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The Impact of Curriculum Design and Educational Equity in the Age of Artificial Intelligence - A Literature Review

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Abstract: With the rapid development of artificial intelligence (AI) technologies, the education sector is undergoing profound changes, particularly in curriculum design and educational equity. The growing use of AI, including adaptive learning platforms, intelligent tutoring systems, virtual tutors, and immersive education technologies (VR/AR), is driving personalized learning and improving the efficient use of teaching and learning resources. However, the impact of AI in education is not all positive, as it can either create new educational opportunities or exacerbate existing inequities. Through a systematic literature review, this study explores the core applications of AI in curriculum design and analyses its contribution to modern educational equity, while revealing the challenges of the digital divide, algorithmic bias, and technological thresholds that AI may bring. This study aims to provide policymakers, educators and technology developers with a comprehensive understanding of AI's dual impact on educational equity, emphasizing both its benefits and potential risks, to guide the development of policies that enhance the role of AI in promoting educational equity, while preventing it from exacerbating existing inequities.

Keywords: Artificial intelligence (AI), Educational Equity, Curriculum Design, Personalized Learning

1. Introduction

With the advent and development of Artificial Intelligence (AI), it has become a universal force in modern society, penetrating all fields and triggering unprecedented changes in various industries. In this context, the education field will be significantly impacted by the potential of AI. Schools and educational institutions are constantly exploring the integration of AI into curriculum design and teaching practices to drive a paradigm shift in education, opening up possibilities for personalized learning and innovative teaching methods, and breaking through the limitations of the traditional 'one-size-fits-all' teaching model. For example, the Adaptive Learning Platform (ALP) uses AI to create a personalized learning experience. It can accurately analyse each student's learning needs, strengths and weaknesses, intelligently adjust the teaching content and provide personalized feedback to ensure that each student can learn and grow efficiently and effectively in the way that suits him or her best [1]. Intelligent Tutoring System (ITS) is a computer-based learning system that uses AI to provide personalized and adaptive instruction by monitoring student progress, providing feedback, hints, and scaffolding for students, and selecting appropriate questions or tasks for students to practice [2]. However, with the widespread use of AI, the debate on educational equity has become increasingly heated. Potential biases in AI algorithms, the digital divide, and ethical and

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moral issues may exacerbate existing inequities. Therefore, it is crucial to study the application of AI in curriculum design and the process of educational equity in the context of the rapid development of educational technology.

Through a literature review and analysis of existing research findings, this essay systematically analyses and understands the advantages of AI in curriculum design and the promotion of educational equity, and reveals potential inequities and biases, so as to provide valuable insights for policymakers, school administrators, and curriculum designers, and to ensure that AI does not amplify and exacerbate educational inequalities in the process of educational change, but rather, it is a powerful tool.

The main goal of this study is to examine human AI-driven curriculum design and its impact on educational equity in the last decade, i.e., through systematic analysis of the relevant literature, to explore how the use of AI in curriculum design affects educational equity, especially how it can respond to existing inequalities or create new educational inequities.

2. Research Questions

The purpose of this study is to systematically review and analyse existing analyses of the use of AI in curriculum design and its impact on educational equity, with a particular focus on its potential impact on underrepresented student populations and the corresponding ethical and moral issues. This study asks the following core questions:

Firstly, what are the main current applications of AI in curriculum design and teaching practice?

Second, how does AI-powered curriculum design mitigate educational inequalities?

Third, what are the challenges and ethical issues that may arise from the application of AI in education, such as the increasing digital divide, algorithmic bias and data privacy breaches?

3. Literature Review

3.1. Artificial Intelligence and Curriculum Design

Traditional ‘one-size-fits-all’ teaching models are unsuitable for a diverse range of learners, as the abilities of each individual vary greatly [3]. Existing curricula and pedagogy do not allow students to be prepared for an AI-driven future, so there is an increasing need for research and improved technologies [4]. The benefits of AI in education are wide and varied. With the rise of learning in the digital age, educators have begun to take a keen interest in ALP as a way to meet individual needs and improve educational adaptability [1]. The Adaptive Structure Model sets SMART goals, writes module plans, identifies four content pathways, designs course structure and navigation, and in doing so prepares electronic media courses for each content pathway, allowing students to select the appropriate course based on their individual needs for personalized, interactive and dynamic adaptation [5]. Unlike traditional lectures, adaptive learning is dynamic and personalized to meet the unique needs of each learner, helping students to understand the functionality and value of an adaptive learning system, and helping students to make the role transition from ‘passive learners’ to ‘active collaborators’ [6].

Integration of immersive educational technologies, such as VR and AR, into education to engage students in immersive educational experiences, such as virtual field trips, historical event simulations, human body research, and improved science and art learning [7]. The integration of Virtual Reality (VR) with interactive technologies brings a new dimension to the educational experience. AI-powered VR platforms provide immersive learning environments that allow students to explore their learning in 3D space. Interactive technologies powered by AI algorithms provide real-time feedback and adapt to user actions, creating interactive learning experiences that can cater to a wide range of student learning styles and make complex subjects easier to understand [8].

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Intelligent Tutoring Systems (ITS) can be used to simulate one-on-one personal tutoring. Based on learner models, algorithms, and neural networks, they can determine an individual student's learning path and the content to be selected, provide cognitive scaffolding and assistance, and engage students in dialogue. AI chat-bots can provide detailed and personalized guidance and feedback on students' work, highlighting areas for improvement and offering suggestions for further study, helping them to understand challenging concepts and improve their understanding [9].

3.2. Definition and Dimensions of Educational Equity

Educational equity has been one of the central themes in the field of educational research, emphasizing that all students, regardless of their background, should have access to quality education and the possibility of academic success [10]. Unlike educational equality, educational equity recognizes that students have different needs and that it is important to ensure that they receive equal educational outcomes [11]. Its connotation has been enriched with social development and theoretical evolution. This review will sort out educational equity from both theoretical foundations and dimensions.

3.2.1. Theoretical Foundations of Educational Equity

The theoretical foundation of educational equity mainly originates from the fields of philosophy and sociology of which the representative ones are John Rawls' equity theory and Amartya Sen's capability theory.

In A Theory of Justice, Professor John Rawls puts forward two principles to guide a just society, one of which is the ‘principle of equal liberty’, which states that every individual should enjoy the same basic freedoms in the broadest sense as others. The most important part of the second principle is known as the “Difference Principle”, whereby everyone has equal opportunities regardless of status [12-13]. In some countries, fewer resources (including infrastructure, equipment, teachers, supervision and funding) are allocated to disadvantaged, poor and cultural minorities [14]. Rawls' difference principle, on the other hand, argues that policy design should prioritize the needs of disadvantaged students, believing that all students, regardless of origin, race, gender, etc., should have equal access to education [15]. This equality goes beyond the apparent right to education, but requires that the system ensure that everyone has access to schools and quality educational resources.

Amartya Sen's capability approach provides an alternative humanistic perspective on educational equity; Sen's core concepts are ‘function’ and ‘capability’. Functions are the things that a person may value to do or be, the practical realization of a chosen way of life. Capability refers to our freedom to promote or realize valued functions [16]. Most countries are diverse. When curricula are overloaded with content that is the same for everyone, some students, often from rural areas, cultural minorities, or poor populations, find the content taught meaningless [14]. Therefore, equity in education should not be limited to the distribution of resources, but should be based on the actual needs and backgrounds of students, and whether education really enables students to acquire the ability to realize their self-worth [17].

3.2.2. Dimensions of Educational Equity

There are three dimensions of educational equity, including opportunity, resource, and outcome equity. Opportunity equity measures the degree of equality in students' access to educational opportunities, which is commonly used indicators include enrolment rate, dropout rate, promotion rate, etc [18]. The resource equity assesses the distribution of educational resources, including teacher strength, educational funding, teaching facilities, etc. [10]. And the outcome equity focuses

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on students' academic achievement and development opportunities, which is commonly used indicators include academic performance, graduation rate, employment rate, etc. [19].

In addition, some scholars have proposed a multidimensional framework for assessing educational equity. For example, Espinoza proposed an educational equity assessment model that includes four dimensions: opportunity, process, outcome, and impact [20]. In addition, Berne and Stiefel assessed educational equity from three perspectives: horizontal equity, vertical equity, and opportunity equity [21].

3.3. Impact of Artificial Intelligence on Educational Equity.

AI, a cutting-edge force in today's technological development, is accelerating its deep integration into multiple fields, and its potential to reshape the way we teach and learn is particularly significant [22]. AI-powered tools offer new opportunities for equity and inclusiveness in educational selection. For example, in the education admissions process, AI analyses large amounts of applicant data based on data analysis and machine learning to generate detailed candidate profiles and enhance the accuracy of comparisons and decision-making [23]. AI also streamlines the admissions process through algorithms and data analysis to reduce human bias and subjectivity and improve the fairness of the education selection process [24]. AI works to promote equity and inclusion in educational opportunities by providing suitable learning opportunities for marginalized groups, people with disabilities, refugees, out-of-school children, and people living in remote areas. For example, Telepresence Robotics enables special needs students to receive education at home or in hospitals, or to maintain continuity of learning in emergency situations. This approach effectively promotes educational inclusion and enables ubiquitous learning support [25]. In addition, AI is effective in promoting better educational outcomes. For example, AI personalized learning systems support students who can progress at their own pace by analyzing student data, tailoring learning content and accelerating the allocation of differentiated learning programs [26]. This promotes a more equitable and inclusive progression of the educational process.

While AI holds great potential to open up countless possibilities, it can also be a disruptive force that exacerbates existing inequities and divisions. As marginalized and disadvantaged groups are more likely to be excluded from the AI education system, this could lead to the emergence of a new type of digital divide [27]. Thus, AI may unintentionally exacerbate socioeconomic disparities due to its greater tendency to cater to students who are able to use advanced technologies [26]. There are also differences in the use of AI across geographic regions, with urban areas typically having greater access to AI, as opposed to rural or remote areas, which lack infrastructure, expertise and resources. Inequities resulting from this urban-rural digital divide are likely to be exacerbated [28]. Bias in AI, especially as it relates to equity and inclusive education, poses a complex challenge. AI algorithms may perpetuate and exacerbate existing inequalities and discrimination against specific groups of people by inheriting biases in the training data or reflecting the inherent biases of the developers and societies involved in coding [29]. When machine learning algorithms are trained based on a specific data set (e.g., student data from Western European countries), the results they generate may not be directly applicable to students in other regions of the globe.

As the training data set may be biased towards one group, it may lead to inequitable and discriminatory results when applied to other groups [25]. In addition, AI is at risk of data leakage and inconsistent data quality, which may expose sensitive student information and lead to incorrect recommendations, weakening the accuracy and reliability of AI technology [30]. Some of the negative impacts also centre on the interaction between teachers and AI technologies, where over-reliance on AI may diminish the role of teachers, reduce the humanistic and empathy dimensions of education [31], and even seriously undermine important traditional pedagogy and the development of critical thinking and problem-solving skills [32]. For example, if students

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constantly have access to solutions or information easily through the help of AI, they may not understand the topic in depth [9]. Therefore, when exploring the potential of AI for educational equity, it is also important to be wary of the risks of inequity and ethical challenges it may pose.

4. Discussion and Recommendation

This study reviews the English literature in journal articles, conference papers, dissertations, and research reports in the fields of education, computer science, sociology, psychology, and other related disciplines from 2014 to 2024. It also identifies keywords, such as 'artificial intelligence (AI)', 'curriculum design', 'educational equity', 'curriculum design', 'personalized learning', 'digital divide', and so on. It can be concluded that with the rapid development and innovation of technology, education, as one of the important application scenarios of AI, is experiencing unprecedented changes.

From the literature reviewed and analyzed, there are two sides to the impact of AI on educational equity, which can either promote equity or exacerbate inequality.AI has significant advantages in expanding access to education, especially in rural and developing countries, where distance learning and smart tutoring systems lower geographic and resource barriers and provide wider learning opportunities for disadvantaged groups. In addition, AI-personalized learning systems can help students with learning difficulties or special needs by providing personalized learning paths through data analysis to enhance learning outcomes. However, the spread of AI may instead widen the education divide, giving affluent students a greater advantage while disadvantaged groups face greater barriers to learning and are further marginalized. In addition, bias in AI training data may affect the fairness of the algorithms in terms of course recommendations, learning assessments, etc., affecting the educational opportunities of minority groups. Although AI can reduce teachers 'workload and improve teaching efficiency, over-reliance on AI may weaken teacher-student interactions, reduce emotional connections in education, and weaken students' critical thinking and independent learning abilities. Thus, it is clear from the analysis that AI is having a significant impact on the education industry, especially in the area of educational equity

In terms of recommendations, policymakers and education practitioners need to take concrete steps to minimize the risk of inequality that AI may pose. Governments can invest more in digital education infrastructure in rural and remote areas to ensure that all students have equitable access to AI-enabled learning opportunities. Technology developers and educational institutions should collaborate to optimize the design of AI algorithms and reduce the negative impact of algorithmic bias on educational equity through diverse training data and rigorous algorithm review. Schools, governments, tech companies and social organizations should strengthen cooperation to promote the equitable application of AI in education and guarantee that AI can serve all students.

Based on these findings, future research needs to further explore the potential and challenges of AI in education, especially the performance of equity in different cultural contexts, and how to safeguard educational equity through technology and policy synergy. It is recommended that AI equity research in cross-cultural contexts be conducted to explore in depth how AI performs in educational equity in the cultural contexts of different countries or regions. Educational resources, technological infrastructure and socioeconomic conditions vary widely in different regions, and the effects of AI application may also vary. In addition, future research should focus on ethical issues in AI curriculum design, such as algorithmic bias, data privacy protection, and equity, and explore how to safeguard the equity of AI in education through the synergy of technology optimization and policy. In particular, research should focus on possible biases in AI course recommendations and learning assessments to avoid inequitable impacts on certain groups of students.

Through the multi-party collaboration of academic research, policymaking and practical exploration, AI is expected to provide new possibilities for the realization of global educational

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equity, while avoiding its potential risks and challenges. Only with the joint efforts of technology, policy, and society can AI truly empower education and help every student get a chance to learn equitably.

5. Conclusion

This study explored the application of AI in curriculum design and its dual impact on educational equity by systematically combing and analyzing the existing literature. Existing literature suggests that AI is being widely used in areas such as adaptive learning platforms, intelligent tutoring systems, virtual tutors, and immersive educational technologies (VR/AR), driving changes in teaching and learning models. These enable personalized learning and optimize the allocation of educational resources. However, the role of AI in educational equity is not all positive; it presents both opportunities and accompanying challenges. On the one hand, AI broadens access to education for students in rural and developing countries, advancing the cause of educational equity. On the other hand, the digital divide, algorithmic bias, and issues of technological thresholds and over-reliance may allow AI to further exacerbate educational inequalities. Therefore, the application of AI curriculum design needs to find a balance between technological innovation and educational equity.

Despite its contributions, this study has several limitations. First, the study relies heavily on a systematic review of existing literature and lacks empirical data or primary research, which may limit the depth and applicability of the findings. Second, the study focuses on English-language literature published between 2014 and 2024, which may have overlooked relevant studies published in other languages or earlier. Third, although the study emphasized the global perspective of AI and educational equity, it may not have adequately considered regional or cultural differences, which may affect the general applicability of the findings. Future research should address these shortcomings through cross-cultural studies, empirical investigations, and a broader review of the literature to increase the comprehensiveness and relevance of the findings.

Overall, AI is profoundly affecting the education industry, especially in the area of educational equity, which brings both opportunities and challenges. Future research and policy-making should focus on how to optimize the equitable distribution of AI resources, reduce algorithmic bias, and ensure that AI does not undermine the central role of teachers while empowering education. Policymakers, educational institutions, and technology developers need to work together to ensure that AI can close the education gap while driving change in education. It is only through the combined efforts of technology, policy and educational practice that AI can truly become an important force for educational equity, rather than a tool for exacerbating educational inequity.

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