ISSN 2522-6398 Vol. 8, Issue 9: 18-22, DOI: 10.25236/FER.2025.080904

Exploration and Practice of the Online - Offline Hybrid Teaching Model Featuring Synchronized Theory and Practice, and Integration of Virtual and Real Elements

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Abstract: *The embedded system development course confronts challenges such as difficulties in AI - empowered talent cultivation, poor integration of virtual and real experiments, obstacles in online - offline teaching connection, and a gap between practice and theory. To tackle these issues, a digital and intelligent teaching reform was launched. It involves strengthening AI application, deepening virtual - real integration, promoting online - offline connection, and perfecting multi - dimensional evaluation. The reform has achieved remarkable results. The teaching model combines theory with practice, integrates virtual and real, and online and offline elements. It focuses on cultivating engineering - oriented talents with ideological education. The evaluation system features engineering thinking and AI support, and teaching resources are intelligent and shareable, effectively cultivating innovative talents and improving teaching quality.*

Keywords: *Embedded System Development Courses; Digital and Intelligent Teaching Reform; Online - Offline Hybrid Teaching; Talent Cultivation; Teaching Evaluation*

1. Introduction

Although artificial intelligence (AI) technology plays a crucial role in intelligent education, it encounters numerous difficulties in empowering talent cultivation in the embedded system development course. The large - scale, complex structure, heterogeneous resources, and wide application fields of modern AI large - models make it hard to accurately identify teaching key points and achieve effective empowerment[1-2]. The multi - disciplinary nature of the course strains the existing digital and intelligent teaching system. Students are overwhelmed by the extensive learning content and find it difficult to sort out their thoughts. Some universities lack high - performance digital platform resources, and their teaching goals are limited to technology popularization, neglecting the cultivation of systematic application thinking[3-4]. As a result, students struggle to integrate embedded system knowledge with practical applications, and their practical abilities improve slowly, failing to meet the diverse industry needs for talent.

There are obvious problems in the integration of virtual simulation experiments and real experiments in the teaching of the embedded system development course. The significant differences in the effects between virtual simulation and local experiments, along with the lack of scientific planning of teaching resources, lead to a loose connection between practical and theoretical teaching resources[5]. While virtual simulation can provide a certain simulation environment, it fails to offer the tactile sensations, operational experiences, and the ability to handle unexpected problems that real experiments can. Real experiments, on the other hand, are restricted by factors such as venue, equipment, and time, preventing students from sufficient practice. This separation between virtual and real experiments makes it difficult for students to transfer knowledge from the virtual environment to actual operations, reducing the learning effectiveness. Moreover, the lack of research on their organic integration in the blended learning platform hinders the improvement of teaching quality.

The online - offline blended teaching model has not fully realized its advantages in the embedded system development course, facing many connection obstacles. Online teaching allows students to access theoretical knowledge at any time, but the lack of real experimental links makes it difficult for students to understand abstract concepts, resulting in low learning efficiency and limited development

ISSN 2522-6398 Vol. 8, Issue 9: 18-22, DOI: 10.25236/FER.2025.080904

of practical skills. In offline teaching, theory and practice are separated in time and space. Theory classes are held in classrooms, and practical classes are in laboratories, with theory taught before practice, which disrupts the coherence and integrity of teaching. It is challenging for teachers to switch teaching between the two scenarios, and students also find it difficult to effectively combine the online - learned theory with offline practice[6-7]. Additionally, the lack of effective interaction mechanisms and teaching management means that online and offline teaching cannot form a synergy, reducing the teaching effect.

2. Exploration and Practice of Teaching Reform

2.1 Strengthening AI Empowerment to Precisely Meet Talent Cultivation Needs

To address the challenges in talent cultivation empowered by AI, the role of artificial intelligence technology in the embedded system development course should be fully leveraged. First, in - depth research should be conducted on the industry's demand for applied embedded system development talents. Combining the characteristics of modern AI large - models, the course objectives and knowledge system should be reshaped. Driven by engineering projects, enterprise and scientific research projects should be introduced into teaching, enabling students to be exposed to real - world industry needs in practice and enhancing their ability to solve practical problems.

2.2 Deepening the Integration of Virtual and Real to Optimize the Experimental Teaching Mode

To solve the dilemma of integrating virtual and real experiments, the combination of virtual simulation technology and real experiments needs to be deepened. On the one hand, teaching resources should be scientifically planned, and virtual simulation experiments should be organically integrated with theoretical teaching and real experiments to form a close - knit teaching chain. A digital - intelligent integrated BOPPPS large - class teaching model should be established, using virtual simulation technology to assist theoretical teaching and achieving the synchronization of theory and practice[8]. For example, when explaining the complex principles of embedded systems, virtual simulation can be used to demonstrate the system's operation process to help students better understand.

2.3 Promoting the Connection between Online and Offline Teaching to Innovate the Teaching Interaction Mechanism

To overcome the obstacles in the connection between online and offline teaching, the effective connection between the two should be promoted. In the course design, the limitations of time and space should be broken, and the teaching content of online and offline teaching should be organically integrated. Online teaching provides rich theoretical knowledge and learning resources, such as video tutorials and online tests, allowing students to learn anytime and anywhere; offline teaching focuses on practical operations and interactive exchanges, such as experimental courses and group discussions.

3. Achievements of the Digital and Intelligent Curriculum Reform of the Embedded Systems Course

3.1 Achievements in Teaching Model Innovation

3.1.1 Realization of Synchronization between Theory and Practice and Combination of Virtual and Real

In this digital and intelligent reform project of the embedded systems course, a blended online - offline learning model featuring "synchronization between theory and practice, and combination of virtual and real" has been successfully established. This represents a significant breakthrough in traditional teaching models. In traditional teaching, there is often a disconnection between theory and practice. Students lack timely practical verification when learning theoretical knowledge, which leads to a shallow understanding of the knowledge[9-10]. In contrast, the new model created in this project closely synchronizes theoretical teaching with practical operations. While learning the theoretical knowledge of embedded system development, students can immediately conduct practical verification through virtual simulation experiments or actual hardware experiments.

ISSN 2522-6398 Vol. 8, Issue 9: 18-22, DOI: 10.25236/FER.2025.080904

3.1.2 Organic Blending of Online and Offline Classes

The organic blending of online classes and traditional classes is another important measure in this reform. Online classes and traditional classes each have their unique advantages. Online classes are rich in teaching resources and offer flexible learning methods, while traditional classes emphasize teacher - student interaction and practical guidance. This project has achieved the organic blending of online and offline classes by reasonably integrating the advantages of these two types of classes, providing students with a higher - quality learning experience.

3.2 Achievements in Talent Cultivation

3.2.1 Cultivation of Engineering - Oriented Talents

This project is based on the theory of embedded system development, focuses on industrial application experiments, and expands with scientific research innovation. It constructs a progressive teaching process aiming to cultivate engineering - oriented talents who understand theory, are proficient in technology, and are rich in innovation. In today's era of rapid technological development, the demand for engineering - oriented talents is increasing. They not only need to have solid theoretical knowledge but also rich practical experience and innovation ability.

3.2.2 Integration of Ideological and Political Elements

In the process of talent cultivation, this project emphasizes the integration of ideological and political elements into the course teaching and practical innovation system. A talent cultivation team for "theoretical teaching, experimental training, and scientific and technological innovation" that can guide the integration of ideological and political elements has been established, integrating characteristics such as patriotism, science, and innovation for strengthening the country through science and technology into the course teaching and practical innovation system.

3.3 Achievements in Teaching Evaluation

3.3.1 Built - in Engineering Thinking Evaluation Mechanism

In terms of teaching evaluation, this project has built in an evaluation mechanism based on engineering thinking, which is an innovation in traditional teaching evaluation methods. Traditional teaching evaluation often focuses on students' exam scores while ignoring the cultivation of students' engineering thinking and practical ability. The evaluation mechanism adopted in this project draws on the experience of hardware and software product development engineers. It requires students to have a clear understanding of the parameter adjustment range on the basis of correctly understanding theoretical knowledge points. Only when appropriate experimental parameters are obtained within the correct adjustment range can students get full marks.

3.3.2 AI - Empowered Teaching Evaluation

With the development of artificial intelligence technology, this project has applied AI technology to teaching evaluation, realizing the intelligence and real - time nature of teaching evaluation. AI can monitor students' learning situations in real - time and provide timely feedback. Teachers can understand students' learning progress and difficulties based on the data provided by AI, and then adjust teaching strategies to improve teaching quality.

3.4 Achievements in Teaching Resource Construction

3.4.1 Construction of Data - Intelligent Curriculum Resources

Supported by artificial intelligence technology, this project has carried out the construction of data - intelligent curriculum resources. A virtual simulation experimental platform for embedded system development and an embedded system development experimental platform based on STM32 have been developed, providing students with rich practical resources. The virtual simulation experimental platform can simulate various complex experimental scenarios, allowing students to conduct experimental operations in a safe and convenient environment, improving their practical ability and innovation ability. The embedded system development experimental platform based on STM32 provides a real hardware environment, enabling students to experience the whole process of embedded system development and deepen their understanding and mastery of embedded systems.

3.4.2 Promotion of Teaching Resource Sharing

Through the online platform, the sharing of teaching resources has been realized. Teachers can upload their teaching materials to the platform for other teachers and students to refer to and use. Students can also share their learning experiences and achievements on the platform, promoting communication and cooperation between teachers and students and among students.

The sharing of teaching resources not only improves the utilization rate of teaching resources but also promotes educational equity. Teachers and students from different regions and schools can obtain high - quality teaching resources through the online platform, narrowing the educational gap. At the same time, the sharing of teaching resources also stimulates teachers' teaching innovation and students' learning enthusiasm, promoting the development of education and teaching.

4. Conclusions

In summary, the digital and intelligent curriculum reform of the embedded systems course has achieved remarkable results in teaching models, talent cultivation, teaching evaluation, and teaching resource construction. Through the blended teaching model of "synchronization between theory and practice, combination of virtual and real, and integration of online and offline", the teaching quality has been improved, and innovative talents for embedded system development who meet the needs of the times have been cultivated.

Acknowledgments

This research was supported by the following two projects:

1) The Xi'an Peihua College curriculum innovation initiative, titled 'Research and Application of Blended Online-Offline Instructional Approaches in "Integrating Theory with Practice and Fusing Virtual with Real"' (Project No.: PHJG2333).

2) The general project of the 14th Five - Year Plan (2024) of Shaanxi Provincial Education Science, namely "Innovative Exploration and Practice Research on Digital and Intelligent Courses of 'Synchronizing Theory with Practice, Combining Virtual with Real, and Integrating Online and Offline' Empowered by AI" (Project No.: SGH24Y2696).

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