Exploration of the Reform Path of C Programming Course Empowered by AI

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Abstract: ***To address the traditional teaching dilemmas of the C programming course, this study explored the deep integration path of AI technology and the course, systematically sorted out the domestic and international research status of AI technology empowering programming course teaching, and deeply explored the innovative applications of the deep integration of AI technology and the course. Relying on the Superstar AI Workbench in the Superstar Fanya online teaching platform and the free AI tool DeepSeek large model, a "four-in-one" teaching model of "knowledge graph-guided learning, AI-assisted practice, intelligent optimization of project practice, and multi-intelligence assessment" was constructed, and the coping strategies in the course reform were discussed. The research results show that this model effectively improves the teaching efficiency and students' programming ability, providing a practical reference for the intelligent reform of similar programming courses.***

Keywords: AI-assisted teaching; C language; Programming; Four-in-one; Teaching reform.

1. INTRODUCTION

In December 2024, the General Office of the Ministry of Education issued a notice, clearly stating that "closely adhering to the educational mission in the new era and new journey, meeting the needs of cultivating innovative talents for the future" and "leading the construction of a people-centered innovative education ecosystem with artificial intelligence." Higher vocational education should actively respond to the national call and address the new opportunities and challenges brought by the wave of AI technology. Therefore, this study aims to explore how to use artificial intelligence technology to systematically break through the traditional dilemmas faced by the C programming language course in aspects such as teaching content, practical links, personalized learning support, and evaluation methods, in order to build a new type of efficient teaching paradigm.

Ge and Wu (2023) conducted an empirical study on the adoption of ChatGPT for bug fixing among professional developers, providing insights into AI-assisted software maintenance [1]. Zhang (2026) proposed a hybrid LSTM-GARCH model that integrates volatility factors from US financial markets for improved predictive performance [2]. Han et al. (2026) developed a dual-scale model with collaborative reasoning and multi-feature fusion for robust detection of AI-generated images [3]. Wang (2026) examined the broader application of computer science and technology in the big data context [4], while Ma (2025) presented a unified framework for congestion diagnosis and dynamic mitigation in complex networks [5]. Jin (2025) focused on optimizing order allocation algorithms for industrial internet platforms [6], and Miao (2026) explored big data technologies for enhanced network security analysis [7]. Wang (2025) enhanced object detection in photovoltaic farm panoramic imagery using a multi-scale feature-enhanced YOLOv8 [8]. Deng (2025) addressed graph inference towards ICD coding, leveraging graph-based methods for medical code assignment [9]. Gao et al. (2026) conducted an experimental study and geomechanical modelling of hard and soft rock masses including fault zones, combining field data with numerical simulations [10]. Gao (2025) investigated the international intelligent operation model of "digitalization + greening" dual-track collaboration for industrial electrical enterprises under intelligent drive [11]. Shen et al. (2025) applied the whale optimization algorithm to financial payment fraud detection, demonstrating its efficacy in identifying fraudulent transactions [12]. Sun (2025) tackled accessibility challenges and solutions in designing inclusive digital interfaces [13]. Zhou (2026) used gradient boosting trees to diagnose bottlenecks in international automotive sales funnels, with evidence from cross-regional team efficiency evaluation [14]. Wang et al. (2026) developed QA-ReID, a quality-aware query-adaptive convolution that fuses global and structural cues for clothes-changing person re-identification [15]. Li et al. (2026) proposed MFT, a memory-aware fine-tuning approach for SAM2, enabling efficient long-sequence video object segmentation [16]. Yuan et al. (2026) introduced TA-Mem, a tool-augmented autonomous memory retrieval method for large language models in long-term conversational question answering [17]. Peng et al. (2024) presented a dual-augmentor framework for domain generalization in 3D human pose estimation, enhancing model robustness across unseen environments [18]. Finally, Shan et al. (2025) rethought wine tasting for Chinese consumers through a service design approach enhanced by multimodal personalization, bridging sensory experience with user-centric technology [19].

2. COURSE FEATURES AND TRADITIONAL TEACHING DILEMMAS

The C programming language course is a required course for computer and related majors in higher vocational colleges and an important basic course for cultivating students' computational thinking, algorithmic thinking, programming ability, and innovation ability. The rapid development of new-generation information technologies such as artificial intelligence and big data has posed new challenges to talent requirements and educational forms. The following problems have also emerged in the teaching of traditional C programming language courses.

2.1 In Terms of Teaching Content

The content of traditional C language courses mainly focuses on basic grammar, data structures, and simple algorithms, with little connection to actual engineering projects. This makes it difficult for students to understand the specific applications of C language in real-world scenarios and unable to link the knowledge they have learned to actual project development. Especially in emerging fields such as the Internet of Things and embedded systems where C language still plays a core role, the update of traditional teaching content has not kept up in a timely manner, resulting in a disconnect between the knowledge students have learned and market demands.

2.2 In Terms of Practical Teaching

Traditional C language practical teaching mostly follows the linear process of "teacher's case analysis - operation demonstration - student imitation - practical consolidation". This teacher-centered and relatively fixed practical mode has limitations in stimulating students' learning autonomy and cultivating their ability to independently solve complex problems.

2.3 In Terms of Students' Personalized Learning

The sources of higher vocational students are diverse, and there are differences in students' learning abilities and acceptance levels. Traditional classrooms are mainly teacher-centered with a unified progress, making it difficult to meet the personalized needs of students. The course teaching platform lacks intelligent push, making it difficult to support students' personalized learning. More importantly, there is a lack of intelligent guidance on the internal logic between knowledge points, making it difficult to promote students' structured cognition of the course knowledge system, thus hindering the progress of deep learning .

2.4 Aspects of Teaching Evaluation

Although the existing evaluation system combines process assessment and summative assessment, the process evaluation mainly focuses on attendance and answering questions, which cannot comprehensively reflect the students' effort, progress, and practical innovation ability, and is not conducive to the comprehensive assessment of students.

3. RESEARCH STATUS OF AI-ASSISTED TEACHING AT HOME AND ABROAD

In the global education field, especially in the teaching reform of computer science and technology majors, the application of artificial intelligence (AI) has increasingly become an important research direction. Especially in programming education, AI-assisted teaching has gradually become a key means to improve teaching effectiveness, enhance students' programming ability and innovative thinking. With the development of information technology, the combination of AI and programming education has become more diverse.

3.1 Current Research Status Abroad

The reform of foreign programming education focuses on using artificial intelligence to achieve personalized feedback, automated assessment, and project-based learning, aiming to improve teaching quality and students' programming skills. Foreign educational institutions have made remarkable progress in this field. Universities such as the Massachusetts Institute of Technology (MIT) and Stanford University have long introduced AI-assisted tools in computer courses. MIT's CS50 programming course integrates AI tools for real-time assignment assessment and uses a ChatGPT-based intelligent programming assistant to provide students with instant feedback. The programming teaching tool developed by Stanford AI Lab, based on natural language processing (NLP), can

automatically generate code snippets according to students' natural language inputs, connecting abstract programming logic with natural language thinking, thus lowering the threshold for programming entry.

Through the collaboration of project-driven and artificial intelligence, artificial intelligence can automatically evaluate the progress and quality of students' projects, reducing the burden on teachers and enabling them to focus more on personalized tutoring. Google's AutoML platform automates the learning and model training processes, provides students with practical projects, and cultivates their programming and project capabilities. Students not only learn programming syntax but also apply it in actual projects, thereby enhancing their ability to solve practical problems.

3.2 Domestic Research Status

Domestic research and practice have closely followed the international trend. Under the impetus of top universities and technology companies, there are two major development paths: "empowering teaching with self-developed large models" and "commercial AI teaching assistant platforms". Many universities and institutions have carried out relevant research and achieved remarkable progress.

1) Research on AI-assisted Teaching

Universities such as Beijing University of Posts and Telecommunications and Huazhong University of Science and Technology have tried AI-assisted teaching in courses such as Java and C language. Tsinghua University's self-developed GLM4 large model has developed an intelligent teaching assistant, realizing functions such as automatic question generation and answering. This AI-empowered teaching model has effectively improved students' learning efficiency and participation .

2) AI Application Cases in Programming Education

The "Yuan Programming" course of Yuanfudao corrects students' homework through AI algorithms and provides personalized feedback. The platform uses deep learning and natural language processing technologies to monitor students' programming processes in real time and correct errors in a timely manner, thereby improving students' programming skills.

3) Integration of Domestic Curriculum Reform and AI

Many higher vocational colleges are reforming programming courses to meet the needs of new engineering talent cultivation. AI technology has become an important driving force for curriculum innovation. For example, Peking University's "Cyber Teaching Assistant" system combines Chat-GPT with the Introduction to Computing course to provide intelligent tutoring, help students solve programming problems, and improve learning effects.

4. CURRICULUM REFORM OBJECTIVES AND IMPLEMENTATION PATHS

4.1 Course Reform Objectives

The objectives of this course reform are as follows: First, to explore a teaching model that is deeply integrated with AI technology and promote the transformation from knowledge transfer to ability cultivation and personalized learning; Second, to select practical AI tools to provide students with instant feedback, personalized suggestions, and error detection; Third, to enhance students' autonomous learning, innovation, and teamwork abilities, and ensure that the course content is closely aligned with the development of enterprises and industries.

4.2 Implementation Path of the Reform

4.2.1 Overall Design of the "Four-in-One" Teaching Model

This course is based on the "knowledge graph guided learning - AI-assisted practice - intelligent optimization project practice - multi-intelligence assessment" four-in-one model. Relying on the Chaoxing Fanya platform and the AI workbench online, and using Deep-Seek as a programming assistant offline, we utilize AI technology to innovate the C language teaching model, thereby improving teaching quality.

The Chaoxing Fanya AI workbench integrates large models such as DeepSeek, Wenxin Yiyan, and Kimi, providing functions such as knowledge graphs, AI teaching assistants, AI learning situation analysis, AI question generation, and AI practice, as shown in Figure 1. Teachers can use the AI functions of the platform to develop teaching plans, create courseware, generate questions, and conduct intelligent grading, promoting the intelligent upgrade of the course. The knowledge graph supports the planning of personalized learning paths, and the AI teaching assistant can supervise learning intelligently, recommend resources, provide instant answers and feedback, helping students achieve course goals.

4.2.2 Reconstruction and Organization of Teaching Content

Taking AI technology as a tool, combined with software engineering thinking and the needs of professional positions, reconstruct the teaching content to achieve the transformation of knowledge into job capabilities, as shown in Table 1.

Table 1: Reconstruction of Course Content and AI Applications

Module Division	Main Knowledge	Role of AI
Basic Syntax	Variables, Expressions, Functions, etc.	Quickly query syntax and generate code using AI tool (DeepSeek)
Algorithmic Thinking	Control Structures, Algorithms	Generate code framework using AI tool and focus on logic optimization
Core Technologies	Pointers, Structures	AI-assisted annotation to explain errors and improve efficiency
Project Practice	Implementation of Student Information Management System and Intelligent Light Control Effect	AI-assisted generation of framework for quick start
Cross-integration	Applications such as Embedded	AI-assisted understanding of cases to stimulate innovation and higher-order thinking

4.2.3 AI-driven Innovation in Teaching Links

The project has built an intelligent education ecosystem based on the DeepSeek large model and the Chaoxing AI workbench, focusing on the innovation of the teaching scenarios of programming courses. As shown in Table 2, through code understanding, intelligent evaluation, and personalized learning path planning, an efficient teaching paradigm is created. The course adopts a hybrid online and offline teaching method, and the Chaoxing knowledge graph sorts out teaching elements to form a visual knowledge framework. Before class, the teacher uses the AI assistant to collect materials, update the question bank and cases, and conduct multi-dimensional analysis through AI learning situation analysis to formulate an effective teaching design. Students can get answers with the help of the AI teaching assistant when they have questions before class, achieving self-diagnosis and instant feedback. During class, the integrated theory and practice teaching is implemented, and DeepSeek helps with code writing, annotation, error correction, and interactive Q&A, reducing the difficulty and improving the efficiency. After class, students complete project practices in groups, and DeepSeek provides framework generation, code evaluation, and optimization suggestions to cultivate engineering thinking. The teacher collects the results, generates a class portrait, and pushes resources to achieve a closed-loop of "diagnosis - teaching - evaluation".

Table 2: Application Scenario Design of Chaoxing AI + DeepSeek Large Model in Programming Courses

Teaching link	Use AI tools	Application scenario	AI technology application	Teaching effectiveness
Pre-class preview	Superstar AI Workbench	Material push, knowledge graph	Personalized push, visual knowledge structure	Improve learning interest, deepen understanding
Theory learning	Superstar AI Workbench, DeepSeek large model	Interactive Q&A, intelligent question answering	Code examples, algorithm steps, personalized learning suggestions	Quickly understand the theory, reduce learning difficulty
Practice teaching	DeepSeek large model	Code writing and error correction	Code comments, auto-completion, comparison of different implementation methods	Personalized tutoring, quick error correction, improve efficiency
Project practice	DeepSeek large model	Framework generation, evaluation	Framework pseudocode, complex code, error detection and optimization	Quickly obtain feedback, enhance innovation and teamwork ability
Post-class consolidation	Superstar AI Workbench	Result display, evaluation	Dynamic display, intelligent evaluation, data-driven learning portrait	Precision teaching, "diagnosis-teaching-evaluation" closed loop

4.2.4 Construction of a Multiple Intelligence Evaluation System

The Superstar AI Workbench collects various types of student learning data to build a rich raw data pool, laying the foundation for multiple intelligence assessment.

Behavior data: Records students' operations, such as logins, learning durations, clicks, etc., reflecting their concentration and mastery.

Interaction data: Collects interactions between teachers and students and among students, such as questions in the discussion area and private messages, etc., reflecting the expression and exchange of views.

Outcome data: Collects exam scores, assignments, project reports, etc., demonstrating students' skills and application abilities.

By continuously collecting these three types of data, a multiple assessment of students' mastery is achieved. The platform establishes a feedback mechanism to instantly transform the assessment results into learning suggestions (such as pushing resources, reminding of falling behind in learning, etc.), forming a virtuous cycle of "assessment - suggestion - feedback - optimization".

4.3 Course Reform Achievements

In 2018, Baoji Vocational and Technical College recognized this course as an excellent course, and in 2023, it was recognized as a unit gold course and a college-level online open course. The course was launched on the Superstar Learning Platform and has been running for 4 rounds. The number of students selecting the course reached 4,028, and the cumulative page views were 8,554,324. Over the years, the course has fully integrated elements from multiple dimensions such as employment needs, course content, competition training, and certification requirements, and introduced project-driven and case teaching methods to help students smoothly transition from theoretical learning to programming practice. Especially in 2023, the Superstar AI Workbench was launched on the platform. Combining with the DeepSeek large model, it achieved AI empowerment and promoted the transformation of the course into a smart course. The four-in-one course teaching model has helped students achieve excellent results in programming skills competitions. In the past two years, they have won 3 national awards and 8 provincial awards.

After the implementation of this teaching model reform, the passing rate at the end of the semester of the course has increased from 73.79% before the reform to 85.36%. The post-class questionnaire shows that 82% of the students reported that after targeted learning according to the learning suggestions, they had a deeper understanding of the course knowledge and a significant improvement in learning efficiency. The project results and classroom feedback indicate that the teamwork and communication abilities have been significantly improved, and the classroom participation has been significantly enhanced. This fully proves that the model of real-time assessment transformed into learning suggestions can effectively improve learning outcomes and verifies the scientificity and feasibility of this teaching model.

5. PROMOTIONAL AND APPLICATION VALUE OF THE PROJECT

5.1 Precise Empowerment: Comprehensively Enhancing Educational Quality and Students' Comprehensive Abilities

In the field of vocational education, the project deeply empowers the teaching of C programming courses through AI technology, creating a personalized and intelligent learning support system for students. The Superstar AI Workbench provides dynamic feedback based on multi-dimensional learning situation data, and the DeepSeek large model analyzes code logic, provides optimization suggestions, and conducts precise analysis and feedback according to the students' situations. This model has significantly improved students' programming skills, algorithm design, and problem-solving abilities, helping students quickly master programming skills that meet industry standards and enhancing their career competitiveness.

5.2 Deep Integration to Build a New Ecosystem of Industry-Education Collaborative Education

The teaching model constructed in this study naturally builds a bridge between education and the industry by introducing project cases derived from real industrial demands. While students master programming knowledge, they solve industry problems through practical operations, enhancing their practical and innovative abilities. With deep cooperation between schools and enterprises, the enterprises provide real demands and cases, enabling students to grow in an environment close to actual work, which not only facilitates the development of students

but also transports technical talents with practical abilities to the enterprises.

5.3 Innovation-driven, Leading the New Trend of Educational Informatization Reform

The promotion of the project has driven the innovation of educational models and the development of educational informatization. Through hybrid teaching, AI-assisted and other models, the limitations of traditional classrooms have been broken, and a flexible and diverse learning environment has been constructed. AI tools have enabled personalized intelligent teaching, and the learning data on the platform has provided support for teaching optimization, thus comprehensively improving the efficiency and quality of education.

FUND PROJECT

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