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Exploring the Applications and Challenges of ChatGPT in Educational Contexts

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Abstract. In the 21st century, Artificial Intelligence (AI) technology has profoundly revolutionized the education model, and the birth of ChatGPT has triggered extensive attention and practice in the education field. Its application has shown opportunities in helping personalized learning, improving teaching efficiency, and promoting the universalization of resources. Still, it is also accompanied by challenges such as an academic integrity crisis and technological limitations, so it is imperative to clarify its educational value and risks and explore the path of human-machine collaboration. In this paper, we analyze the technical characteristics of ChatGPT, systematically sort out the advantages of its educational applications, meticulously explore the challenges it faces, and put forward human-machine synergy strategies such as reconfiguring the role of teachers, optimizing the technical functions, and innovating the institutional norms. The research results provide comprehensive decision-making references for educators, policymakers, and technology developers, help promote the high-quality development of education in the digital era, and help build a new education ecosystem that combines efficiency and fairness, innovation and standardization.

Keywords: ChatGPT, educational applications, ethical challenges, personalized learning, teacher role.

1. Introduction

The penetration of artificial intelligence (AI) technology in education has been deepening since the 21st century, from early intelligent question banks to today's high-profile generative dialog models, which continue to drive changes in the education model. 2022 saw the launch of OpenAI's ChatGPT, which sparked widespread attention globally for its superior language generation and interaction capabilities. By 2025, the percentage of teenagers using ChatGPT to assist in their studies has risen significantly, jumping from 13% to 26% in 2023, highlighting the development of AI technology from the edge to the core of educational scenarios. The education community has mixed attitudes toward the adoption of ChatGPT, with both anticipation and skepticism. Expectations stem from its potential to revolutionize teaching efficiency, promote the universalization of educational resources, and inject new momentum into educational development; doubts are mainly focused on the academic integrity crisis and technological limitations brought about by ChatGPT, which may have an impact on the traditional order of education and the development of students. For example, there

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have been indications that the content generated by ChatGPT can pass basic academic tests, raising concerns about ghostwriting. At the same time, its technological limitations also affect the accuracy of knowledge transfer and the provision of emotional support. Against this background, it has become a key issue in the field of education to explore the application of ChatGPT in education, analyze its advantages and challenges, and explore the future path of human-computer collaboration. In this paper, we will start from the dimensions of technical characteristics, educational applications, challenges, and coping strategies to conduct comprehensive and systematic research, to provide valuable references for educators, policymakers, and technology developers, and assist the high-quality development of education in the era of Artificial Intelligence. Application of ChatGPT in the field of education

2. Literature review

2.1. The application of ChatGPT in the field of education

At present, research on the application of generative artificial intelligence in the field of education has been accumulated on a certain scale at home and abroad. Zhu Guanghui et al. pointed out that ChatGPT, as a typical application in the field of natural language processing, has demonstrated excellent language processing capabilities relying on advanced algorithms, powerful arithmetic power, and massive data support [1]. Lu Yu et al. further added that the technology can not only generate logical and stylized textual content by self-adjustment in human language tasks but also realize basic translation, creation, and code-writing functions [2]. At the level of teaching mode change, Feng Yuhuan's research shows that the new generation of AI technology represented by ChatGPT is promoting the transformation of traditional education to online, informatization, and personalization. Its dual roles of both teachers' digital assistants and students' virtual tutors have injected new kinetic energy into the innovative development of education patterns [3]. In the dimension of educational equity and inclusion, Hu Xiaoyong et al. emphasized that ChatGPT has a positive significance in alleviating the problem of unequal educational opportunities by breaking through the technological characteristics of time and space limitations, providing a new path to promote the balanced distribution of educational resources [4]. Yang Zongkai focuses on personalized learning scenarios and proposes that with the help of a human-computer dialogue interaction mechanism, ChatGPT can dynamically monitor the learning process, capture learning needs analyze the behavioral patterns, and then accurately push the appropriate learning resources to meet the diversified academic needs of students [5]. Li Yi et al. pointed out from the perspective of teachers that technology can provide educators with real-time, intelligent feedback on learning conditions, help achieve the goal of teaching according to the student's ability, and promote the formation of a “student-centered” closed loop of education [6].

2.2. Challenges of ChatGPT in education

Although ChatGPT brings unprecedented opportunities for education model innovation, it is also accompanied by multiple real-world challenges. Zhou Hongyu et al. pointed out that the technology is prone to information screening dilemmas due to the lack of knowledge source annotation and doubtful content accuracy - unstructured output knowledge often lacks clear source traceability, and the generation of erroneous or one-sided content may mislead cognitive judgment, which directly impacts the authenticity of the knowledge transfer in the education process, and then affecting the realization of educational equity [7]. Guo Yuanxiang et al., on the other hand, start from the

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structural contradiction of technology popularization and emphasize that there are significant resource barriers in the application of ChatGPT: its development and maintenance of high requirements for technology and funds, resulting in the natural disadvantage of poverty-stricken areas and disadvantaged groups in the acquisition of technology; even if the basic application is realized, the differences in digital literacy among different groups will also result in the divergence of the effectiveness of the use of technology, which will ultimately exacerbate the impact of the digital divide in the education field [8]. The digital divide is projected in the educational field, forming a new dimension of inequality [9]. Wu et al. further reveal the deep-seated risks of technology application, pointing out the algorithmic black box, potential discrimination, and privacy and security risks that are exposed in the process of its use - opaque algorithmic decision-making mechanisms may lead to hidden bias in the delivery of educational resources, and security vulnerabilities in data collection and processing pose a threat to the protection of personal information of teachers and students, which are endogenous to technology. These endogenous issues need to be systematically regulated [8].

3. Discussion

3.1. Technical characteristics and educational adaptability of ChatGPT

ChatGPT relies on the advanced large-scale pre-trained language model (LLM) architecture, and with the help of massive data for training, it can generate logically coherent and naturally expressed text content. Its core advantages are significant, with interdisciplinary knowledge coverage, instant and accurate knowledge retrieval and output; support for natural language interaction, which can highly simulate the thinking process and dialogue mode of human Q&A; through model fine-tuning, it can be flexibly adapted to a variety of educational application scenarios, such as language learning, STEM education, etc., which fully demonstrates its strong adaptability to educational scenarios and its integration capabilities.

3.2. Technology needs for educational change

The theory of technological demand for educational change is a theoretical framework that reveals the interaction mechanism between the educational system and technological innovation, focusing on the inherent demand for technological application in the process of educational development and how technology can satisfy the demand to drive change. The theory points out that as the goal of education evolves in the direction of cultivating innovative ability and personalized development, education generates clear technological needs in terms of improving teaching efficiency, balanced allocation of resources, and optimizing the learning experience. Technology responds to these needs by providing intelligent teaching tools, digital learning environments, and accurate evaluation systems, and promotes the innovation of teaching models, management systems, and evaluation mechanisms. At the same time, the new demands generated by education practice will guide the direction of technology research and development and application, prompting the continuous iteration of technology in education scenarios, forming a dynamic cycle of “demand-driven technology-technology-driven change-change-generates new demands”, and ultimately helping to improve the quality and fairness of education, and building a new education model and a new education system. Enhancement of the quality of education and the realization of education fairness, building a benign life of technology-enabled education innovation and development.

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4. Educational applications of ChatGPT

4.1. Personalized learning support

ChatGPT shows unique advantages in personalized learning support, which can dynamically adjust teaching strategies and contents according to students' knowledge level and learning characteristics, providing precise services for students with different learning needs. Specifically: first, with its powerful data analysis and algorithmic capabilities, ChatGPT builds adaptive learning paths that can analyze students' wrong data, accurately identify knowledge weaknesses and common error types, and then push targeted reinforcement exercises to help students efficiently make up for knowledge loopholes and improve their learning effect. Secondly, in the multilingual learning scenario, ChatGPT's multilingual assistance function can not only provide real-time translation for non-native speakers, but also make detailed grammatical corrections to help students understand the language rules, improve the accuracy and fluency of language use, and at the same time, promote the learning of cross-cultural knowledge and the cultivation of cultural comprehension skills. In addition, for the special group of visually impaired students, ChatGPT breaks the limitation of traditional text reading through voice interaction technology and conveys the knowledge clearly in the form of voice, so that they can access the knowledge conveniently, which provides a powerful technical support for the development of special education, and promotes the practice of educational fairness in the field of special education, so that the visually impaired students can also enjoy the high-quality learning resources and support services.

4.2. Revolutionizing teaching efficiency

In the field of education, ChatGPT revolutionizes teaching efficiency in many ways. It enriches teachers' support tools, automatically generating lesson plans, quizzes and course outlines based on teaching objectives, curriculum standards and students' characteristics, significantly saving about 50% of lesson preparation time and allowing teachers to devote more energy to teaching design and personalized guidance; the instant Q&A system introduced by ChatGPT can provide real-time answers to students' questions in the classroom to avoid the generation of blind spots in knowledge and promote teaching interactions; and it can track learning progress and intelligently analyze students' knowledge mastery, habits and thinking, generating visual reports through dialogue data, helping teachers accurately grasp the learning situation, and providing a platform for teaching interaction. It can also track learning progress through dialogue data, intelligently analyze students' knowledge mastery, habits, and thinking, and generate visual reports to help teachers accurately grasp the learning situation, provide a scientific basis for teaching decisions, and enhance the relevance and effectiveness of teaching.

4.3. Universalization of educational resources

The application of ChatGPT plays an important role in promoting the process of universalizing educational resources. On the one hand, it effectively breaks the barrier of geographical restrictions. Under the traditional education model, students in rural and remote areas have relatively little access to quality education resources due to their geographical location and economic conditions. Relying on Internet technology, ChatGPT enables students in these areas to conveniently access the curriculum resources of famous schools, cross spatial barriers, and come into contact with cutting-edge and diversified knowledge content, thus narrowing the gap in educational resources caused by

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geographical differences. On the other hand, ChatGPT provides a low-cost educational solution. It can replace some paid tutoring services and provide students with knowledge explanations, tutorials, study planning, and other support in a relatively inexpensive or even free-of-charge way, which greatly reduces family education expenses, enables more families to obtain high-quality educational assistance for their children at a lower cost, helps realize educational equity, and promotes the common use of high-quality educational resources in a wider range of groups.

5. The educational challenges and ethical risks of ChatGPT

5.1. Academic integrity crisis

As the application of ChatGPT in the field of education becomes more and more widespread, the academic integrity problems it raises gradually come to the fore. On the one hand, there is the risk of homework and essay writing. Although a survey shows that 42% of teenagers oppose the use of ChatGPT to write papers, the text generated by the tool has a certain quality and can pass basic academic testing, which is likely to induce some students to use it to write on behalf of others, destroying the authenticity and originality of academic creation and eroding the foundation of academic integrity. On the other hand, over-reliance on ChatGPT will give rise to inertia in thinking. Students complete their learning tasks with the help of ChatGPT for a long time, lacking independent thinking and knowledge construction process, critical thinking ability will gradually decline due to the lack of exercise, and it is difficult to truly internalize the knowledge and improve academic literacy, which is not conducive to the cultivation of academic talents and the healthy development of the academic ecosystem in the long run.

5.2. Limitations of technology

Although ChatGPT is widely used in the field of education, its technology still has limitations that cannot be ignored. In terms of information reliability, due to possible errors or biases in the training data, it is difficult for ChatGPT to completely avoid transmitting inaccurate or even incorrect information during the knowledge output process, which poses a potential threat to students' acquisition of correct knowledge. In addition, ChatGPT, as an artificial intelligence technology, lacks the human ability to perceive and express emotions and is unable to give emotional care and support to students like teachers or peers. Emotional support is crucial in the development of students' mental health and the maintenance of their learning motivation, and its absence may adversely affect students' overall growth. Privacy and Ethics Controversies In the process of using ChatGPT, privacy and ethical issues have caused many controversies. On the one hand, there is a risk of data leakage. Users' conversation records with ChatGPT may contain sensitive personal information, such as identity information and details of study and life. If data management and protection measures are not in place, such information may be improperly accessed or misused, seriously infringing on user privacy. Therefore, it is crucial to strengthen security protection mechanisms such as data encryption and anonymization. On the other hand, the problem of algorithmic bias should not be ignored: ChatGPT's algorithm may be influenced by the training data and implicitly spread gender and racial bias in the answers, which not only violates the ethical principle of fairness and impartiality but also misleads students' value shaping, which is not conducive to the creation of a tolerant and egalitarian educational environment.

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6. The future path of human-computer collaboration

Artificial intelligence (AI) has developed rapidly in recent years, leading to various applications in different disciplines, such as healthcare and education.AI applications have also been utilised in education to enhance administrative services and academic support [10].

6.1. Reconstructing the role of teachers

Under the development trend of human-computer collaboration in education, the role of teachers needs to be changed from traditional lecturers to guides. On the one hand, teachers should focus on cultivating students' innovative abilities and emotional literacy, which are difficult to achieve with AI. By designing open learning tasks and organizing creative activities, they can stimulate students' innovative thinking and encourage them to break through the routine and explore boldly; in daily teaching interactions, they should give students sufficient emotional care, pay attention to their psychological state and learning feelings, and create a warm and supportive learning atmosphere. On the other hand, teachers need to improve their technical literacy and receive systematic training to master the evaluation and error correction skills of AI tools. They should be able to accurately judge the reliability and applicability of the content provided by AI, correct any errors or inappropriateness promptly, and make reasonable use of AI-assisted teaching so that it can better serve the teaching goals and optimize the development of the technology for students.

6.2. Techniques of optimizations

Given the existing technical problems of ChatGPT, it can be optimized in the following two aspects. First, enhance the fact-checking function. By embedding links to authoritative databases and constructing a rigorous knowledge verification mechanism, the source of information can be strictly traced and verified in the content generation phase to ensure the accuracy and reliability of the output knowledge and effectively reduce the dissemination of misinformation. Secondly, it incorporates emotional computing technology. Comprehensive use of facial recognition, voice emotion analysis, and other means to accurately capture the user's emotional state, so that ChatGPT can give a more empathetic and personalized response according to the user's emotions, create an anthropomorphic interaction experience, make up for the current shortcomings in emotional support, and enhance the user's experience and learning effect in the educational scene.

6.3. Institutional innovation

To promote the healthy development of human-computer collaboration in the field of education, institutional innovation is imperative. First, establish academic integrity norms. By formulating a strict labeling system for the use of AI, users are required to clearly distinguish between human-created and machine-generated content, preventing students from overly relying on AI to complete academic tasks, ensuring the authenticity and originality of academic results, and maintaining an environment of academic integrity. Second, build a data governance framework. Formulate AI ethical guidelines applicable to the education field, clearly define the ownership of data, standardize the boundaries of data collection, storage, use, and sharing, safeguard the privacy and security of teachers' and students' personal data, prevent data misuse and algorithmic bias, and promote the operation of education AI technology on a compliant and ethical track.

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7. Conclusion

This paper studies the application of ChatGPT in education, comprehensively analyzes its technical characteristics, application scenarios, challenges, etc., and finds that ChatGPT has great potential to help personalized learning, innovate teaching efficiency, and promote the universalization of educational resources, etc., but there are also problems such as academic integrity crisis, technological limitations, and privacy and ethical disputes. Based on this, it is proposed to reconstruct the role of teachers, optimize the function of technology, and promote institutional innovation and other human-computer synergistic development paths. Overall, ChatGPT brings a new situation of both opportunities and challenges to the education field, and by promoting human-computer synergy through multi-dimensional initiatives, it can effectively play to its strengths, avoid risks, promote the development of education in the direction of intelligence, fairness, and standardization, and help build a better quality education life.

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