Journal of Electronic Research and Application, 2025, Volume 9, Issue 6
http://ojs.bbwpublisher.com/index.php/JERA
ISSN Online: 2208-3510
ISSN Print: 2208-3502

Applied Research on AI Technology Empowerment in Single-Chip Microcomputer Course Teaching

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Abstract: In recent years, the application of various advanced technologies, such as digitization and informatization, has become the primary tool for innovation in education and teaching. For traditional single-chip microcomputer course teaching, it is necessary to emphasize the introduction and application of high-tech innovations in its path of innovative development. This course is a typical representative of multidisciplinary teaching, involving multiple disciplines such as electronic engineering, automation, and computer science. In response to issues faced in traditional teaching, such as rigid organization of teaching content that struggles to keep pace with technological advancements, resulting in a noticeable lag in knowledge transfer, and monotonous teaching methods that fail to precisely meet the diverse learning needs of students, analyzing the innovative applications of this course under the empowerment of AI technology holds significant practical relevance. In this regard, the study relies on AI technology empowerment to analyze the application paths for the deep integration of AI technology and single-chip microcomputer courses, constructing a new teaching model to provide references for enhancing teaching quality and stimulating students' innovative potential.

Keywords: AI technology; Single-chip microcomputer; Course teaching; Technological application

Online publication: December 16, 2025

1. Introduction

The single-chip microcomputer is an important course in the teaching of electronic information majors and is crucial for cultivating the innovative ability and practical application skills of students in mechanical design, manufacturing, and automation majors. Innovating and optimizing the teaching of single-chip microcomputer courses and exploring new teaching models and methods have become hot topics of focus for experts and scholars in this field. Through continuous innovation and development, science and technology have been widely applied in multiple fields. Meanwhile, professional course teaching also needs to explore more novel, effective methods, measures, and pathways at the levels of teaching models and methods to continuously enhance overall teaching quality and promote the high-quality development of microcontroller course teaching [1].

Considering the existing course content, it mostly focuses on classical theories, lacks integration with emerging technologies, and suffers from outdated knowledge updates, making it difficult to meet students' needs in adapting to rapidly changing professional environments. The teaching methods primarily rely on traditional lectures, lacking personalized design, and fail to accurately address the needs of students with different learning styles and ability levels. This leads to diminished learning enthusiasm among some students and uneven teaching effectiveness [2]. Therefore, this study explores the application effects of AI technology empowerment in microcontroller course teaching from the perspective of AI technology application, aiming to leverage AI's powerful data analysis, intelligent interaction, and adaptive learning support capabilities to address the shortcomings of traditional teaching, establish a new teaching model that aligns with modern educational philosophies and industry demands, and drive the microcontroller course teaching towards intelligent and personalized development.

1.1. Current status and issues in microcontroller course teaching

1.1.1. Limited presentation of course content organization

From the perspective of traditional teaching forms in microcontroller courses, the organization and presentation of the entire course content are based on textbook materials, with teaching conducted in the order of chapters in the textbook, representing a typical linear structure. While this organizational approach provides clear logical coherence in the teaching content of microcontroller courses, it lacks in-depth exploration of the interrelationships between knowledge points. Taking the teaching of microcontroller hardware structure and instruction systems as an example, instead of considering the structural integrity of the microcontroller, the hardware structure and instruction systems are explained separately, lacking a visual demonstration of how hardware characteristics influence instruction design and execution efficiency. This results in students' difficulty in constructing a complete knowledge system and their inability to flexibly apply multiple knowledge points to solve complex problems [3]. From this, it can be seen that under a single mode of presenting teaching content, when teachers explain key points of knowledge, they still primarily rely on theoretical instruction. The teaching space is confined to the classroom, where teachers transmit professional knowledge points to students through lectures supplemented by blackboard writing and simple PowerPoint presentations.

In this teaching process, students are in a passive stage of receiving knowledge input, resulting in a lack of in-depth understanding of abstract conceptual knowledge, such as the internal data transmission process of single-chip microcomputers and the interrupt handling mechanism. Relying solely on verbal descriptions paired with static images makes it difficult for students to understand and learn, increasing the difficulty of comprehension. It is challenging to visualize microscopic and complex principles, making the learning process dull and tedious, reducing students' enthusiasm and initiative in learning, and failing to stimulate their interest. Additionally, there is a significant lag in updating teaching content, failing to keep pace with industry developments. Single-chip microcomputer technology is advancing rapidly, with new architectures and functions constantly emerging. However, the revision cycle for textbook content is long, preventing it from promptly reflecting the latest technological trends. This results in students being unable to access cutting-edge knowledge and technical points of single-chip microcomputers in a timely manner during actual teaching, making it difficult for them to accurately grasp technological development trends [4].

1.1.2. Teaching methods and means fail to meet student needs

The monotonous and uninteresting explanation of traditional theoretical knowledge highlights the "spoon-feeding" nature and inadequacy of teaching methods. Teachers hold the initiative in classroom instruction, while students can only passively receive knowledge, making it difficult for them to exert their subjective initiative and thus affecting the cultivation of their innovative thinking and abilities. The traditional teaching model severely neglects the dominant position of students, failing to fully consider individual differences and learning needs. Moreover, the uniform teaching pace and difficulty level cannot meet the learning needs of all students, leading to a continuous decline in overall teaching efficiency and quality.

Simultaneously, from the perspective of practical teaching, traditional methods still emphasize theoretical instruction, with practical teaching being overly weak. Experimental projects are outdated and monotonous, mostly consisting of verification experiments, lacking comprehensiveness and innovation. Therefore, students only need to follow steps during experiments without in-depth thinking and exploration, making it difficult to cultivate practical skills and problem-solving abilities, thereby constraining the effectiveness of practical teaching [5].

In addition, in teaching evaluation, the assessment methods are monotonous, and a scientific and comprehensive assessment and evaluation system has not been established. The traditional approach of relying solely on examination-based evaluation persists, where students' learning abilities are gauged by their performance in final written exams. This ultimately leads students to study merely for the sake of passing exams, without delving deeply into knowledge in related fields. This indicates that traditional teaching methods and approaches have completely overlooked the cultivation of students' practical abilities and do not align with their learning and developmental needs, which is detrimental to their long-term development.

2. Principles and methods of teaching single-chip microcomputer courses empowered by AI

2.1. Establishment of teaching principles empowered by AI

To effectively integrate AI technology into the teaching of single-chip microcomputer courses and innovate the course content and teaching methods, the following principles should be adhered to:

(1) Student-centered approach: AI-empowered teaching necessitates a precise understanding of individual student differences. By leveraging AI's data analysis capabilities, various types of data can be collected during the learning process, including learning progress, mastery of knowledge, and learning preferences. Based on the results of data analysis, personalized learning paths can be tailored for different students, providing suitable learning resources to meet the learning needs of students at various levels and stimulate their learning potential [6];

(2) Enhanced practicality: Adhering to the teaching philosophy of integrating theory with practice, and under the empowerment of AI, the practical teaching components should be continuously optimized. Virtual simulation technology can be utilized to create highly realistic single-chip microcomputer experimental environments, allowing students to perform hardware connections, program debugging, and other operations in virtual scenarios without being constrained by the quantity of experimental equipment or physical space. This increases practical opportunities. In the meantime, AI can provide real-time feedback on experimental results, point out operational errors, and offer improvement suggestions, helping students quickly acquire practical skills and enhance their ability to apply knowledge and solve real-world problems;

(3) Synchronized knowledge updates: Given the rapid development of single-chip microcomputer technology, the teaching system empowered by AI should leverage its advantages in information integration and dissemination to promptly capture the latest industry trends and technological breakthroughs. Integrate

new knowledge and new cases into teaching content to keep the course at the forefront of technology, guide students to understand the latest technological trends, and broaden their learning horizons.

2.2. Explore AI-integrated characteristic teaching methods

In microcontroller courses, AI-supported instructional strategies can be applied to improve learning effectiveness across multiple dimensions. An intelligent interactive teaching method can be implemented by employing AI chatbots to construct an adaptive communication platform through which students can seek assistance whenever learning difficulties arise. The chatbot provides detailed explanations based on its knowledge base and prompts deeper reflection through follow-up questions, thereby cultivating students' autonomous learning and inquiry skills.

Project-driven teaching methods can be adopted by using AI to design challenging microcontroller projects that integrate key course concepts and reflect real-world application scenarios. During project implementation, AI offers guidance on project planning, resource selection, and progress tracking, while students independently complete hardware design, programming, and system debugging, ultimately strengthening their ability to apply knowledge comprehensively and enhancing innovative thinking.

Visual teaching methods can also be realized by using AI to convert complex microcontroller principles and data-transmission processes into intuitive, dynamic visual models. Through animations, three-dimensional demonstrations, and other visualization techniques, students gain a clearer understanding of the microcontroller's internal structure, instruction execution, and signal variations, thereby reducing cognitive barriers and improving overall learning efficiency.

3. Strategies for AI-empowered teaching applications in microcontroller courses

3.1. Optimize microcontroller course resource construction with AI

To address the issues of monotonous and insufficiently rich content presentation in traditional microcontroller course teaching, and to achieve timely updates of course resources and enrich content presentation forms, AI can be employed. Under AI empowerment, industry trends and the latest research findings can be captured in real-time. By analyzing professional forums and academic journals, information on new architectures, algorithms, and other relevant information related to microcontrollers can be quickly screened and integrated into microcontroller course resources.

After AI detected the widespread application of LoRa technology in Low Power Wide Area Network (LPWAN) communications, course resources were promptly updated to include explanations of LoRa module principles, programming examples, and practical application cases. Through timely updates to course materials, students are exposed to cutting-edge industry knowledge, ensuring that the course content remains aligned with industry trends and keeps pace with the times.

In improving the presentation of resources, AI can transform abstract knowledge into intuitive and vivid forms. For the complex circuit structures and operational principles inside microcontrollers, AI can be utilized to generate three-dimensional animated models. When explaining the timer and counter functions of the 51 microcontrollers, animations can be used to demonstrate the timer's operating modes, counting processes, and interrupt triggering mechanisms, providing students with a clear and intuitive understanding of the changes in register states. This approach guides them to deeply grasp key knowledge points and reduces the difficulty of understanding abstract concepts [7].

3.2. Leveraging AI to create personalized learning support pathways

Considering the individual differences among students, including variations in foundational knowledge, learning styles, and progress, innovative teaching methods empowered by AI can create personalized learning support pathways for each student. To achieve this, learning analytics technology can be employed to collect data on students' classroom performance, homework completion, online learning duration, and other relevant information. Based on this data, AI constructs student profiles to accurately assess students' mastery of knowledge and learning characteristics. For instance, if a student demonstrates weakness in learning the instruction set of a microcontroller, AI analyzes the types of errors in their homework and their online learning patterns, revealing difficulties in understanding indirect addressing instructions. Based on the student profile, a personalized learning plan is developed, and AI provides one-on-one intelligent tutoring. When students encounter problems, the AI tutoring system promptly offers solutions and guidance, ensuring that the learning plan perfectly aligns with the student's learning needs and progress [8].

3.3. Building a multifaceted teaching evaluation system with AI

When addressing the issue of traditional teaching methods relying on a single evaluation approach that fails to comprehensively reflect students' learning processes and abilities. By leveraging AI, a diversified teaching evaluation system can be established to assess students' learning from multiple dimensions. Among these, process-based evaluation utilizes AI to monitor students' online learning behaviors, recording metrics such as learning duration, frequency of participation in discussions, and homework submission status. For instance, on an online learning platform for a microcontroller course, a student actively participated in course discussions and proposed multiple valuable viewpoints. Eventually, AI incorporated the student's discussion performance into the process-based evaluation, awarding corresponding bonus points [9].

On top of that, in project evaluation, AI can automatically assess students' submitted microcontroller project works. Taking the intelligent vehicle project as an example, AI employs image recognition technology to analyze the vehicle's exterior design and structural rationality. It utilizes code analysis tools to evaluate program logic and optimization levels, and can also simulate the vehicle's operating environment to test its functional implementation [10]. By integrating multiple factors, AI generates an objective and comprehensive project evaluation report, highlighting strengths and weaknesses while providing improvement suggestions. This serves as a basis for optimizing the teaching of microcontroller courses.

4. Conclusion

Based on the aforementioned research and analysis, it has been found that in the teaching of microcontroller courses, traditional teaching models exhibit limitations in content organization and a mismatch between teaching methods and student needs. To overcome these constraints of traditional teaching and innovate and optimize the teaching model for microcontroller courses, research from the perspective of AI technology application analysis explores the application content enabled by AI. This presents new opportunities for addressing and improving the issues and shortcomings in microcontroller course teaching, promoting high-quality development. The study proposes adhering to principles such as student-centeredness, enhancing practicality, and synchronizing knowledge updates. It explores characteristic teaching methods featuring intelligent interaction, project-driven learning, and visualization, achieving significant results in teaching applications. Leveraging AI to optimize course resource construction enables timely capture of industry trends and updates content, presenting abstract knowledge in an intuitive manner. It creates personalized learning support pathways, accurately grasping student characteristics to provide tailored learning plans. Additionally, it constructs a diversified teaching evaluation system, comprehensively evaluating student learning from multiple dimensions such as process and project work, providing a basis for cultivating innovative talents adapted to industry development.

Funding

Single-Chip Microcomputer and Interface Technology Project (Project No.: SYSJ2025032)

Disclosure statement

The authors declare no conflict of interest.

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