simultaneously, integrating and analyzing big data can

enhance educators' comprehension of students' learning situations and increase their efficiency. It also helps students better understand their own learning performance and knowledge, and improves the learning experience of students.

This paper focuses on the application of AI technology in education and the perception of its transformative impact, mainly in four areas: self-service grading, educational diagnostics, personalized education and adaptive learning. The paper will also analyze the challenges faced by AI in educational applications, such as issues of data privacy security and maturity of AI applications.

2. The Application of AI in Education

2.1. Personalized Learning

As technology develops, artificial intelligence can do many innovative things, such as personalized learning.Personalized learning uses artificial intelligence technology to customize a specific educational experience for each user to meet their personal needs, preferences, learning pace and abilities. AI systems can identify students' learning styles, strengths, weaknesses, and progress by analyzing data on their interactions with educational content. AI can then use these analyzes to adjust the difficulty of educational content, provide personalized feedback, and customize learning paths to suit each student's specific requirements. Holotescu developed the Buddy teaching robot for the MOOC (Massive Open Online Course) to offer personalized and focused instruction to students [5]. AI can tailor the learning to each Learning materials and tasks are adjusted to the specific needs of individual students, so that students can learn at their own pace, thereby improving learning efficiency. Personalized learning also enhances the student learning experience, making educational methods more efficient by optimizing learning speed and teaching methods.

2.2. Adaptive Learning

Adaptive learning and personalized learning both aim to provide a teaching experience that is more responsive to student needs and characteristics. However, unlike personalized learning, adaptive learning focuses on using artificial intelligence technology to automatically adjust teaching content, difficulty, modality, and pacing of instruction to fit a student's learning pace, style, ability, and level of understanding. Adaptive learning systems collect data on student learning behaviors, such as student performance and interactions in class, and analyze this data. Based on these analysis results, teaching strategies can be adjusted, such as planning the best learning path for students by modifying teaching content and difficulty. There are currently many companies developing adaptive systems, such as Smart Sparrow. Smart Sparrow is an Australian online adaptive education platform that allows teachers to serve as the center to design adaptive courses. To help students learn the material by completing certain "tasks" in the course, teachers can create courses using the online platform's tools and content library, while can also adding interaction with students each step in the teaching process. The system can gather data on students' learning progress, identify their requirements, and modify its teaching approach to provide encouragement and feedback through engagement. These strategies may include methods such as adjusting the difficulty or changing the content, or even changing the learning materials. These methods can better help students and allow them to learn in the most adaptive way.

2.3. Virtual Reality Technology

The use of VR technology opens up a whole new way of learning and creates immersive, interactive and engaging learning environments that go beyond traditional methods. Virtual reality combines a number of scientific disciplines, including network technology, computer graphics, intelligent technology, image processing and pattern recognition, sensor technology, voice and sound technology, etc., and it converts computer-processed digital data into multidimensional, emotionally charged information that resonates with people's emotions and senses [5]. The three key areas in which virtual reality technology is applied in education are the smart campus, virtual laboratory, and virtual classroom.

Virtual classroom through VR technology can not only simulate the classroom environment, lets students in different geographic locations can remotely located in the same online classroom to interact and learn. VR can also simulate things that are difficult to observe or explain in real life and present them in the classroom to help simple and quickly understanding. This immersive learning environment promotes engagement by stimulating multiple senses and gives students a sense of reality. It also allows for a multi-dimensional presentation of learning content, while also allowing for the visualization of some indescribable and abstract concepts, thereby stimulating student interest and enhancing student understanding.

Virtual laboratory use VR technology to create and simulate experimental environments that allow students to conduct experiments in a risk-free, cost-effective and easily accessible way. 3D modeling techniques create corresponding hardware and software operating systems on the computer by utilizing multimedia, simulation, and virtual reality technologies. These can help supplement, partially replace, or even completely replace the operating linkages of conventional tests [4]. Experimenters can also be immersed through advanced somatosensory equipment and realistic modeling. For experiments that are dangerous, expensive, realistically restrictive, or difficult to perform, VR technology can provide a safe, affordable, and convenient simulation of the experiments.Virtual experiments and virtual prediction analysis can be performed by students and teachers on computers [5]. This approach is adaptable to a wide range of disciplines and bridges the gap between theory and practice. By increasing the number and experience of experimental operations, there is no need to worry about being affected by safety issues, resource constraints, or operational errors in a traditional laboratory environment.

Smart campuses build intelligent management methods by collecting and analyzing big data, face and voice recognition, and other AI-driven technologies such as hearing and sensing. Through these methods and technologies, campuses can enhance campus security, streamline administrative processes, efficiently allocate resources and provide personalized services, and resulting in improved administrative efficiency and student satisfaction. This concept extends to a variety of campus facilities, such as intelligent book borrowing and returning in libraries; automatic food recognition and price calculation in dining halls; access control in academic buildings, dormitories and laboratories; and detect dangerous people in campus with surveillance, all of those examples demonstrate the benefits of AI to campus life in terms of convenient, safety and quality of education.

2.4. Teaching Assessment

In traditional teaching, teachers need to spend a lot of time manually evaluating, grading student homework, test, and paper, etc. Teaching evaluation can automatically help teachers save time, provide feedback, and enhance teaching strategies. AI technologies like prediction systems, image recognition, and computer vision make teaching assessment easier [4]. The main goal of teaching assessment is to comprehensively understand and improve teaching quality, learning effectiveness and educational experience. Teaching evaluation covers not only the evaluation of student learning, but also the evaluation of teaching methods, course content, educational resources and learning environment. The diversity of teaching evaluation methods is increased by AI, resulting in a more scientific evaluation process, and improves the accuracy of assessment outcomes [4,6,7]. Through AI technology, teaching evaluation can provide a comprehensive and broader perspective to guide the improvement and development of teaching quality. Automated grading systems are a very common component, and it mainly focus on using technical tools to simulate the behavior of teachers to provide fast, accurate grading and feedback on students' specific tasks. These systems help provide a better understanding of student learning and achievement levels. At the same time, it solves the shortcomings of traditional teaching evaluation such as time consumption and human error.

3. Impact of AI in education

The advancement of artificial intelligence in education fields offers new ways of working, educational methods, and social interactions. It has enabled personalized learning through platforms like intelligent tutoring systems and adaptive learning, where students can make learning choices based on their own

style and preferences. AI also changed the traditional grading system in education by providing feedback to students and teachers through intelligent assessment systems, and this helps them understand their own situation or drawbacks better.

3.1. Positive Impact

a) Efficiency and Quality of Education: From the viewpoints of teachers and students alike, AI significantly enhances the effectiveness and caliber of education while introducing innovative teaching styles and learning methods. AI is different from traditional teaching situations, by collecting and analyzing large amounts of educational data, it establish links between different data sources and reveal patterns and trends in the learning process. Artificial intelligence technology can provide customized learning plans and resources based on each student's learning ability, knowledge level, and preferences through big data and machine learning technology, thus providing students with a tailored learning experience and shortening the learning time by targeting weak points. This personalized approach helps students learn with greater interest while also improving learning efficiency and quality. Furthermore, AI technology can provide teachers with real-time feedback from students by predict the data to identify student problems. This helps teachers make timely adjustments to their teaching methodology and content, thus improving the teaching efficiency and quality [8].

Artificial intelligence can also help teachers get rid of busy and repetitive tasks by automating many traditionally time-consuming teaching tasks (e.g., grading homework, exams, or essays), allowing educators to invest more time and energy in interacting with students. This enables educators to spend more time focusing on personalized and precise instruction for students, such as the development of students' morals, abilities, and qualities, further improving the quality of teaching. Beyond that, AI can also help educational institutions achieve their stated goals. Utilizing AI maximizes the benefits of data analysis, with the data itself holding the correct answers; it simply requires the application of AI technology to uncover them [9,10,11]. AI can also help leaders of educational institutions manage and lead the institutions more effectively, since it can make optimal decisions based on extensive data analysis to optimize educational resources and strategies to improve the overall efficiency and quality of education (Figure 1).

Student teaching	Student supporting	Teacher supporting	System supporting
• Intelligent tutoring systems (including automatic question generators) • Dialogue-based tutoring systems • Language learning applications (including pronunciation detection)	• Exploratory learning environments • Formative writing evaluation • Learning network orchestrators • Language learning applications • AI Collaborative learning • AI Continuous assessment • AI Learning companions • Course recommendation • Self-reflection support (learning analytics, metacognitive dashboards) • Learning by teaching chatbots	• ITS+learning diagnostics • Summative writing evaluation, essay scoring • Student forum monitoring • AI teaching assistants • Automatic test generation • Automatic test scoring • Open Education Resources (OER) content recommendation • Plagiarism detection • Student attention and emotion detection	• Educational data mining for resource allocation • Diagnosing learning difficulties (e.g. dyslexia) • Synthetic teachers • AI as a learning research tool

Figure 1. AI provides support features for teachers and students to improved efficiency and quality of education [9].

b) Teaching and Learning Experience: AI enhances the teaching and learning experience and supports teachers and students by applying advanced technologies in a variety of ways. AI is crucial in managing campus administration and services since the building of smart campuses involves the use of face recognition, hearing, and sensing technologies [4]. These technologies can ensure that students learn on a safe campus and effectively prevent and recognize potential threats. Face recognition technology is used for identification authentication in dormitories, labs, libraries, and other locations where non-school staff must not be allowed entry. This effectively keeps suspicious individuals who failed the audit out of these spaces [4]. This also effectively prevents students from forgetting their student IDs and being unable to freely access school facilities, or having their student IDs fraudulently used or stolen by others. This will not only improve campus security but also enhance the convenience of students. At the same time, these technologies can be used to monitor and record classroom performance and attendance. This improves management efficiency, reduces labor costs, and prevents the possibility of fraudulent student attendance. Teachers can apply classroom recordings to give comments and feedback, and students can also apply recordings to review the class content, which enhances the teaching experience for both of them.

AI technology also helps to break down geographic and resource differences and achieve a balanced distribution of educational resources through remote personalized teaching and intelligent homework correction, which in turn enhances the teaching experience of each student. Regardless of age, success level, social standing, or financial stability, students can profit greatly from leveraging AI technology, which has the potential to enhance their learning quality and outcomes [11]. Educational resources for children in poorer areas can be significantly scarce compared to those in large cities. Due to geographic problems or economic development, there are educational disparities across different nations and areas [4]. However, AI can break these differences by giving every student fair access to knowledge through online classes taught by the same teachers, as well as gaining interaction with teachers through functions in apps such as online reviews. All of these technologies can help break down regional disparities, which is especially important for regions with different levels of economic development or geographic remoteness. It can greatly even out differences in teacher resources and improve the teaching experience for students in different regions. Figure 2. AI in education market prediction market research future is expected to achieve USD 23.82 billion by 2030, up from USD 3.45 billion in 2023 [7].

Artificial intelligence in education also facing many challenging which contain some negative impacts, particularly concerning data privacy and security, along with issues related to the maturity and scalability of AI applications.

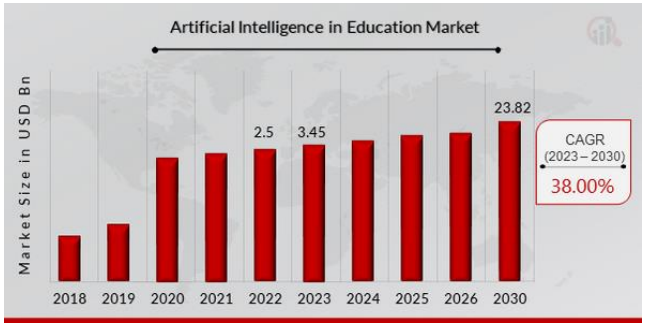

Figure 2. AI in education market prediction market research future [7].

3.2. Negative Impact

a) Data Privacy: The efficiency and training of AI is based on a large database of users. Customized personalized education requires the collection, processing, and analysis of a large amount of personal data, such as browsing history, geographic location, preference settings, and ability level. In case of data leakage, students will not only suffer from psychological and physical shock but also seriously affect the teaching effectiveness and raise concerns. This raises data privacy and security concerns,

including how to protect students' personal information from unauthorized access or misuse. The law requires that educational institutions secure student personal data against loss, damage, and unauthorized access and obtain written authorization for the collection, processing, and use of such data [11]. This represents the need for technical support to ensure the implementation of the policy, the cooperation of educational companies and businesses, and also encryption methods to protect privacy from leakage.

b) The Equality and Inclusion of Education: Moreover, except for the concerns of user privacy and security issues, AI has some important shortcomings in terms of inclusiveness and equality. One of these is data and algorithmic bias, due to the fact that AI systems rely on data to learn and make predictions. The performance of modern AI algorithms, which heavily depend on data, is entirely dictated by the nature of the data itself. Algorithms adjust to the intrinsic quantitative and qualitative properties of the data [6]. When the data is biased, or the data is collected in an incomplete way, then the AI system will inherits these biases when it learns through its algorithms. In an example from Ignazio and Klein [2], Amazon develops a new hiring algorithm to screen job applicants but due to the fact that the algorithm is trained based on previous data where there are far more male applicants than female. As a result, the algorithm learns and replicates this gender bias, thereby unfairly favoring male applicants when screening candidates. In educational applications, this could lead to unfair treatment of certain groups of students because of the algorithm's own biases, such as those based on race, gender, or socioeconomic status.

AI also has the potential to create a digital divide. Given that the underprivileged and marginalized population is more likely to be excluded from AI-powered education, AI has the potential to be a disruptive technology that widens already existing gaps and injustices [8]. This suggests that the lack of necessary infrastructure, Internet access and digital skills leads to marginalised and vulnerable groups at risk of being further excluded from the advantages of AI-driven education. The development of AI poses a risk of creating new technological, economic, and social divides, particularly impacting the least developed countries [8]. Avoiding the emergence of the digital divide requires emphasizing the fundamental values of AI education policy design, with a focus on achieving educational inclusion and equity. Such as tailoring AI to serve vulnerable populations, accelerating digital education in developing countries to close the education gap.

4. Future

The implementation of AI in education is currently in its early stages. However, its future holds significant untapped potential, surpassing the current market dominance characterized by applications in assisted teaching and personalized learning design. As emphasized by Yufeia, Salehb, Jiahuic, and Syed in [10], there is a call for increased focus on interdisciplinary research encompassing educational science and professional science in the development of artificial intelligence education applications. Interdisciplinary research not only aids in broadening students' perspectives and enriching their learning experiences through the integration of knowledge from diverse disciplines but also equips them with the capacity to tackle multifaceted challenges. Therefore, the future trajectory should concentrate on enhancing more models that are both applicable and scalable across various domains.

To facilitate this evolution, novel recommendations are essential to refine and adapt existing models with theoretical underpinnings. This could involve the formulation of innovative teaching strategies, assessment methodologies, and learning materials to ensure that the developed applications effectively cater to educational requirements. Moreover, through interdisciplinary research and the optimization of application models, the scope of AI in education can be expanded, fostering the diversification of educational application scenarios. This expansion transcends traditional classroom learning environments, extending to vocational training, skill acquisition, simulation experiments, and addressing special education needs. This outlook anticipates a future of education that is more dynamic, inclusive, and and responsive to the changing needs of the digital era.

5. Conclusion

Artificial Intelligence has undergone a lengthy development process, from its birth to evolution and innovation. It now plays a revolutionary role in the construction of the educational field and has been applied in many aspects of the educational field, while having great prospects. This paper systematically describes the application of AI in personalized learning to adjust learning according to student's requirements; adaptive learning using technology to change learning content and difficulty dynamically; virtual reality technology for immersive learning experiences and teaching assessment to open up new avenues for assessing students' skills and knowledge acquisition. Those applications have greatly improvement on the efficiency, quality and experience of education. These include: collecting student data and customizing environments for appropriate learning journeys; helping teachers adapt teaching methods and content while also free them from repetitive and time-consuming tasks; helping educational institutions streamline administration and enhance the teaching and learning experience for both students and teachers through advanced technologies. However, AI in education also has its challenges, especially the dilemma of data privacy and the algorithmic bias. If not properly addressed this issued, it could be exacerbate the undermining of equity and inclusion in the education system.

As AI continues to evolve, its application in education will become even more sophisticated in the future. By exploring AI's potential and overcoming the challenges it faces in this process, there will be many new avenues for learning and teaching will open up in the future. Overall, AI in education is a cutting-edge field full of great potential and challenges, and it requires scientists to keep exploring and discovering, as well as reforming and innovating the existing education model.

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