Application Research of Artificial Intelligence Generated Content in Programming Courses

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Abstract: Against the background of digital transformation of education and the demand for teaching innovation in programming courses, this paper analyzes the state of Artificial Intelligence Generated Content (AIGC) technology application, and elaborates in-depth on how AIGC empowers the teaching of programming courses. By introducing the new technologies, methods, and programs brought by AIGC, such as intelligent instructional design assistance, course learning assistant applications, and the outlook of new digital teaching materials, this paper demonstrates the great potential of AIGC in teaching. These innovations are expected to promote personalization and differentiation of teaching and learning, enhance the quality and effectiveness of teaching and learning, and provide forward-looking insights and directions for further deepening education reform. In addition, this paper explores the challenges of implementing these AIGC-enabling strategies, which provide useful references for practitioners and are valuable for promoting the development of programming education.

Keywords: AIGC; Teaching Programming Courses; Intelligent Instructional Design; Personalized Learning

1. Introduction

The digital transformation of education has emerged as a significant trend in the field of education today due to the quick growth of digital technology. The emergence of ChatGPT, a generative artificial intelligence platform, has not only sparked a new wave of industrial upheaval but has also created previously unheard-of possibilities for educational innovation. The speed at which technology is developing not only raises expectations for the education sector to see methodical advancements and changes but also advances China's efforts to digitize education and create a nation and society where everyone has access to lifelong learning. This emphasizes the significance and urgency of digital transformation for the education sector.

Against this backdrop, the Ministry of Education (MOE) has successively issued a series of important policies and strategic actions to respond to and promote the process of education digitization.2022 In April 2022, in-depth implementation of the Pilot Action for Artificial Intelligence-assisted Teacher Team Building was explicitly proposed in the Plan for Strong Teachers in Basic Education for a New Era jointly issued by the Ministry of Education and eight other departments. In the Overall Layout Plan for the Construction of Digital China released in February 2023, it was emphasized to vigorously implement the strategic action of digitization of national education and improve the national wisdom education platform [1]. In the World Conference on Digital Education held in the same year, the standard of Digital Literacy for Teachers was released, which includes teachers being able to build a new form of teaching based on digital technology, carry out digitally empowered teaching practices, and realize the cultivation of first-class talents. The release of this series of important documents not only fully demonstrates the government level's deep concern and strong support for contemporary education in the new technological environment, but also foretells the broad application prospects of AIGC and other advanced technologies in the field of education.

2. Status of Teaching and Learning in AIGC-Enabled Computing Programs

On November 30, 2022, OpenAI released the artificial intelligence model ChatGPT, sparking a revolution in information technology. The AI model represented by ChatGPT is called Generative Pre-trained Transformer (GPT) or Large Language Model (LLM) based on its working principle. AIGC includes both GPT and LLM, which represents a broader concept. broader concept. Compared to professionally generated content (PGC), which is limited by capacity, user-generated content (UGC), which is limited by content quality, and occupation-generated content (OGC), which is limited by technological conditions, AIGC has gained a lot of attention in the academic community by the intelligent and real-time nature of its content generation [2].

As a "wisdom tool", AIGC can promote innovative changes in the concepts, ideas, modes, and methods of education and teaching in the digital transformation of education, injecting new vitality into the field of education. Currently, AIGC technology has reached a high level of maturity in the field of content generation, which significantly improves the professional ability of teachers in the preparation of teaching materials and the design of learning experiences, and helps promote the teaching model at the ideological level towards human-computer collaboration, knowledge breakthroughs, downward compatibility, and iterative "wisdom"[3]. More importantly, AIGC can meet the differentiated needs of individual learners and help students adjust their learning process in time through the instant interaction mechanism, thus providing scientific support for the construction of highly personalized learning paths [4]. Zhang et al. analyzed the research value of the educational Q&A system based on the large language model in the field of education from the dimensions of the practical application of AIGC in the educational Q&A system and its impact on the field of education. The superiority and feasibility of such systems are verified through quantitative analysis in three dimensions: multi-round Q&A effect, no-sample (few-sample) learning, and multi-modal question processing [5]. Xu et al. developed a dialogue teaching system called "Socrates Playground", which focuses on teaching behavioral statistics and can implement Socratic teaching mode using a large language model, revealing the great potential of generative artificial intelligence in revolutionizing personalized learning methods [6].

In the teaching practice of computer courses, AIGC technology can assist teachers in the construction of intelligent teaching resources, such as the automatic generation of programming code examples, project design cases, online Q&A, and other teaching sessions, breaking the traditional teaching time and space limitations. For example, in the process of designing the teaching program for the data structure course, Guo et al. used the multimodal generation function of Wenxin Yiyin for the production of microclasses and courseware materials, as well as the assisted design of serial problems and open questions corresponding to the teaching knowledge points [7]. Jiang innovated the teaching strategy in response to the trend of tooling and simplification of microcontroller programming presented in the context of rapid development in the field of artificial intelligence. Students are allowed to use automatic code generation tools in teaching so that they can focus more on the learning and practicing of the hardware part when learning the development of microcontroller application devices. Thus accelerating the development of practical projects and better adapting to the development needs of the industry [8]. In the process of designing the corresponding experiments for the operating system course, Yingpei Zeng simplified the process of kernel debugging, kernel data viewing, and programming implementation by introducing tools such as QEMU, Crash, and ChatGPT. While maintaining the simplicity and intuition of the basic steps of the experiments, special emphasis was placed on the innovative requirements of the experiments to ensure that the students are not completely dependent on the tools but can utilize their creativity and problem-solving abilities based on the use of the tools to assist their learning [9].

3. Application and Prospects of the Big Language Model in Programming Courses

Most of the practical applications of computer science courses that incorporate AIGC technology use the Generalized Large Language Model. The general-purpose model benefits from its extensive training dataset,

which can cover multiple domains and thus be applied to different types of courses. Programming courses, as an important part of training students' computational thinking, are now taught in many universities as general education courses or professional foundation courses. Such courses have certain requirements for students' programming skills, logical thinking, and problem-solving abilities. However, in the traditional classroom model, it is often difficult for teachers to take care of the individual differences of each student. The introduction of the Big Language Model can provide a new way to realize the Smart Adaptive Teaching mode so that the programming courses can tailor the learning paths and resource recommendations for different students according to their learning progress, style, and ability, and further realize personalized and differentiated teaching.

3.1 Intelligent Instructional Design Assistance

In recent years, online course resources based on MOOC and SPOC forms of programming have been relatively abundant, and teachers can help students realize independent learning of knowledge points with the help of high-quality resources from first-class colleges and universities or through self-built courses. At the same time, teachers can release online learning activity tasks for microcourse knowledge points to evaluate the learning effect of students. However, the current online platform statistics are more based on the evaluation of learning results, such as the completion rate of programming exercises, the correct rate, the score level, and other conventional data. However, digital intelligent tools built based on big models can provide a more intelligent evaluation of the learning process. In the course, KIMI and ERNIE Bot Large Model can be utilized to upload students' homework documents based on the evaluation criteria given for programming assignments, and the system will generate more diversified evaluation suggestions for individual students and the class as a whole, such as the mastery level of different programming knowledge points and learning difficulties based on the feedback from the evaluation. At the same time, teachers can further interact with the big language model based on the evaluation data generated, by clearly describing the students' learning situation in their majors, enabling the model to help teachers analyze the students' learning difficulties, and generate programming cases and exercises that are more suitable for the current teaching class, on which the teachers can optimize the generated content and improve the course teaching design so that the teaching can be transformed from "teacher-student interaction" to "teacher-student interaction". Teacher-student interaction" to "teacher/student/machine" in-depth interaction change, to achieve the reconstruction of the teaching process.

3.2 Use of Course Learning Assistants

Figure 1. The Interactive Interface of the Python Learning Assistant of Zhipu AI

The Generalized Large Language Model is not completely accurate from input to output, so it may have problems such as lack of accuracy and illusion in serving specific courses. The AI identity roles can be set in the application process so that they can be more accurately applied to different programming courses. For example, the course can utilize the intelligence related to the programming class courses that have been released in the Zhipu AI platform to assist in teaching, such as the Python Learning Assistant shared by the platform as shown in Figure 1. At the same time, the instructor can also create and use assistants that are suitable for course learning by personalizing the intelligent bodies according to the teaching design of the course itself, the pre-accumulated lecture materials, and the specific needs of the course. During the creation process, structured prompts can be designed to describe the attributes of the intelligent body in a comprehensive and detailed manner, including its application scenarios, capabilities, targeting, operational constraints, and overall workflow, and the design of the intelligent body can be optimized by using the Retrieval Augmented

Generation (RAG) technology.

As shown in Figure 2, by incorporating the course knowledge base and using augmented request cue words in the process of creating the intelligent body, the teacher can, to a certain extent, solve the problems of lack of accuracy and illusion of the large language model in the service vertical, ensure the consistency of its interactive content with the teaching content, and make it become a smart-adaptive assistant teacher of the course, and provide personalized learning guidance and question-answering services for the students. The functions that can be realized by the intelligent body as a learning assistant include:

(1) Knowledge point inquiry and display

When students use the Learning Assistant to query the knowledge points related to programming courses, the system can respond quickly and provide more detailed syntax descriptions, clear and intuitive explanatory videos, as well as programming examples close to the actual application.

(2) Intelligent Practice Question Generation

During the student's learning process, the learning assistant can dynamically generate practice questions matching his/her level according to his/her current learning status and progress, to help the student consolidate what he/she has learned.

(3)Evaluation of Learning and Suggestions

At the end of the study, the Learning Assistant can provide objective and fair grading based on the student's overall learning performance and outcomes, as well as personalized follow-up learning suggestions for the student's weak areas.

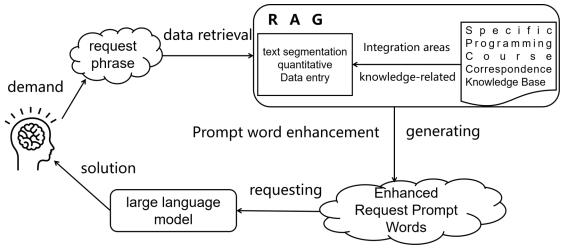

Figure 2. Principle of Intelligent Body Design based on RAG Technology

(4) Instant Q&A

Learning Assistant also has an instant Q&A function, which can quickly answer all kinds of questions encountered by students in programming learning and help students solve learning obstacles in time. To prevent students from directly utilizing the learning assistant to complete their assignments, the course can choose a platform that includes a question-answering interface and a strict time limit for question-answering for the release of assignments.

3.3 Prospect of Digital Teaching Material Sample

At present, big data, the Internet of Things, cloud computing, 5G, artificial intelligence, virtual reality augmented reality, and other technologies have gradually realized in-depth integration in the field of teaching, which has manifested in a radical change in the external form of teaching materials. Digital teaching materials surpass the knowledge carrier function of traditional teaching materials, integrate different forms of educational resources, and have multi-dimensional patterns such as knowledge patterns and technology patterns, expanding into a teaching system that integrates various types of resources, and is also a learning platform that supports students' personalized learning and close interaction with multiple subjects[10]. Currently, the presentation form of digital teaching materials for programming classes is still single, mainly focusing on the embedding of microclasses and the integration of question-answer interaction, which limits the richness and interactivity of the learning experience to a certain extent. With the integration of AIGC technology in digital textbooks, we need to reconstruct digital textbooks to reconstruct the learning scene and improve the learning effect. The following is a multidimensional sample outlook for future digital textbooks to reconfigure the learning scene.

(1) Personalization and Generation of Knowledge Samples

In programming courses, we anticipate that digital textbooks will be expected to realize an automatic pre-study interaction mechanism. After students select a course, the system comprehensively collects students' learning backgrounds, learning objectives, and learning needs through questionnaires and pre-knowledge tests. Based on these data, the digital teaching material platform can utilize AIGC technology to deeply analyze and adaptively generate digital teaching materials. For example, it can be customized according to students' characteristics, including difficulty adjustment, knowledge point selection, and case design, to ensure that each student can

obtain the most suitable learning materials for him or her, to improve the learning effect.

(2) Intelligent analysis and real-time optimization of learning samples

With the digital textbook platform, students' learning process is fully tracked, including reading materials, watching videos, and completing exercises. We expect the platform to automatically generate learning reports and process feedback through intelligent analytics, helping teachers and students to clearly understand the learning status and identify weaknesses in learning. At the same time, based on students' learning data, the platform can regularly assess the adaptability and effectiveness of the content of the teaching materials and make real-time updates and optimizations accordingly.

(3) Intelligent Recommendation and Extension of Content Samples

Students are the users of teaching materials and also the participants in optimizing and adjusting the materials. In the future, with the accumulation of knowledge graph data, we will be able to intelligently recommend programming learning materials through students' learning process data. This includes data on students' participation in computer-related learning seminars, sharing of learning experiences, and summarization of learning. These perspectives and reflections from students can be incorporated into the database as an important source of content for textbook expansion. Through continuous content expansion, digital teaching materials will become richer, more diverse, and practical to meet the diverse learning needs of students.

(4)Multimodal Expansion of Presentation Patterns

The future digital teaching materials for programming courses will realize multimodal expansion, which can introduce audio, animation, VR/AR, and other modalities in addition to the traditional forms of text, pictures, and video. These multimodal presentations will make the presentation of knowledge points and cases more vivid, intuitive, and easy to understand. At the same time, the digital teaching material platform can also incorporate the virtual simulation experiment function, so that students can practice in a programming environment close to the real one. A rich project library and resource library are established to provide students with more practice opportunities and learning resources.

When looking forward to the construction of digital teaching materials in future learning scenarios, we also have to face up to the challenges and problems it faces. With the continuous integration and development of technology, the boundaries between teaching materials and learning platforms are becoming increasingly blurred, and the interpenetration of the two has become an inevitable trend. However, there is still a lack of clear standards and guidance in this area, and there are urgent issues to be resolved on how to define the functional scope of teaching materials and learning platforms, how to ensure the synergy of the two, and how to assess the quality and effectiveness of digital teaching materials.

4. Conclusion

Under the background of the era of rapid development of digital technology, the digital transformation of education has become an irreversible trend, and the rise of AIGC has injected new vitality and possibilities into this process. The high degree of maturity of AIGC technology in the field of content generation makes it able to play an important role in the construction of teaching resources and the design of learning experiences. In programming courses, the application of AIGC technology provides a new way for the realization of the smart-adaptive teaching mode. With the support of intelligent tools, teachers can more accurately analyze students' learning, and tailor learning paths and resource recommendations, thus further realizing personalized and differentiated teaching. At the same time, the big model can also play an important role in the evaluation of the learning process, course learning assistant, etc., providing teachers and students with more comprehensive and diversified teaching and learning support.

Looking ahead, with the continuous development and improvement of AIGC technology, the prospect of its application in the field of education will be even broader. We look forward to seeing more educators and technology developers working together to explore the innovative applications of AIGC in education and to contribute to the cultivation of more high-quality talents with innovative spirit and practical ability. At the same time,

we also need to pay attention to the ethical issues and potential risks in the application of technology to ensure that the fruits of technological development can benefit the majority of teachers and students, and promote the sustainable and healthy development of education.

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