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# Research on Computer Science Education Empowered by GenAI

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**Abstract:** The uneven distribution of higher education resources between eastern and western China has a long history. In particular, computer science education in Western regions, constrained by geographical, economic, and brain drain issues, lags significantly behind that in Eastern regions. The development of GenAI technology brings new opportunities for Western computer science education to catch up. This paper focuses on GenAI-empowered reform in computer science education and explores its application in optimizing teaching content and innovating teaching models. The study proposes GenAI-based strategies for optimizing course teaching content, including enhancing basic, practical, and cutting-edge content of computer courses. Additionally, it explores the innovation of a "teacher-student-machine" collaborative teaching model, emphasizing the improvement of teaching effectiveness and students' learning experience through human-machine collaboration. This study provides new ideas and methods for the reform of computer science education and offers practical references for the application of GenAI technology in higher education.

**Keywords:** Computer science; GenAI; Teaching model; Teaching content

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## 1. Introduction

China's eastern-western divide in higher education resources persists, with western universities housing under 30% of "Double First-Class" institutions and facing lower per-student funding, higher student-teacher ratios (e.g., 17.2 in Xinjiang vs. 17.7 in Jiangsu), and inadequate tech infrastructure (0.16 devices/student vs. 0.23 in Jiangsu) [1]. These disparities hinder computer science education, particularly in practical training for programming and software development.

GenAI technology, encompassing tools like GitHub Copilot and CodeGeeX, presents a breakthrough by automating routine tasks, enabling personalized learning, and updating curricula with industry trends [2-4]. It allows teachers to focus on creative instruction while providing students with AI-assisted coding practice and adaptive learning support. However, challenges include data privacy risks and ethical concerns [5].

This study examines how GenAI can address western universities' critical needs: outdated curricula, rigid teaching models, and limited practical opportunities. By optimizing course content and developing human-AI collaborative models, it aims to contribute to educational equity in computer science education.

# 2. Education empowered by GenAI

## 2.1. GenAI products empowering programming education

GenAI's educational application has evolved from rule-driven systems to intelligent creation: 2010–2017 focused on adaptive learning and basic tutoring; post-2018, large models like GPT enabled content generation; and since 2023, vertical models such as DeepSeek have fully unleashed its potential. Today, GenAI handles grading, test generation, and serves as programming/personalized learning assistants, even enabling multimodal virtual teaching. Its educational product forms have advanced from Apps, mini-programs, and cloud platforms to large models and virtual robots [6].

**Table 1.** GenAI products empowering programming education

| Product Name | Main Functions | Supported Languages | Applicable Scenarios |
|---|---|---|---|
| Cursor | Code suggestions, error detection and repair, multi-line editing, cross-file context analysis, etc. | Python, Java, C++, and other mainstream programming languages | Programming education, rapid development |
| Trae | Code generation, code optimization, project construction, interactive Q&A | Python, JavaScript, etc. | Programming education, daily development |
| CodeGeeX | Code generation, code completion, code translation | Over 100 programming languages | Programming education, technical research |

**Table 1** outlines GenAI programming assistants in education. Tools like Cursor and Trae support natural language code generation, interactive preview, and multi-language programming, offering students an efficient learning aid. Aligned with computer science curricula (covering C/C++, Java, Python, and mobile development), these tools complement coursework by enhancing practical skill mastery, learning efficiency, and innovation.

GenAI assistants boost efficiency across skill levels: beginners gain code examples to grasp concepts and reduce teacher repetition; intermediate learners get code completion, error detection, and project support to accelerate practice. Such support helps students translate theory into engineering competence, master tech stacks, build teamwork, and strengthen employability—aiding both learners at all stages and teaching innovation.

## 2.2. Computer science education empowered by GenAI

GenAI tools streamline teaching but raise demands on educators: they must update technical skills, shift from knowledge transmitters to learning guides, and design engaging scenarios. While GenAI accelerates content creation and updates, teachers must vet quality, accuracy, and relevance to avoid over-reliance. They also need to navigate data privacy regulations, guide ethical tool use, and master human-machine collaboration.

Gao Qiong *et al.* [7] categorize human-machine collaboration as invisible (intelligent grading, resource), visible (smart robots, interactive learning), and hybrid, stressing integration of both to optimize teaching. Educators should blend these models, leveraging GenAI for personalized plans while steering objectives and focus on AI-resistant competencies like emotional guidance and critical thinking [8,9].

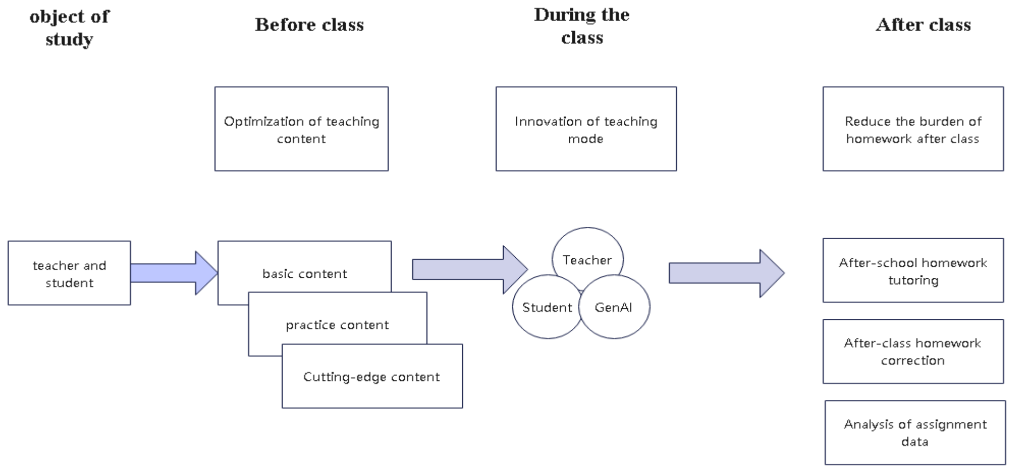


**Figure 1.** Framework diagram of GenAI integration into the classroom.

This study leverages invisible human-machine collaboration to optimize teaching content and innovate the "teacher-student-machine" model (**Figure 1**). Pre-class, GenAI (Deepseek, KiMi, etc.) updates curricula with cutting-edge industry content and personalized learning materials. In-class, a tripartite interaction model encourages dialogue between students and AI teaching assistants, fostering a collaborative ecosystem of teacher guidance, student practice, and AI support. Post-class, GenAI aids teachers in grading, tutoring, and homework data analysis.

## 3. Optimization of computer science course teaching content based on GenAI

The core value of GenAI technology is not to replace teachers but to release teachers' energy to engage in creative teaching by handling standardized work in teaching. Especially in computer science course teaching, GenAI provides strong support for optimizing teaching content, forming a dynamic cycle process covering foundation, process, practice, frontier, literacy, and ability, as shown in **Figure 2**.

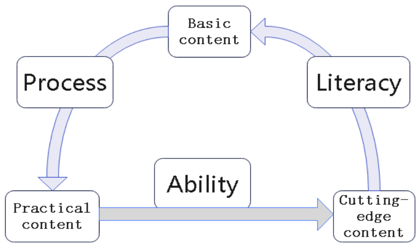


**Figure 2.** Flowchart of AI-assisted teaching content optimization.

As can be seen from **Figure 2**, the optimization of computer science course teaching content empowered by GenAI presents a three-dimensional pattern integrating the vertical deepening of "basic content-practical content-cutting-edge content" and the horizontal expansion of "process-literacy-ability." In the theoretical teaching of computer courses, GenAI products such as DeepSeek, Kimi, and Doubao help teachers improve lesson preparation efficiency and lay a solid theoretical foundation for students. DeepSeek is good at automatically generating teaching objectives, analyzing key and difficult points, recommending teaching strategies, and intelligently screening high-quality resources, saving lesson preparation time. Kimi is proficient in quickly generating high-quality PPT pages, supporting text-image mixing and animation effects, making teaching more vivid. In addition, products like Doubao can also automatically generate test questions, simplifying the question-setting process. By reasonably using these tools, teachers can efficiently design basic teaching content and improve the efficiency and quality of lesson preparation.

## 4. Innovation of the computer science course teaching model based on GenAI

GenAI technology provides new opportunities for innovating computer science course teaching models. In the classroom, introducing GenAI teaching assistants forms a new model involving teachers, students, and GenAI teaching assistants, with efficient interaction among the three parties to improve teaching effectiveness and students learning experience. The "teacher-student-machine" teaching model is shown in **Figure 3**.

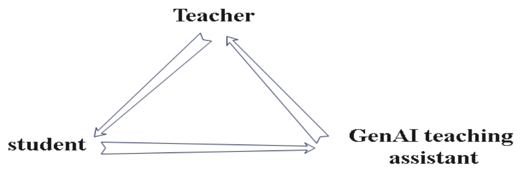


**Figure 3.** "Teacher-Student-Machine" teaching model.

**Figure 3** shows the "teacher-student-machine" teaching model, revealing the collaborative relationship between teachers, students, and technology in GenAI-empowered educational reform. In this model, teachers transform from knowledge transmitters to learning guides and supporters, stimulating students' independent exploration by designing inspiring scenarios and using AI teaching assistants for accurate data analysis to implement personalized teaching. GenAI teaching assistants generate teaching plans, courseware, and exercises for teachers, reducing teaching burdens and providing feedback on learning effects through intelligent evaluation functions to facilitate teaching adjustment. Students become active knowledge constructors, acquiring knowledge through interaction with GenAI teaching assistants, conducting in-depth exploration in scenarios created by teachers, and cultivating practical abilities.

## 4. Conclusion

This study deeply explores the application of GenAI technology in computer science course teaching, proposing GenAI-based strategies for optimizing teaching content and a "teacher-student-machine" collaborative teaching model. The research finds that GenAI technology can significantly accelerate the update speed and enrich the richness of teaching content, while innovating teaching models to improve students' learning enthusiasm and innovative abilities. These achievements not only provide new ideas and methods for the reform of computer science education in Western universities but also strongly support the equalization of educational resources. Future research will further deepen the application of GenAI technology in the education field, especially in addressing data privacy and ethical issues and improving teachers' technology application abilities.

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## Disclosure statement

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