

Ethical Analysis of Ethical Issues and Countermeasures in Education in the Era of Artificial Intelligence

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Abstract: The integration of artificial intelligence (AI) in education has revolutionized teaching and learning methodologies, offering personalized experiences and efficient resource management. However, this technological advancement has also surfaced a plethora of ethical concerns that necessitate careful consideration. This paper delves into the ethical issues arising from AI applications in education, such as data privacy, algorithmic bias, educational equity, and the evolving role of teachers. Through a comprehensive analysis, we identify the challenges and propose strategic countermeasures to mitigate these ethical dilemmas. Case studies from both domestic and international contexts are employed to illustrate real-world applications and the associated ethical decision-making processes. The paper concludes with a summary of findings, policy recommendations, and an outlook on future research directions, emphasizing the need for a balanced approach that respects both technological innovation and ethical standards in educational AI deployment.

Keywords: Artificial Intelligence; Educational Ethics; Data Privacy; Algorithmic Bias; Educational Equity; Teacher Role Evolution

1 Introduction

1.1 Research Background

With the rapid development of artificial intelligence (AI) technology, its application in the field of education is becoming increasingly widespread. From intelligent tutoring systems to the design of personalized learning paths, AI is transforming traditional educational models. However, the introduction of these technologies has also raised a series of ethical issues, such as data privacy, algorithmic bias, educational equity, and the transformation of the teacher's role. These issues are not only related to the effectiveness and safety of the technology but also to the fairness and sustainability of education.

1.2 Significance of the Study

This study aims to explore the ethical issues arising from the application of artificial intelligence in the field of education and analyze the impact of these issues on educational practice and policy-making. Through in-depth analysis of these issues, guidance can be provided for educators, policymakers, and technology developers to ensure the reasonable, fair, and responsible use of AI technology.

1.3 Research Objectives and Questions

The main purpose of this paper is to identify and analyze the main ethical issues faced by the application of artificial intelligence in education and propose corresponding solutions. Research questions include: How does artificial intelligence affect the privacy and security of educational data? How does algorithmic bias affect educational equity? How does artificial intelligence change the role and responsibilities of teachers? And how to formulate effective policies to address these ethical challenges?

2 Application of Artificial Intelligence in Education

2.1 Overview of Artificial Intelligence Technology

Artificial Intelligence (AI) is a branch of computer science dedicated to the development of algorithms and computer systems that perform tasks typically requiring human intelligence. The essence of AI lies in its ability to simulate cognitive functions such as perception, reasoning, learning, and problem-solving.

The foundation of AI technology rests on algorithms capable of processing and analyzing data to make decisions or predictions. Machine Learning (ML), a significant subset of AI, focuses on developing algorithms that enable computers to learn from data and enhance their performance.

Machine Learning: Algorithms that allow computer systems to improve automatically through experience, encompassing various forms such as supervised learning, unsupervised learning, and reinforcement learning.

Deep Learning: A special machine learning technique using neural network structures similar to the human brain to handle complex data patterns, achieving notable success in fields like image and speech recognition.

Natural Language Processing (NLP): Technology that enables computers to understand, interpret, and generate human language, widely used in machine translation, sentiment analysis, and chatbots.

Computer Vision: Technology that allows computers to "see" and comprehend the content in images and videos, essential for applications like autonomous vehicles, facial recognition, and medical imaging analysis.

Expert Systems: Systems that simulate the decision-making capabilities of human experts, solving specific domain problems through knowledge bases and inference engines.

Advancements in AI technology have been remarkable over the past few decades, especially with the increase in computing power and the accessibility of big data. These developments have allowed AI systems to tackle more complex tasks and achieve breakthroughs in multiple domains, including education. The application of AI in education is altering the way teaching and learning are conducted, providing personalized learning experiences, and optimizing educational strategies through data analysis.

While AI offers immense potential and benefits, it also raises a range of ethical and social issues, including privacy concerns, the need for transparent algorithms, bias and discrimination, and changes in the job market. Addressing these issues requires a concerted effort from all sectors of society to ensure the healthy development and responsible application of AI technology.

2.2 Case Studies of AI in the Education Sector

The application of AI in the education field is maturing, with several representative real-world cases as follows:

Adaptive Learning Platforms: Knewton is an adaptive learning platform that uses ML algorithms to analyze students' learning behaviors and adjust course content and difficulty based on each student's proficiency. This personalized learning path helps students master knowledge more effectively.

Intelligent Tutoring Systems: Photomath is a popular mobile application leveraging computer vision and ML to identify and solve math problems. By photographing a math problem with a smartphone, students can receive detailed steps and explanations.

Virtual Teaching Assistants: At Georgia Tech, a virtual teaching assistant named Jill Watson is used for online courses. Based on IBM Watson technology, Jill can automatically answer students' forum questions, reducing the burden on teachers.

Intelligent Assessment Tools: Turnitin is a widely used tool for academic integrity and writing assistance, employing AI to detect plagiarism and provide writing feedback. By analyzing students' texts against a database, Turnitin helps teachers ensure academic honesty.

Language Learning Applications: Duolingo is a popular language learning app that combines gamification elements with AI to offer personalized learning experiences. By analyzing user behaviors, Duolingo adjusts course difficulty and content to fit different users' needs.

Personalized Recommendation Systems: Coursera is an online learning platform that uses AI to recommend courses to students. Based on interests, learning history, and career goals, Coursera can provide personalized course suggestions.

Intelligent Classroom Management: Smart Sparrow is an intelligent educational platform allowing teachers to create interactive courses and adjust content in real-time based on student interactions and performance. This real-time feedback mechanism helps improve teaching effectiveness.

Educational Robots: Squirrel AI is a K-12 education-focused company that has developed an intelligent educational robot providing personalized learning resources and tutoring based on students' real-time performance.

These cases illustrate the diverse applications of AI in education, from personalized learning to intelligent assessment, virtual assistants, and smart classroom management. AI is becoming a significant driver of educational innovation. However, with the widespread application of these technologies, discussions on data

privacy, algorithmic transparency, and educational equity are also emerging, and these ethical issues need to be properly addressed during implementation.

2.3 Potential Impact of AI on Education

The application of AI in the field of education is triggering an educational revolution, with potential impacts that are multidimensional, including the following aspects:

Personalized Learning Experiences: AI can provide customized learning content and teaching methods based on students' study habits, ability levels, and interest preferences.

Improvement of Teaching Efficiency: AI technologies, especially intelligent assessment tools and virtual assistants, can automate many teaching management tasks.

Optimized Allocation of Educational Resources: AI can help educational managers allocate resources more effectively through data analysis and learning management systems.

Promotion of Educational Equity: AI technologies can help bridge the educational gap between students from different regions and backgrounds by providing remote education and personalized learning opportunities.

Innovation in Educational Content and Methods: The development of AI technologies has driven innovation in educational content and teaching methods.

Ethical and Privacy Issues: The collection and use of student data have become increasingly common with the application of AI in education.

The Importance of Lifelong Learning: The development of AI also emphasizes the importance of lifelong learning.

Socio-economic Impact: The impact of AI on education extends beyond schools and classrooms, potentially having profound effects on society and the economy.

3 Ethical Issues in Education in the Age of Artificial Intelligence

As artificial intelligence technology is widely applied, the field of education is also facing a series of ethical challenges that require our serious attention and resolution.

3.1 Data Privacy and Security Issues

The application of artificial intelligence in the field of education, while providing strong support for personalized learning, also brings challenges in terms of data privacy and security.

Transparency of Data Collection: AI systems need to collect a large amount of student data, including personal information, learning behavior, and performance, to provide personalized learning experiences. The collection of this data often lacks transparency, and students and parents may not be clear about the purpose, scope, and storage method of data collection.

Risk of Data Breaches: Data breaches in the field of education may lead to the misuse of students' personal information by criminals, resulting in serious consequences. For example, once students' contact information and home addresses are leaked, they may be at risk of fraud and harassment.

Concerns about Data Misuse: Even if the data is not leaked, the issue of data misuse is also worth paying attention to. Some educational institutions or third-party service providers may use student data without authorization for commercial promotion or

other purposes, infringing on students' privacy rights.

Challenges of Data Protection Regulations: Different countries and regions have different regulations on data protection, which poses compliance challenges for cross-border educational service providers. How to ensure the global flow and use of data while complying with local regulations is an urgent problem to be solved.

Insufficient Technical Protection Measures: Despite continuous technological advancements, there are still deficiencies in protection measures such as data encryption and access control. Educational institutions need to invest more resources to strengthen technical protection to prevent unauthorized access or tampering with data.

Educators' Sense of Responsibility: Educators bear an important responsibility in the issues of data privacy and security. They need to understand relevant data protection regulations, properly manage student data, and educate students on how to protect their privacy.

Solutions and Best Practices

To address data privacy and security issues, educational institutions and technology developers can take the following measures:

Enhance the transparency of data collection and use, clearly informing students and parents about the purpose and scope of data collection and use.

Strengthen data protection technology, such as using encrypted storage and transmission of data, implementing strict access control and audit mechanisms.

Comply with data protection regulations to ensure that data processing activities meet local and international legal requirements.

Provide data privacy education to cultivate students' awareness and ability to protect their data.

Establish an emergency response mechanism to take quick action in the event of a data breach or other security incidents to mitigate the impact.

3.2 Algorithmic Bias and Discrimination

The application of artificial intelligence algorithms in the field of education, while bringing many conveniences, may also trigger issues of algorithmic bias and discrimination, which may affect students' educational opportunities and outcomes.

Analysis of Causes: If the data set used to train the algorithm is not diverse enough or has biases, the algorithm may learn and amplify these biases, leading to unfair treatment of certain groups.

Design of Algorithms: The algorithm design process may not fully consider diversity and inclusiveness, leading to unequal results when processing data from students with different backgrounds.

Lack of Transparency: The decision-making process of many algorithms is not transparent, making it difficult for educators and students to understand the working principles and basis for decisions.

Impact Discussion

Inequality in Learning Opportunities: Algorithmic bias may lead to some students receiving more learning resources and opportunities, while others are neglected.

Unfair Assessment Results: In automated assessment systems, algorithmic bias may affect students' grades and feedback, thereby affecting their motivation and self-perception.

Limitations in Career Development: Students affected by algorithmic bias over the long term may encounter obstacles in career development, as these biases may affect their educational

paths and career choices.

Resolution Strategies

Diversify Data Sets: Ensure that the data sets used for training algorithms are representative and diverse to avoid data set biases.

Algorithm Fairness Testing: Regularly test algorithms for fairness to identify and correct potential biases.

Algorithm Transparency: Improve the transparency of algorithms so that educators and students can understand the working principles and decision-making processes.

Multi-Party Participation: Encourage students, parents, educators, and technology developers to participate in the design and evaluation process of algorithms to ensure their fairness and applicability.

Policies and Regulations: Develop and implement relevant policies and regulations that require educational institutions to consider algorithmic bias and discrimination issues when using artificial intelligence technology.

Case Studies

Gender Bias: Some language processing algorithms may exhibit gender bias when assessing students' writing, such as giving higher scores to compositions that use certain gender-specific vocabulary.

Racial Bias: In some cases, algorithms may provide different learning suggestions or assessment results based on students' racial backgrounds, which may exacerbate educational inequality.

Future Outlook

As artificial intelligence technology continues to develop, the issues of algorithmic bias and discrimination will require ongoing attention and research. The field of education needs to continuously update its methods and tools to ensure that technological advancements promote fairness and inclusiveness in education.

3.3 Issues of Educational Equity

The introduction of artificial intelligence technology aims to improve the quality of education through personalized learning, but it also brings a series of issues related to educational equity.

Inequality in Access to Technology: There are significant differences in the access to artificial intelligence technology among different regions, economic levels, and social groups. This may lead to regions or groups with abundant technological resources gaining more educational opportunities, while those with scarce resources are at a disadvantage.

Personalized Learning and Educational Differentiation: AI systems provide personalized learning resources and suggestions by analyzing students' learning behaviors and grades. However, this personalization may lead to an expansion of learning gaps between students, especially when the system fails to properly identify and support students with learning difficulties.

Fairness Issues in Algorithmic Decisions: The use of artificial intelligence in educational assessment and resource allocation may be affected by algorithm design and data bias, leading to unfair decision outcomes. For example, automatic grading systems may not fully consider students' special circumstances, leading to unfair grading.

Digital Divide and Educational Opportunities: The digital divide refers not only to the inequality in access to technology but also to the differences in the ability to use technology and information literacy. In the age of artificial intelligence, these differences may prevent some students from fully utilizing the

educational opportunities brought about by technology.

Resolution Strategies

Improve Technology Accessibility: Governments and educational institutions should strive to improve the accessibility of artificial intelligence technology, especially in remote and impoverished areas, to ensure that all students can access these technologies.

Design Fair Algorithms: When designing artificial intelligence algorithms, consider their impact on educational equity to ensure that algorithms can serve all students fairly, regardless of their background.

Strengthen Teacher Training: Teachers play a key role in promoting educational equity. Strengthen teacher training in the application of artificial intelligence in education so that they can use technology to support all students more effectively.

Develop Inclusive Policies: Policymakers should develop inclusive policies to ensure that the development and application of artificial intelligence technology do not exacerbate educational inequality but promote educational equity.

Promote Community Participation: Encourage community participation in the design and evaluation process of artificial intelligence applications in education to ensure that technological solutions meet the needs of different communities.

Case Analysis

Specific cases can be analyzed, such as a government project in a certain area providing tablets and internet access to students from low-income families to narrow the digital divide. Or discuss some failed cases, such as some personalized learning systems failing to identify and support students with learning difficulties, leading to educational differentiation.

Future Outlook

As artificial intelligence technology continues to develop, issues of educational equity will require ongoing attention and research. The field of education needs to continuously update its methods and tools to ensure that technological advancements promote fairness and inclusiveness in education.

4 Analysis of Countermeasures to Ethical Issues

In response to the ethical issues triggered by the application of artificial intelligence in the field of education, it is crucial to take the following measures to ensure that the application of technology is both efficient and ethically sound.

4.1 Strengthening Data Protection and Privacy Policies

Policy Formulation: Develop comprehensive data protection policies that clarify the purpose, scope, and storage period of student data collection.

Technical Enhancement: Adopt advanced data encryption technologies, such as end-to-end encryption, to ensure the security of data during transmission and storage.

Access Control: Implement strict access control policies to ensure that only authorized personnel can access sensitive data.

Regular Review: Establish a regular review mechanism to assess the effectiveness of data protection measures and adjust according to new security threats.

4.2 Transparency and Fairness of Algorithms

Transparency Improvement: Develop user-friendly interfaces and documentation that clearly show the working principles and decision basis of algorithms to educators and students.

Fairness Assessment: Establish an independent algorithm review committee to regularly audit algorithms to ensure their decision-making process is fair and unbiased.

Open Design: Encourage the development of open-source algorithms so that the academic community and the public can participate in supervising and improving the fairness of the algorithms.

4.3 Measures to Promote Educational Equity

Equal Access: Ensure that all schools, regardless of geographical location or economic status, have access to the necessary artificial intelligence educational resources and technical support.

Resource Allocation: Provide special funding for technology-deficient areas through the support of governments and non-governmental organizations to narrow the digital divide.

Inclusive Design: Develop educational software and tools suitable for different abilities and learning styles to ensure that all students can benefit.

4.4 Professional Development of Teachers and Ethical Education

Continuous Training: Provide regular training for teachers on the use of artificial intelligence tools and ethical issues to help them adapt to technological changes.

Integration of Ethical Education: Include ethical education modules in teacher education courses, covering topics such as artificial intelligence ethics, data privacy, and algorithmic fairness.

Teacher Participation: Encourage teachers to participate in the design and evaluation process of artificial intelligence educational applications, enabling them to provide constructive feedback on the application of technology.

Cross-disciplinary Collaboration

Promote cooperation between experts in education, technology, law, and ethics to jointly develop and implement comprehensive ethical strategies.

Policy and Regulation Development

Cooperate with policymakers to formulate and update policies and regulations related to the application of artificial intelligence in education to address emerging ethical challenges.

Public Awareness Enhancement

Raise public awareness of ethical issues in the application of artificial intelligence in education through public lectures, seminars, and media promotion.

Case Study and Best Practice Sharing

Conduct regular case studies to analyze successful ethical practices and share these best practices in the educational community.

Ethical Impact Assessment

Conduct ethical impact assessments before introducing new artificial intelligence educational tools or systems to predict and mitigate potential ethical risks.

5 Analysis of Domestic and International Cases of Artificial Intelligence Application in Education

5.1 Domestic Case Analysis

Case One: Intelligent Tutoring System

Background: An online education platform in China has developed an intelligent tutoring system using artificial intelligence technology to provide a personalized learning experience for students.

Application: The system adjusts teaching content and difficulty by analyzing students' learning data, such as test scores, homework performance, and online interactions.

Success: The system has significantly improved students' learning efficiency and grades, receiving widespread praise from students and parents.

Challenges: In terms of data privacy protection, the system needs to ensure the security of student information to prevent data leakage and misuse. The fairness of the algorithm is also a major challenge, ensuring that the system does not generate unfair learning recommendations due to data bias.

Case Two: Adaptive Learning Platform

Background: A university has developed an adaptive learning platform to provide customized learning resources for students from different majors.

Application: The platform uses machine learning algorithms to analyze students' learning behavior and grades, automatically recommending courses and materials suitable for their learning level and interests.

Success: The adaptive learning platform has helped students master professional knowledge more effectively, improving learning satisfaction and graduation rates.

Challenges: In terms of resource allocation, the platform needs to ensure that all students can access learning resources fairly, avoiding exacerbating educational inequality due to technological reasons.

International Case Analysis

Case Three: Knewton

Background: The American educational technology company Knewton has developed an adaptive learning system using machine learning technology to provide a personalized learning experience for students worldwide.

Application: The Knewton system adjusts learning content and difficulty by analyzing students' online learning behaviors, such as click-through rates, reading time, and test scores.

Success: The Knewton system has been widely applied worldwide, helping students achieve excellent results in various exams.

Challenges: In terms of data privacy, Knewton needs to comply with privacy protection regulations in different countries to ensure the security of student data. In addition, the transparency and fairness of the algorithm are also major issues it faces.

Case Four: Georgia Tech's Jill Watson

Background: Georgia Tech has developed a virtual teaching assistant, Jill Watson, using IBM Watson technology to provide real-time Q&A services for students in online courses.

Application: Jill Watson analyzes students' questions on

the forum, providing accurate answers and explanations, greatly improving students' interactive experience.

Success: The introduction of Jill Watson has reduced the workload of teachers, allowing them to focus more on teaching and research. At the same time, students also welcome this new interactive method.

Challenges: In terms of ethics, the introduction of Jill Watson has sparked discussions about the role and responsibilities of teachers. Teachers and students need to adapt to the new way of cooperating with the artificial intelligence system and redefine their roles and responsibilities.

Case Summary

By comparing different cases at home and abroad, it can be seen that the application of artificial intelligence in the field of education has great potential, but it is also accompanied by ethical issues such as data privacy, algorithmic fairness, and educational equity. These cases provide us with valuable experience and lessons, which help us to better apply artificial intelligence technology in future educational practices and solve related ethical issues.

5.2 Ethical Decision-Making Process in Cases

In the case of the application of artificial intelligence in education, the ethical decision-making process is a key step to ensure that the application of technology complies with moral and social standards. Here is a discussion of some specific case analyses and ethical decision-making processes.

Case One: Intelligent Tutoring System

Background: An online education platform has developed an intelligent tutoring system using artificial intelligence technology, aiming to provide students with a personalized learning experience.

Ethical Decision-Making Process:

Data Collection and Privacy Protection: When designing the system, the first consideration is how to collect students' learning data while ensuring the privacy and security of this data. Decision-makers need to balance the needs of personalized learning with the protection of students' privacy rights.

Algorithm Fairness: The system requires a large amount of data to train the algorithm, and decision-makers must ensure the diversity and representativeness of this data to avoid algorithmic bias and discrimination.

Resource Allocation: In terms of resource allocation, decision-makers need to consider how to provide learning resources fairly to all students to avoid exacerbating educational inequality due to technological reasons.

Case Two: Adaptive Learning Platform

Background: A university has developed an adaptive learning platform to provide customized learning resources for students from different majors.

Ethical Decision-Making Process:

Transparency: The platform needs to clearly explain its working principles and recommendation logic to students and teachers to enhance transparency so that users can understand and trust the system.

Fairness: When recommending learning resources, the platform needs to consider the needs of students from different backgrounds to ensure that all students can access resources suitable for their learning level and interests.

Teacher Role: Decision-makers need to consider the role of teachers in the adaptive learning process, ensuring that teachers can

effectively cooperate with the system rather than being replaced by it.

Case Three: Knewton

Background: The American educational technology company Knewton has developed an adaptive learning system using machine learning technology.

Ethical Decision-Making Process:

Compliance with Data Privacy Regulations: Knewton needs to comply with privacy protection regulations in different countries to ensure the security and lawful use of student data.

Algorithm Transparency: To enhance user trust in the system, Knewton needs to explain the working principles and recommendation logic of its algorithms to users.

International Cooperation: When promoting the system in different countries, Knewton needs to consider cultural differences and educational needs, adjusting algorithms to adapt to different education systems.

Case Four: Georgia Tech's Jill Watson

Background: Georgia Tech has developed a virtual teaching assistant, Jill Watson, using IBM Watson technology.

Ethical Decision-Making Process:

Teacher-AI Collaboration: Decision-makers need to consider how to define the cooperative relationship between teachers and virtual teaching assistants, ensuring the leading role of teachers in the teaching process.

Student Trust: To enhance student trust in the virtual teaching assistant, decision-makers need to ensure that Jill Watson provides accurate and reliable answers and clearly states its virtual identity.

Responsibility Attribution: In the process of virtual teaching assistants participating in teaching, decision-makers need to clarify the attribution of responsibility to ensure timely resolution in case of problems.

Case Summary

Through the analysis of the ethical decision-making process in these cases, we can see that the application of artificial intelligence in the field of education requires a comprehensive consideration of various ethical issues such as data privacy, algorithmic fairness, educational equity, and the role of teachers. Decision-makers need to find a balance between technological development and ethical standards to ensure that the application of artificial intelligence technology can enhance the quality of education while also complying with social ethics and legal requirements.

6 Conclusion and Recommendations

6.1 Research Summary

This study comprehensively examines the ethical issues

brought about by the application of artificial intelligence in the field of education. Through literature review, case analysis, and discussion of the ethical decision-making process, we have revealed key ethical issues such as data privacy, algorithmic bias, educational equity, and the transformation of the teacher's role. The study emphasizes the necessity of formulating and implementing comprehensive data protection policies, enhancing algorithmic transparency, ensuring educational equity, and strengthening the professional development of teachers. Case studies further demonstrate the manifestations and potential impacts of these ethical issues in actual educational scenarios.

6.2 Policy Recommendations

Formulate comprehensive data protection policies that clarify the rules for the collection, use, and storage of student data, ensuring data security and privacy.

Promote algorithmic transparency and fairness by establishing third-party review mechanisms to assess and correct biases and discrimination in algorithms.

Take effective measures to promote educational equity, including providing equal access to artificial intelligence educational resources and opportunities, especially for resource-poor areas and groups.

Strengthen the professional development of teachers by providing continuous training and education to enhance their understanding and use of artificial intelligence tools, as well as their ability to identify and handle ethical issues.

6.3 Research Limitations and Future Prospects

Although this study provides an in-depth analysis of the ethical issues in the application of artificial intelligence in education, there are some limitations. For example, the study may not cover all ethical issues in different cultural and social contexts, and with the rapid development of technology, some emerging issues may not have been fully explored. Future research should focus on the following directions:

Continuously monitor the latest developments in artificial intelligence technology and assess its long-term impact on educational ethics.

Explore the ethical issues of artificial intelligence applications in special education needs to ensure that the development of technology benefits all students.

Promote interdisciplinary cooperation, combining knowledge from fields such as education, computer science, and ethics, to jointly address ethical challenges.

Strengthen international cooperation, share best practices, and jointly formulate global ethical guidelines for the application of artificial intelligence in education.

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