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STUDY OF GENERATIVE ARTIFICIAL INTELLIGENCE TECHNIQUES IN THE DIGITISATION TRANSFORMATION OF EDUCATION

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Abstract: Generative Artificial Intelligence Techniques is an AI system capable of generating new, original content. The field of artificial intelligence is witnessing a period of rapid growth, driven by the emergence of large generative AI models in recent years. OpenAI introduced ChatGPT, a dialogue chatbot with advanced natural language generation capabilities, which garnered significant attention globally. This led to a surge in the development of large generative AI models, including Gemini, Copilot, LLaMA, SAM, SORA, and numerous others. At the present time, the information age is entering a phase of accelerated development characterized by the advent of intelligent computing. The breakthroughs in generative AI technology that have been achieved to date are numerous and significant, and they are gradually and profoundly transforming thousands of industries.First, this paper elaborates on the development history of artificial technology, especially the iteration of generative AI technology. Secondly, this paper provides a systematic overview of the current status of the application of generative AI technology in education, and at the same time analyzes the role played by generative AI technology in the digital transformation of schools. Finally, the paper sheds light on the issues and challenges that generative AI technologies will bring to education.
Keywords: Generative artificial intelligence; Education; Digital transformation

1 INTRODUCTION

The application of generative artificial techniques has brought about three changes. The first is the law of scale, which means that the accuracy of many AI models increases rapidly after the parameter size exceeds a certain threshold, the reason for which is not very clear and controversial in the scientific community[1]. The performance of an AI model has a "log-linear relationship" with the three variables of model parameter size, dataset size, and the total amount of arithmetic power, and therefore Therefore, the performance of AI models can be continuously improved by increasing the model size. At present, the number of the most cutting-edge large model GPT-4 parameter has reached the trillion to ten trillion scale, and is still growing[2]. Secondly, the demand for computing power in the industry is exploding, the training of large models with hundreds of billions of parameter scales usually needs to be trained on thousands or even tens of thousands of GPU cards for 2-3 months, and the dramatically increased demand for computing power has led to the rapid development of related arithmetic enterprises, and the market value of Nvidia is close to two trillion U.S. dollars. , for the chip business has never happened before[3]. Third, the social impact on the labour market, the most affected 20 occupations in accounting, sales, paperwork is located in the forefront of the need to deal with people and provide services to the physical labour-type work, such as human resources, administration, logistics, etc. Instead, relatively more secure. One of the impacts on the labour market has a direct impact on changes in the shape and pattern of education.

The history of computing technology can be broadly divided into four phases, as shown in Figure 1. Early computing devices were manually assisted computing devices and semi-automatic computing devices.The history of human computing tools began with the Chinese abacus in 1200 A.D., followed by the Napier chip (1612) and the roller adder (1642), and then in 1672 the first computing device to automate the quadratic arithmetic operation, the step calculator was born[4]. The basic concepts of the modern computer had already emerged during the period of mechanical computing. Charles Babbage developed the design concepts of the Differential Machine[5] (1822) and the Analytical Machine[6] (1834) to support automatic mechanical computation. During this period, the concepts of programming and programmers took shape, with the concept of programming originating in the Jacquard machine[7], where print patterns were controlled by punched cards, and eventually evolving into the storage of all mathematical calculations in the form of computational instructions; the first programmer in the history of mankind was Ada, daughter of the poet Byron, who wrote a set of computational instructions for the Babbage Difference Machine for the solution of Bernoulli's series, which was the first computer algorithmic programme in the history of mankind[8]. This set of instructions was also the first set of computer algorithmic programs in human history, which separated hardware and software, and for the first time the concept of a programme appeared. Until in the first half of the twentieth century, there appeared Boolean algebra (mathematics), Turing machines (computational models), von Neumann architecture (architecture), transistors (devices), the four scientific foundations of modern computing technology. Among them, Boolean algebra is used to

describe the program and hardware such as the underlying logic of the CPU[9]. The Turing machine is a general-purpose computational model that transforms complex tasks into automatic calculations, automated processes that do not require human intervention; the von Neumann architecture proposes the construction of the computer's three basic principles: the use of binary logic, the implementation of the program storage, as well as the computer by the operator, the controller, the memory, the input device, Output device of the five basic units; transistors are the basic logic circuits and storage circuits constitute the semiconductor devices, is the construction of the tower of modern computers "bricks". Based on the above scientific foundations, computing technology has beenable to develop at a high speed and form a large-scale industry.

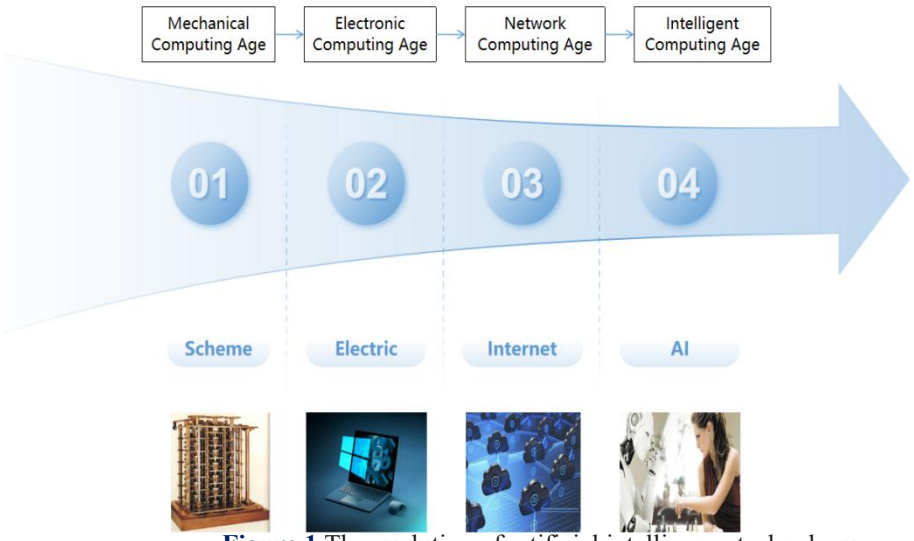

Figure 1 The evolution of artificial intelligence technology

From the birth of the world's first electronic computer, the ENIAC, in 1946 to the present day of the 21st century, five successful types of platform-based computing systems have been developed[10]. These five types of platform-based computing devices can support all kinds of current applications in various fields, and their characteristics are shown in Table 1. These five types of devices cover almost every aspect of our information society, while the sixth type of platform-based computing system, which has long been pursued as the centre of intelligent computing applications, has yet to be formed. The development of modern computing technology can be roughly divided into three eras: IT1.0, also known as the era of electronic computers (1950-1970), whose basic feature is centred on "machines". The basic architecture of computing technology was formed, and with the advancement of the integrated circuit process, the scale of the basic computing unit was rapidly miniaturized, and the transistor density, computing performance and reliability were continuously improved.With the advancement of the integrated circuit process, the scale of the basic computing unit was rapidly miniaturised, transistor density, computing performance and reliability were continuously improved, and computers were widely used in scientific engineering calculations and enterprise data processing.IT 2.0, also known as the era of networked computing (1980-2020), is centred on the "human being"[11].

Table 1 Platform-based computing system

No.	Computing Platform Name	Service Areas
1	High Performance Computing Platform[12]	Scientific and engineering computing issues in core national sectors
2	Enterprise Computing Platform[13]	Enterprise-class data management, transaction processing
3	Personal Computer Platform[14]	Comes in the form of desktop applications through which people interact with their PCs
4	Smart Phone[15]	Connected to the data centre through the network, Internet-based applications are deployed in a distributed manner in the data centre and mobile phone terminals
5	Embedded Computer[16]	Embedded in industrial and military equipment, the real-time control guarantees the completion of a specific task within a defined period of time

Intelligent computing, including AI technology and its computational carrier, has roughly gone through four stages, namely, general-purpose computing device, logical reasoning expert system, deep learning computing system, and big model computing system, as shown in Table 2. Among them, a typical application of the big language model in the field of dialogue system is ChatGPT of OpenAI, which adopts the pr-training base big language model GPT-3 and introduces a training corpus of 300 billion words, which is equivalent to the sum of all English texts on the Internet[17]. Its basic principle is: train the model by giving it an input and letting it predict the next word, improve the prediction accuracy through a large amount of training, and eventually reach the point where it is asked a question and the big model produces an answer to have an instant dialogue with a person. On the basis of the base big model, it is then given some

cue words for supervised command fine-tuning, and through human <command, reply> pairs, the model gradually learns how to have multiple rounds of dialogues with people; finally, iterative reinforcement learning is carried out through the human-designed and auto-generated reward functions, gradually achieving the alignment of the big model with human values. The characteristics of the big model is to win with "big", which has three meanings, (1) big parameters, GPT-3 has 170 billion parameters; (2) big training data, ChatGPT uses about 300 billion words and 570GB training data; (3) big arithmetic demand, GPT-3 uses about tens of thousands of V100 GPUs for training. V100 GPUs for training.

Table 2 Platform-based computing system

No.	Step	Time	Representative Individual	Main course
1	Automated Calculator[18]	1946	Alan Turing & John von Neumann	In the beginning, they all hoped to be able to simulate the process of processing knowledge in the human brain, and invented machines that think like the human brain, which failed to be realized but solved the problem of automation of computation and promoted the birth of the concept of Artificial Intelligence (AI), and since then all the development of AI technology has been built on a new generation of computational devices with stronger computing power
2	Logical reasoning expert systems[19]	1990	Edward Albert Feigenbaum	With the automation of logic and reasoning ability as the main goal, expert systems capable of reasoning logically from knowledge symbols are proposed. Human a priori knowledge enters the computer in the form of knowledge symbols, enabling the computer to assist humans in making certain logical judgement and decisions in specific domains, but expert systems rely heavily on manually generated knowledge bases or rule bases
3	Deep learning computing system[20]	2014	Geoffrey Hinton	Through the automatic learning of deep neuron networks, the ability of statistical generalization of the model has been greatly improved, and great breakthroughs have been made in the effectiveness of applications such as pattern recognition, with the recognition accuracy of certain scenarios even surpassing that of human beings.
4	Large Model Computing System[21]	2020	Sam Altman	From "small model + discrimination" to "large model + generative", from the traditional face recognition, target detection, text classification, upgraded to today's text generation, 3D digital human generation, image generation, speech generation, video generation.

The paper is organized as follows. In the first chapter, this paper elaborates on the development history of artificial technology, especially the iteration of generative AI technology. In the second and third chapters, this paper provides a systematic overview of the current status of the application of generative AI technology in education, and at the same time analyzes the role played by generative AI technology in the digital transformation of schools. Finally, the paper sheds light on the issues and challenges that generative AI technologies will bring to education.

2 GENERATIVE ARTIFICIAL INTELLIGENCE TECHNIQUES IN EDUCATION

With the continuous progress of technology and the expansion of application scenarios, the application of generative AI technology in the field of education will be more extensive and in-depth. It will bring unprecedented changes to education, improve the efficiency and quality of education, and promote the fairness and personification of education. At the same time, educational institutions, teachers and students need to continuously learn and adapt to the development of new technologies to jointly promote the progress of education[22]. Since February 2023, there has been a notable interest in the utilization of generative AI in the field of education, with a peak in interest observed in June 2023. This interest has persisted throughout the subsequent period. Concurrently, academia commenced a period of heightened interest in generative AI technology, promoting research into the intersection of AI and education. As illustrated in figure 2, the nexus of generative AI and education has emerged as a focal point of attention across all societal sectors, including academia.

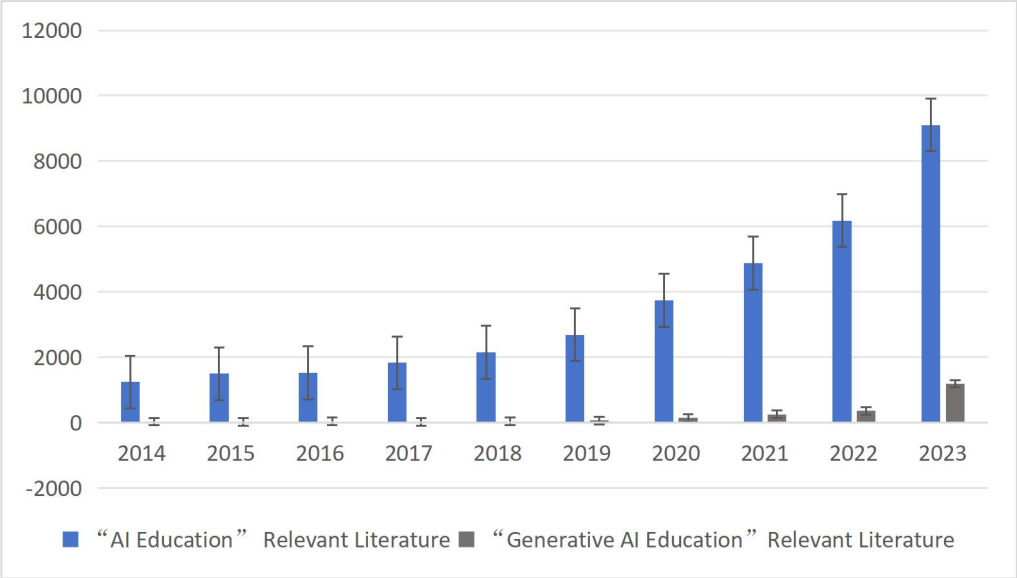

Figure 2 Number of "AI+Education"related documents in ScienceDircet database(2014-2023)

The combination of generative AI and teaching activities is centered on the teaching objectives, and through the technological empowerment and upgrading of the three major elements of course content, teaching methodology and teaching environment, it improves the efficiency of the interaction between the subjects in the teaching activities and creates more valuable teaching results[23]. We proceed to examine the three principal elements of the teaching medium, teaching method and teaching environment, respectively, and illustrate their application and value creation process in the context of actual teaching activities through the use of illustrative examples, as shown in figure 3.

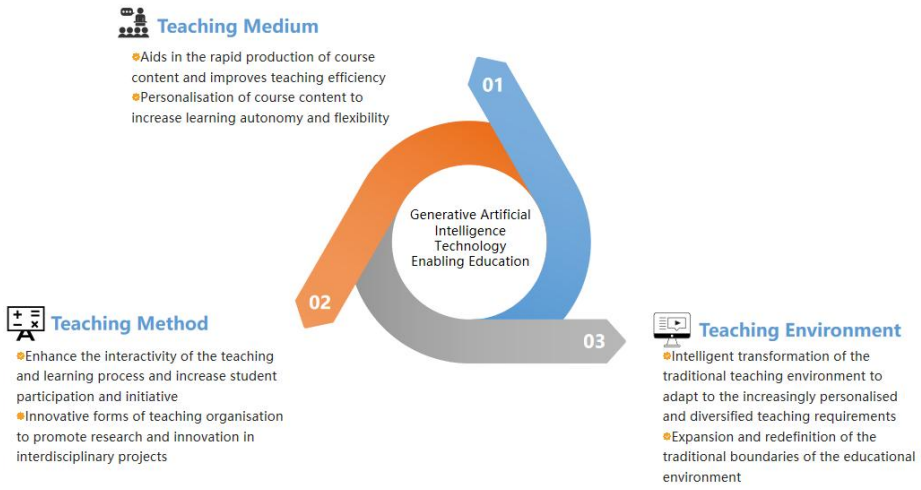

Figure 3 Generative artificial intelligence technology enabling education

2.1 Teaching Medium

The innovation of generative AI on course content is mainly reflected in two major aspects: firstly, it assists in the rapid production of course content and improves the efficiency of teaching; secondly, it personalizes the course content and improves the autonomy and flexibility of learning.As an auxiliary tool for content generation, generative AI can help teachers quickly generate teaching content in various aspects, including teaching preparation before class, creating exercises during class, designing or correcting assignments after class, and researching outside the classroom, etc., which can reduce the burden of teaching in tedious and repetitive teaching tasks. Lesson planning, for example, is a task that requires a great deal of work and creativity[24]. The workload is mainly reflected in the writing of syllabic, lesson plans, collection of curriculum resources and production of courseware for different periods and classes, while the need for creativity is mainly reflected in the personalized modifications and adjustments according to the learning conditions and progress of each class, as well as the design of classroom interactions, and so on. In the traditional mode, all these tasks require a lot of teachers' time and energy. Especially for courses with high practical requirements, fast information updating or strong interdisciplinarity, the workload of teachers is even heavier to ensure the timeliness, accuracy and innovation of the course content. The application of generative AI can make some repetitive and execution-type work in the lesson preparation stage more quickly and efficiently completed under the drive of big data. For example, teachers

can use generative AI tools to automatically search and organise relevant teaching materials by entering prompts to generate a syllabus, and based on these materials, quickly generate various styles and forms of multimedia courseware, such as PPTs, videos, animations, and interactive diagrams, etc., so as to make the course content more vivid and interesting, and to enhance the students' learning experience and comprehension[25].

2.2 Teaching Method

Generative AI optimises teaching methods in two main ways: firstly, it enhances the interactivity of the teaching process, increasing student engagement and initiative; secondly, it innovates the organization of teaching and promotes practice and innovation in interdisciplinary projects.Generative AI introduces rich interactive elements and anthropomorphic and innovative contexts to the teaching and learning process, dramatically improving the interactive experience and efficiency both inside and outside the classroom. By interacting with AI, students can participate in learning more actively, thus stimulating their interest in learning[26]. This approach is of great value in developing students' independent thinking and innovative spirit.In daily teaching scenarios, generative AI effectively enhances teaching interactions inside and outside the classroom. In self-directed learning environments, generative AI tools can also help students stay motivated and engaged by simulating real teaching interactions and providing personalised learning paths and instant feedback. Generative AI's ability to provide real-time access to vast databases of knowledge spanning multiple disciplines, as well as its natural-language form of interaction, shows great potential and application value in cross-disciplinary educational innovation.

2.3 Teaching Environment

Generative AI will accelerate the overall upgrading of teaching environments, not only in the intelligent transformation of traditional teaching environments to adapt to the increasing demand for personalised and diversified teaching and learning, but also in its expansion and redefinition of the traditional boundaries of the educational environment.Generative AI's intelligent transformation of the traditional teaching environment mainly covers a number of sub-scenarios such as asset management, teaching management, environment optimization and administrative management. Through the intelligent transformation of the traditional environment, it provides more dynamic and responsive hardware and software conditions for teaching activities at the system level.In their daily teaching and management practices, schools and educational institutions have deposited a large number of high-quality digital assets, including operation and management data, teaching document data, etc., which constitute important strategic resources for the institutions. Using generative AI technology, these data resources can be efficiently annotated, organized and analyzed to deepen education managers' understanding of organizational operations and insights, and to build data-driven teaching and management models[27].

3 GENERATIVE ARTIFICIAL INTELLIGENCE TECHNOLOGY ENABLING PATHS IN THE DIGITAL TRANSFORMATION OF EDUCATION

The optimisation path of generative AI technology in the digital transformation of education involves a number of aspects, aiming to promote a comprehensive upgrade of the education system through innovative technologies and models. The following are the key paths, as shown in figure 4.

Figure 4 Generative artificial intelligence technology enabling paths in the digital transformation of education

3.1 Enhancement of Digital Infrastructure

First, promote the improvement of information infrastructure. Build an information infrastructure including new networks, new platforms and new security, provide fast, stable, green and safe network services, and promote high-speed interconnection of school equipment terminals. Build a convergence infrastructure with new resources and new campuses as the main body, and build a smart education application ecology with full scene coverage and interconnection. Second, accelerate the upgrading of the smart education platform. Continuously upgrading the smart education platform, deepening the platform application, enhancing the platform vitality, stimulating the platform vitality, and forming a powerful grip to promote digital transformation[28]. Build a new ecology of smart education platforms with standardised standards, application connectivity and data sharing, and promote open sharing, data interoperability, application synergy and interactive usability of the platforms.

3.2 Promoting Innovation in Teaching Methods and Content

First, accelerate changes in teaching methods. Accelerate the application of generative AI in teaching, such as online classrooms, virtual labs, distance education, etc., to provide a more interactive and personalised learning experience. Use the video generation capability of generative AI (e.g. ChatGPT, Sora, etc.) to visualise complex concepts and abstract theories to enhance the learning experience. Second, the creation and enrichment of teaching content. Generative AI can assist teaching by automatically generating videos containing complex backgrounds and multi-angle shots based on textual instructions, helping students understand complex concepts more intuitively. Personalised learning paths and resource recommendations are generated through intelligent technology to meet the learning needs of different students.

3.3 Strengthening Educational Governance and Decision-making Support

First, carry out deep mining and analysis of education data. Using the data processing capabilities of generative artificial intelligence, it carries out in-depth mining and analysis of education data, revealing the potential laws and problems in the education process, and providing a basis for decision-making for policymakers. Realise real-time monitoring and early warning functions to help the education sector identify and respond to abnormalities in education and teaching in a timely manner, and improve the efficiency and precision of education governance. Second, establish an intelligent education management system: promote the deep integration and integration construction of education management information systems, complete the intelligent upgrade of the education management platform, and enhance the scientific, timely and standardized nature of education management and governance. Strengthen the whole life cycle management and technical optimization of data collection, storage, processing and application, and improve the databases of education foundation, resources, teachers and students, and behaviors.

3.4 Enhancing Digital Skills Training and Professional Development for Teachers

Firstly, improve teachers' digital literacy. Strengthen digital technology training for teachers to equip them with the ability to apply advanced technologies such as generative artificial intelligence. Encourage teachers to use generative AI to quickly generate teaching resources, such as teaching videos, courseware and practice questions, to reduce workload and improve teaching quality. Second, promote teachers' professional development. Provide abundant professional development opportunities, such as online seminars and workshops, to help teachers continuously learn and master new technologies and methods.

In summary, the optimization paths of generative AI technology in the digital transformation of education involve multiple aspects such as infrastructure construction, teaching method and content innovation, education governance and decision support, teacher training and professional development. Through the implementation of these paths, the digital transformation of education can be accelerated, the quality of education can be improved, and the comprehensive upgrading of education can be achieved.

4 SUMMARY AND OUTLOOK

Generative AI has shown great potential for application in education, but it has also triggered a great deal of concern in the education community about the possible risks associated with the new wave of technology, as well as a profound rethinking of educational frameworks. This has forced a rethinking of the question of how the education system, and society as a whole, can maintain a balance between the use of technology and the development of education in a highly uncertain and fast-changing world. This balance is not only about how to use technology to improve teaching and learning, personalize the learning experience and stimulate students' creativity, but also about how to respond effectively to the practical concerns that technology may bring, and to ensure that the use of technology in education drives progress without detracting from the core values and goals of education[29].

4.1 Reflections and Concerns about the Educational Framework

Concerns about how generative AI might affect learning subjects are expressed in three main ways: first, people's

over-reliance on generative AI technology may be detrimental to the initiative and awe of learning subjects. Generative AI has a wide range of knowledge, precise information processing and analysis capabilities, and the potential for rapid development, which are difficult for individuals to match after years of education. Some experts worry that over-reliance on technology instead of thinking and learning on their own may reduce the initiative of learners, weaken their sense of reverence for the learning process, which is not conducive to the cultivation of thinking and creativity, and may even lead to the emergence of the Google effect. Secondly, generative AI may compete with human learners for educational funding. Generative AI attracts a lot of investment, but school improvement, teacher development and infrastructure construction still need public funding. The rational allocation of resources to balance the needs of human education and technological development has become a challenge that governments and relevant organizations need to weigh up. Third, generative AI may reduce the return on investment in human learning. As efficient labour subjects, generative AI may reduce the demand for human labour and affect the return value of human investment in education. Such changes force a rethinking of the pace of technological development and application, and the formulation of appropriate employment and labour security policies to ensure that technological advances are accompanied by a focus on human well-being and the overall progress of society.

The intervention of generative technologies may promote the transformation of the traditional teacher-student dichotomy to a teacher-student-machine model. This process subconsciously changes the positioning of teachers in teaching and triggers further reflection on their subject position. On the one hand, teachers' roles have changed from traditional knowledge transmitters to learning companions and guides. They are more involved in the design of students' personality learning paths, using generative AI technologies to provide more targeted guidance and support for students. At the same time, teachers need to continuously update their teaching methods and skills to adapt to the changes brought about by technological development and ensure the quality and effectiveness of education. In this process, teachers' professional development and lifelong learning become particularly important. They need to remain sensitive to technology, understand the latest technological developments and their potential for application in teaching and learning, and at the same time be equipped with critical thinking to select and evaluate AI tools judiciously and make timely adjustments in their teaching to maximise their positive effects. On the other hand, relying exclusively on generative AI as the sole subject of teaching and learning is also one of the concerns of academics. Generative AI may suffer from values bias, information uncertainty, and the inability to fully replicate human emotions and cultural values, all of which may affect the quality of education and values development.

4.2 Implementing the Balanced Development Concept of AI Education

The best way to deal with emerging technologies is to block as much as to block, and through proper guidance and use, the impact of the integration of technology and education can be reduced. While seizing the opportunities for change, it is also important to be innovative. As pointed out in the Guidelines for the Use of Generative Artificial Intelligence in Education and Research issued by UNESCO, the occurrence and development of generative AI has brought unlimited possibilities for human production and life, especially for the development of education. Effectively preventing the risks posed by generative AI will help us give full play to the advantages of generative AI and better apply it to life and learning scenarios. Therefore, future education reforms need to find the best balance between technological advancement and the essence of education, and ensure that generative AI becomes an aid, not an obstacle, to improving education through policy support and practical innovation. This balance will determine whether AI can truly fulfil its potential in education and drive educational change towards a more equitable, efficient and creative future.

4.3 Creating a Human-computer Co-teaching Educational Future

With the continuous emergence of innovative AI technologies, we are stepping into a new era of human-machine co-teaching, and the combination of AI and education will bring us unlimited imaginations for the future. Drawing on the development experience of the mobile Internet era, it is foreseeable that more intelligent and powerful generative AI tools will come out in the near future. Human-machine co-teaching is an inevitable trend of the mutual integration of technological change and educational innovation. Historically, people have worried that new technologies would replace traditional education, triggering changes in the social structure and even falling into a predicament of self-denial. However, it has been proved that technological progress and educational innovation always provide more free time and space for human beings' own enhancement and comprehensive development, and promote the continuous progress of civilization. In this process, although the relationship between technological change and educational innovation is complex and subtle, they have always been partners in mutual promotion and common development, and have never formed a real antagonism.

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COMPETING INTERESTS

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