The Construction and Reflection of Integrated Circuit Design Liberal Studies Course in the View of AIGC

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Abstract: This dissertation explores the potential and challenges of the application of generative artificial intelligence (AIGC) and the construction of general education courses on integrated circuits. With the implementation of the national education digitalization strategy, AIGC has risen and brought new ideas for the reform of general education. AIGC significantly improves the teaching effect and promotes the overall development of students by optimizing the division of integrated circuits general education courses, automatically generating the materials that nurture original integrated circuits-related majors, and providing students with curriculum planning that combines experimental practice and theoretical teaching. However, challenges such as the opacity of technology, data privacy and security issues, and educational ethics cannot be ignored. By analyzing the status quo of IC education at home and abroad and the application of AIGC, promoting the digital transformation of IC general education courses, optimizing cross-domain teaching, and promoting cross-college cooperation are the future development direction of AIGC.

Keyword: Generative artificial intelligence (AI); General education curriculum

1. Introduction

In 2022, the strategic policy of implementing the digitalization of the country's education was clearly stated at the National Education Conference. At the same time, the report of the 20th Party Congress further pointed out the need to promote the construction of a strong education nation through digital transformation. In the context of modern science and technology education with the rapid development of artificial intelligence, the ability and potential of artificial intelligence have been highly recognized and valued both at home and abroad. Different from the discriminative modeling commonly used in traditional AI systems, generative AI (AIGC) relies on its machine learning algorithms, which have significant advantages in terms of flexibility and

adaptability in processing data [1]. This means that the versatility and practicality of generative AI are greatly improved, especially in the fields of assisting scientific research and educational work, generative AI no longer stays in data analysis, computational simulation, etc., but opens up a new era of AI creation [2,3]. In such a context, how to apply generative AI technology to the reform of general education courses has undoubtedly become a new research direction.

2. The rise of generative artificial intelligence - Education and artificial intelligence

Generative Artificial Intelligence AIGC, as an emerging technology, is profoundly transforming the field of education, offering new insights for the reform of general education [4]. AIGC is characterized by its data-driven, automated, personalized, and customized features, which can enhance the teaching effectiveness of general courses and promote the all-around development of students [5].

(1) AIGC can generate personalized learning content and pathways based on students' learning data and styles, catering to diverse needs. It can recommend personalized learning resources, such as reading materials and video courses, and provide suitable learning methods such as visual, auditory, or hands-on activities to help students learn more effectively [6]. Moreover, AIGC can create a variety of learning resources texts, images, videos, etc., broaden students' knowledge base, and generate content of varying difficulty levels according to learning objectives [7]. At the same time, AIGC can foster inquiry-based learning and critical thinking, cultivating students' autonomous learning and innovative abilities by presenting open-ended questions that guide them towards deeper reflection.

(2) In terms of teaching, AIGC can assist teachers in curriculum design, evaluation, and feedback, lightening their workload and improving teaching efficiency. It can automatically generate teaching plans and courseware, grade assignments, and provide personalized feedback, helping teachers understand their students' progress and tailor their teaching accordingly. Additionally, AIGC can provide high-quality educational resources to students in remote areas, promoting educational equity.

In summary, the application potential of AIGC in general education courses is immense, with the ability to enhance teaching effectiveness and student development. However, it also faces challenges such as technical limitations, ethical and security issues, and the need for teacher proficiency. These challenges must be actively addressed to drive the reform of general education and cultivate innovative talents who can meet the demands of future society [8].

AIGC has the potential to revolutionize the traditional educational model by offering a more personalized and adaptive learning experience. It can analyze vast amounts of educational data to identify patterns and tailor learning experiences to individual student's strengths and weaknesses. This not only optimizes the learning process but also empowers students to take control of their education, fostering a sense of ownership and responsibility for their learning outcomes.

Despite its promise, the integration of AIGC into education must be approached with caution. It is crucial to ensure that the technology is used to complement and enhance, rather than replace, the critical role of teachers in the classroom. Additionally, there is a need for ongoing dialogue and collaboration between educators, technologists, and policymakers to address the ethical implications and to establish guidelines that protect students' privacy and promote a safe learning environment. By harnessing the power of AIGC while being mindful of its limitations and challenges, we can create a more inclusive and effective educational system that prepares students for the complexities of the modern world.

3. Challenges of integrated circuits liberal arts courses and generative artificial intelligence

3.1. Dilemmas faced by domestic IC general education courses

Microelectronics is an emerging discipline that has developed based on various fields such as physics, electronics, materials science, computer science, and integrated circuit design and manufacturing, as well as ultra-clean, ultra-pure, and ultra-precision processing technologies [9]. In recent years, due to the chip blockade imposed by foreign countries on China, the field of microelectronics has become a strategically important discipline for the nation. Although many universities in China have now established relevant microelectronics education courses, there is still a significant gap compared to Western developed countries due to a later start. The educational approaches to microelectronics in foreign and domestic universities differ greatly in terms of professional divisions, teaching methods, educational outcomes, and experimental teaching from related domestic courses. Compared to China, foreign education places more emphasis on the cultivation of students' inner qualities and interests, which can greatly motivate students and spark their interest in related professional knowledge. Domestic microelectronics education is more detailed and tends to theoretical knowledge, which results in less timeliness in learning, weaker practical skills among students, and the overly complicated derivation of formulas and explanations of principles significantly reduce students' enthusiasm and motivation.

In the era of rapid development of digital education, generative AI, with its relatively higher creativity compared to ChatGPT, has undoubtedly become a solution to these issues [10].

(1) Generative AI can provide learning materials and exercises that are more flexible and adaptable based on student's progress and comprehension, helping them better grasp the fundamental knowledge [11]. By analyzing students' feedback and performance, AI can adjust the course content and teaching methods to meet the needs of each student.

(2) In terms of experimental teaching, with the aid of generative AI, virtual experimental environments can be created, allowing students to conduct experiments in simulated settings and enhance their practical skills. To address the issue of cramming teaching, online classrooms utilizing generative AI enable students to ask questions anytime and receive immediate feedback and assistance, improving classroom interactivity. Generative AI can also provide discussion topics to promote in-depth communication between teachers and students, as well as among students, and stimulate thinking. To solve the problem of high repetition in learning resources, generative AI can automatically generate relevant documents, videos, and tutorials based on the latest research and technology, providing students with more diverse and original learning materials [12]. In addition, generative AI can help students integrate knowledge of microelectronics with other disciplines, offering them a broader perspective and application [13].

Through these methods, generative AI can significantly improve the quality of microelectronics education, enhance students' practical skills and learning interests, and thus cultivate talents who are more adaptable to the needs of modern technological development.

3.2. Dilemmas of generative AI

3.2.1. Lack of explanation and opacity

As the application of generative artificial intelligence in the field of education becomes increasingly widespread, its potential risks have also garnered global attention. To ensure the transparency and security of the technology and promote responsible use, it is urgent to establish corresponding regulations and guidelines.

These regulations and guidelines will help address the ethical issues related to the educational application of generative AI and ensure that educational entities can use this technology responsibly.

The content generation nature of generative AI and the disorderly data collection during the pre-training of large models have gradually led people to realize that technology is not value-neutral but carries specific value orientations. Firstly, data theft may infringe on data privacy. The big data and powerful algorithms of large models make people's behaviors in the digital world transparent, with all online actions potentially recorded and monitored by platforms, thus raising privacy concerns. Secondly, powerful algorithms may lead to more severe regulatory challenges. Developers can embed the needs and value orientations of interest groups into algorithmic programming, resulting in biased automated decision-making. Lastly, the quality and value orientation of data will directly affect the generated content. The content generation of generative AI relies on pre-trained big data, and the authenticity, objectivity, and accuracy of the content depend on the big data.

Therefore, it is necessary to ensure the transparency and security of the development of generative AI technology through regulations and guidelines to reduce or avoid potential risks from the source. Firstly, a series of measures can be taken to ensure the implementation of value-sensitive design and participatory design. Value-sensitive design involves technological design from the perspective of human values, regulating designers to integrate ethical requirements into the algorithms of generative AI throughout the design process. Participatory design is a method that ensures all stakeholders can participate in technological design through agreements or systems, safeguarding the voice of vulnerable groups in technological design. Secondly, an appropriate legal and policy framework can be established. Relevant laws, guidelines, and policies should be formulated to prevent disorderly development due to commercialization and ensure that the development and application of generative AI align with ethics and social values. Regulatory content can cover aspects such as data privacy protection, security, fairness, transparency, and accountability. Thirdly, the intelligent review of educational content can be strengthened. It is not only necessary to enhance the use of intelligent technology to review content created by human authors but also to prospectively consider the review of content generated by intelligent technology. Lastly, financial support for the development of generative AI can be increased. The emergence of AI has ignited a technological boom in countries worldwide, making generative AI a new commercial. Commercial competition may lead to technical defects. National governments can provide more financial support for the development and application of generative AI in the education field and strengthen cooperation with universities and research institutions, actively developing large models for educational purposes with independent intellectual property rights.

3.2.2. Data privacy and security

When applying generative artificial intelligence to the field of education, the issues of data privacy and security cannot be overlooked. Since generative AI models require vast amounts of data for training, which may include sensitive information such as personal identification details and academic records, any leak or misuse of this data could pose a serious threat to individual privacy and security.

To effectively protect data privacy and security, a series of measures must be implemented. Firstly, encryption technologies should be employed to ensure the security of data during transmission and storage. Secondly, access control mechanisms should be established to ensure that only authorized personnel can access the data. Additionally, anonymization and de-identification measures should be taken to further safeguard personal privacy.

Beyond technical means, it is also necessary to enact relevant laws and regulations that set standards and processes for data collection, usage, and protection to ensure the legality and security of the data. Moreover, data privacy and security should be incorporated into the development and application guidelines for generative AI, fostering its sustainable development and promoting a culture of responsible use in education.

3.2.3. Keep thinking about education

Ethical considerations for generative AI tools are becoming more prominent in education. With the widespread use of AI, students are utilizing its generated content to complete their assignments, leading to apprehension among educators and schools and the banning of such tools in some districts. At the core of education lies teacher-student interaction, with teachers assuming an important role as knowledge transmitters and enablers, and this educational authority is the foundation for achieving holistic student development.

However, the intervention of AI is challenging the traditional teacher-student relationship and educational authority, and undermining the knowledge advantage of teachers. Michel Foucault pointed out that power is connected to knowledge, and while AI provides rich learning resources, it may lead to teachers' dependence on technology and loss of educational beliefs, triggering a crisis of educational beliefs. Therefore, in the era of AI, it is necessary to rethink the nature of education and clarify the boundaries of the application of AI and the role of AI. AI cannot replace teachers but should complement educational authority, share educational authority, promote educational beliefs, and turn challenges into opportunities.

4. Generative artificial intelligence helps reform integrated circuit liberal arts courses

4.1. Using AIGC to drive the digital transformation of IC general education courses

The researchers conducted a comparative study between AI-generated videos for general IC courses and traditional instructional videos produced by senior faculty members, and the results show that AI-generated learning videos show good potential in online educational environments. With the help of generative AI, the production of IC course materials becomes faster and more cost-effective, offering new possibilities to address the shortage of educational resources in continuing and distance education. The use of AIGC to drive the digital transformation of general IC courses has changed the way of teaching and learning, while also influencing the creation of course content, the innovation of teaching methods, and the optimization of the learning experience.

4.2. AIGC leads interdisciplinary teaching and learning to optimize IC general education courses

D. Ausubel's theory of meaningful learning suggests that carefully selected and processed instructional content by teachers can build an important cognitive bridge between students' prior knowledge and new knowledge [13]. Looking ahead, generative artificial intelligence (AIGC) will improve the efficiency of this process and drive the educational model of IC general education courses toward more openness, diversity, and personalization [14].

AIGC will break down disciplinary barriers, promote cross-disciplinary teaching, and provide students with a more comprehensive and systematic learning experience by automatically analyzing the connections between different fields through machine learning and natural language processing technologies. For example, students can learn about history, geography, and engineering related to integrated circuits and explore the

intersections between different disciplines through the AIGC platform, thus fostering cross-disciplinary thinking and problem-solving skills [15].

In addition, AIGC will promote cross-school cooperation and resource sharing, connecting educational resources from different schools through the Internet and cloud computing technology to provide students with richer and more diverse learning opportunities. Students can communicate and cooperate with their classmates from different schools through the online course platform to expand their learning horizons and collaborate on learning tasks.

Finally, AIGC will provide efficient training and education services for people in different industries and fields, automatically designing IC-related course content and teaching strategies through natural language processing technology and deep learning algorithms, providing customized learning experiences, and helping students enhance their competitiveness in the job market.

5. Reflections and summaries

Generative Artificial Intelligence (AIGC) brings opportunities and challenges to the construction of IC general education courses. It can optimize the division of IC general knowledge courses, automatically generate materials that nurture original IC-related specialties, provide students with curriculum planning that combines experimental practice and theoretical teaching, and promote the overall development of students, but it also faces problems such as technological limitations, ethical safety, and teacher quality. Therefore, there is a need to actively address these challenges and fully utilize the advantages of AIGC to promote the reform of IC general education courses and to cultivate innovative talents who can adapt to the future society.

In the future, AIGC will promote the digital transformation of IC general education courses, and promote interdisciplinary teaching, cross-school cooperation and resource sharing in IC courses. At the same time, the transparency and security of AIGC's technology development must be strengthened to ensure its compliance with ethical and social values and to promote responsible use.

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