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Original Paper

Exploration of the Reform of Blended Teaching in Digital Electronic Technology under the Background of Emerging Engineering Education

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Abstract

Against the backdrop of the Ministry of Education's active promotion of Emerging Engineering Education (E3), this paper proposes ideas and measures for the reform of digital electronic technology teaching from the perspective of talent cultivation to meet society's new expectations for talent development. The goal is to cultivate students' comprehensive qualities, enhance their engineering practice and innovation abilities, and promote the healthy development of teaching. Addressing current issues in digital electronic technology experimental teaching, such as outdated teaching methods, monotonous content, and incomplete and subjective evaluations, this paper advocates for a blended teaching model as the direction for reform. The aim is to effectively strengthen teachers' real-time monitoring of students' learning situations and process guidance in practice, stimulate students' enthusiasm and initiative in learning, improve classroom participation in experimental courses, and conduct teaching evaluations more scientifically and accurately.

Keywords

Digital Electronic Technology, Emerging Engineering Education (E3), Blended Teaching, Teaching Reform

1. Introduction

With the sweeping wave of digitalization, the field of electronic technology applications has undergone profound changes, leading to the vigorous development of global electronic information. Digital electronic technology, as a foundational course for electronic and computer engineering majors, aims to cultivate students' ability to deeply analyze and apply basic electronic circuits and successfully apply this knowledge in practical work. Under the backdrop of the Emerging Engineering Education (E3) initiative, the current curriculum system, content, teaching methods, and experimental schemes urgently need systematic reform (Chen & Qin, 2024). This need arises from a series of issues in the current digital electronic technology courses, such as the monotony of teaching models, lack of student practice opportunities, and differences in students' foundational knowledge levels. Firstly, the profound impact of the digitalization wave on the field of electronic technology applications cannot be ignored.

This paper aims to address the issues present in digital electronic technology teaching, explore the current traditional status of "Digital Electronic Technology Experiments" teaching models, identify existing problems, and propose reform solutions.

2. Current State of Course Teaching

Currently, the teaching of digital electronic technology courses faces numerous challenges, primarily reflected in aspects such as teaching content, methods, tools, and assessment (Fu & Li, 2024). Although digital electronic technology experiments hold a significant place within the course, the teaching model is insufficiently developed, offering students inadequate practical opportunities. The teaching content is overly focused on theory, neglecting practical application, and the course assessment methods lack diversity, relying mainly on final exams. Additionally, there is a considerable disparity in students' foundational levels, outdated teaching platforms, simplistic practical teaching methods, and overly bookish lecture content, all contributing to less-than-ideal teaching outcomes.

3. Strategies for Teaching Reform

Digital electronic technology, as a foundational course in electronic information engineering, requires comprehensive reforms in its teaching model to meet modern educational demands. The traditional teaching model exhibits several shortcomings. To address these issues, it is crucial to adhere to the principles of student-centeredness and teacher-led approaches, while emphasizing case simulation, virtual reality scenarios, and ensuring real-time interaction between teachers and students for autonomous learning. The following are key reform directions:

Updating teaching philosophy and models. Cultivating students' innovation and engineering practice capabilities necessitates continuously updating educational philosophies and forming new teaching models and methods (Fu & Liu, 2023). Teachers should actively utilize internship and training bases and relevant competitions to integrate teaching content with practical engineering problems, thereby enhancing practical teaching. This approach not only integrates theoretical knowledge with practical engineering issues but also provides students with more opportunities to apply learned knowledge in real engineering environments, thereby enhancing their practical skills.

Utilizing modern technological tools. The application of modern technological tools is crucial in digital electronic technology teaching. The widespread use of virtual experiments and online teaching platforms can effectively address the lack of practical opportunities. These tools not only provide more practical operation opportunities for students but also make the teaching process more vivid and intuitive, thereby enhancing students' interest and enthusiasm for learning (Zhou, Zhang, & Huang, 2023). Additionally, through virtual reality technology, students can design and debug complex circuits in virtual environments, significantly improving learning efficiency and effectiveness.

Enhancing teaching interaction and personalized guidance. During the teaching process, teachers should actively engage in effective interactions, promptly address students' questions, and provide different interaction strategies to achieve effective integration of online interaction and classroom communication. By meeting students' individual needs and stimulating their interest and initiative in learning, teachers can enhance students' scientific literacy and developmental assessment. Interactive teaching not only enhances students' sense of participation but also helps teachers understand students' learning situations timely, enabling targeted guidance.

Enriching teaching content and practical segments. In digital electronic technology courses, more device application content should be introduced to lay a solid foundation for subsequent professional courses. Reforming practical teaching content is particularly important, reducing the emphasis on single validation experiments and increasing the integration of comprehensive design experiments to cultivate students' abilities to analyze and solve practical engineering problems (Wang, 2023). This not only enhances students' practical operational capabilities but also strengthens their innovation and engineering practice abilities. Furthermore, teachers should clarify specific requirements for student capability development in the curriculum, construct or select high-quality online teaching resources, emphasize practical teaching segments, enabling students to fully utilize both online and offline teaching environments for continuous training and self-improvement (Ding & Zhang, 2023).

Diversified assessment methods. To improve teaching effectiveness, attention should be given to assessing the learning process, introducing formative assessment, and comprehensively evaluating students from multiple perspectives, integrating into overall grades (Hu, 2023). Evaluating students' daily learning through aspects such as pre-class preparation, classroom participation, and post-class assignment completion breaks away from the traditional sole reliance on final exam grades, providing a more comprehensive assessment of students' academic performance. This diversified assessment approach not only accurately reflects students' learning status but also motivates them to invest more effort and time in their daily studies, thereby improving overall learning outcomes.

4. Specific Measures for Teaching Reform

Digital electronics is a crucial foundational course in electronic information disciplines, and its teaching methods urgently need reform to meet modern educational demands. The following are specific reform measures aimed at enhancing teaching quality and fostering students' practical abilities, innovation awareness, and independent thinking skills.

Transformation of teaching modes and tailored instruction. Facing students with diverse foundational levels, instructors of digital electronics should flexibly apply the principle of tailored instruction to create a high-quality learning environment. Through online platforms, students can independently study foundational knowledge, watch SPOC videos, and master relevant concepts. Teachers should promptly address students' questions to achieve efficient teaching management. Practice has shown that online learning of foundational knowledge does not hinder students' mastery of core knowledge and skills. Hierarchical teaching models are effective methods that group students with similar foundational levels together for optimized learning environments and enhanced learning outcomes. Constructing guidance is also crucial, establishing student-centered learning modes, providing diverse and comprehensive learning materials, guiding students to independently select, comprehend, and apply knowledge, thereby meeting requirements in terms of teaching content, methods, and task settings (Wu, 2023).

Teaching modes should shift from inductive to deductive, from teacher-centered to student-centered. For strongly theoretical topics such as numerical and coding, logic functions, etc., a teaching mode primarily based on deduction and induction should be adopted. For topics with strong practical applications like combinational logic circuits, sequential logic circuits, etc., an "student-centered" deductive teaching mode should be employed to enhance understanding and emphasize application (Wang, Ma, Hu et al., 2023). This transformation of teaching modes can better cater to students' learning needs and improve teaching effectiveness.

Modern technological means and innovation in teaching modes.Using course operation platforms with abundant resources, instructors can publish course introductions, online learning content, teaching objectives, syllabi, instructional videos, key teaching points, teaching schedules, teaching designs, and discussion interactions (Sun, Cai, Guo et al., 2022). Corresponding test questions should be developed for each knowledge point, expanding the question bank and differentiating question difficulty levels. During the process of answering questions, students can identify and address knowledge gaps to refine their learning. Establishing a high-quality training question bank ensures question quality, allowing students to practice with targeted exercises, focusing more on frequently missed questions to enhance learning. Group teaching and virtual simulation experiments can integrate knowledge impartation, skill development, and ideological guidance into the course teaching process, enabling students to access all teaching content, share online resources and instructor materials, obtain knowledge maps, participate in interactive discussions, and vote. Through this approach, students' learning shifts from passive to active, combining theoretical analysis and experimental construction with simulation and debugging techniques, not only stimulating students' thinking and cultivating independence and creativity but also promoting the improvement of students' abilities and qualities, enabling them to apply disciplinary knowledge to electronic design, enhancing hands-on practical abilities. Instructors can grasp students' learning dynamics in real time through online service platforms, focus on explaining difficult knowledge points during offline classes, precisely control the classroom pace, and efficiently interact with students to enhance teaching quality.

Integration of industry, academia, and research to promote comprehensive development. Under the guidance of the new engineering education concept, close collaboration with enterprises and research institutions sets clear project tasks for students, allowing them to apply their learned knowledge in practical projects and develop problem-solving capabilities (Hao, Li, Li et al., 2022). By introducing industrial and research resources, disciplinary barriers are effectively broken down, fostering close interaction between industry, academia, and students. Establishing integrated practice bases combining industry, academia, and research provides students with opportunities to participate in real engineering projects and research tasks. Deep cooperation with enterprises enables students to gain insights into industrial needs, thereby enhancing their ability to tackle practical issues. Practice-oriented teaching models aim to help students deepen their understanding of theoretical knowledge and organically apply it to practical engineering design, cultivating problem-solving awareness and capabilities.

Promoting interdisciplinary integration to deepen cross-disciplinary design. Reform of the digital electronics course not only focuses on knowledge within its own field but also emphasizes cultivating students' interdisciplinary thinking and problem-solving abilities. Introducing comprehensive interdisciplinary course designs is a key step towards achieving this goal. Through collaboration with related disciplines such as computer science, communications, and control, the digital electronics course can transcend narrow disciplinary boundaries, integrating knowledge from different fields, which helps students to comprehensively understand the applications of digital electronics in multiple domains. Organizing students to participate in comprehensive design projects is an effective way to cultivate interdisciplinary capabilities (Hou, Huang, Sheng et al., 2023). For example, designing a smart home system involves not only hardware design in digital electronics but also requires integration with computer networking and communication technologies. Through such projects, students can better understand the interrelationships between various disciplines, develop comprehensive analytical and problem-solving skills, and improve their ability to understand and apply professional knowledge. Participating in science and technology innovation competitions effectively enhances students' practical hands-on abilities, on-site adaptability, and innovative design capabilities. During competition guidance and preparation, instructors maintain close contact with cutting-edge technologies, continuously update knowledge systems, adjust teaching methods, and make them more relevant to actual needs and industry trends. This competition-driven learning and teaching model aligns theoretical knowledge with practical application scenarios, thereby fostering students with stronger practical capabilities and innovative thinking. Through such innovative teaching models, the digital electronics course not only meets the requirements of new engineering education but also lays a solid foundation for students to become future professionals in the field of digital electronics.

Improving the course evaluation system to enhance applied innovation capabilities. Traditional teaching evaluations primarily focus on students' grasp of theoretical knowledge. However, in the context of new engineering education, more emphasis is placed on cultivating students' practical application and innovation capabilities. Through the design and implementation of practical projects, students can flexibly apply theoretical knowledge to real-life situations, thereby enhancing their practical skills. This practical learning approach helps comprehensively assess students' overall competencies, including theoretical levels and the ability to solve practical problems. The teaching evaluation system should fully consider students' contributions and collaborative abilities within teams, as well as their adaptability in interdisciplinary environments. The evaluation system should include assessments of students' abilities to solve practical problems and independently design solutions, such as whether they can independently complete projects, solve real challenges, and propose innovative solutions. Blended learning requires the establishment of flexible and diversified assessment mechanisms to objectively evaluate student learning outcomes. Evaluation contents should include assessments of online learning, online-offline interactive evaluations, offline learning evaluations, and learning results evaluations, exploring reasonable detailed evaluation mechanisms and proportional weight distributions. Designing groups before and after the course to actively participate in group discussions and identify learning errors and help students resolve issues. At the same time, the active level of the classroom in the group can also be used as one of the evaluation methods for daily grades, enhancing students' learning enthusiasm and initiative. In the overall performance evaluation, daily grades are counted according to a certain weight, comprehensively considering students' performance in different aspects, stimulating enthusiasm for learning and promoting progress in educational reform.

5. Conclusion

To adapt to the changing demands for talent in the context of new engineering education, reforms in the digital electronics technology curriculum are essential. The main focus of these reforms should be on teaching methodologies, with theoretical instruction serving as a supplement. Under new teaching paradigms, the effectiveness of digital electronics technology courses will significantly improve, fostering comprehensive development in students' practical abilities, innovative awareness, and independent thinking. Educational institutions across regions should increase investments, continuously improve teaching hardware, software facilities, and curriculum designs to enhance students' understanding and application of digital electronics technology. This approach not only elevates the overall quality of digital electronics technology education but also lays a solid foundation for cultivating more qualified professionals who are adept in application-oriented, interdisciplinary, and innovative fields, meeting the demands of the digital age's electronic information engineering profession. Through systematic and comprehensive educational reforms, advancing digital electronics technology courses to higher quality and standards will nurture exceptional talent for future technological innovation and engineering applications.

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