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Integration and Application of EDA Technology in Electronic Technology Practical Training Courses

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Abstract: In response to the prevalent issues in traditional electronic technology practical training courses, including outdated teaching content, disconnection from vocational competency requirements, monotonous teaching methods, insufficient ideological and political education resources, lack of innovation capability cultivation, and unreasonable assessment approaches, this paper proposes a systematic teaching reform scheme that integrates Electronic Design Automation (EDA) technology into the curriculum. By restructuring the training content, a three-tier project-based teaching system-"Fundamental Verification-Advanced Design- Comprehensive Innovation"-is established. Blended online-and-offline teaching models are adopted, ideological and political elements are thoroughly explored, a three-dimensional (knowledge–skills–competencies) multi-faceted evaluation framework is constructed, and the second classroom is extended through competition-course synergy. Teaching practice demonstrates that the integration of EDA technology effectively stimulates students' learning initiative and significantly enhances their practical abilities, innovative thinking, and overall professional competencies, providing a replicable paradigm for the reform of practical courses in electronic and information disciplines.

Keywords: Electronic Technology Practical Training, EDA Technology, Project-Based Teaching, Blended Teaching, Curriculum Reform.

1. Introduction

With the rapid rise of emerging technologies such as 5G communication, the Internet of Things, and artificial intelligence, the design and manufacturing of electronic products are accelerating towards digitalization, integration, and intelligence, placing higher demands on the practical and innovative capabilities of electronic technology talents. The electronic technology practical training course, as a fundamental hands-on course for electronic information and related engineering majors, serves as an important bridge for students to integrate theoretical knowledge of electrical and electronic engineering with practical application. However, traditional electronic technology practical training courses have long been constrained to discrete component soldering and simple kit assembly, failing to incorporate modern electronic technologies such as surface-mount technology, programmable logic devices, and Electronic Design Automation (EDA) [1]. As a result, the teaching content is severely disconnected from industry needs. Meanwhile, teaching methods are dominated by "teacher demonstration and student imitation," leading to passive reception and mechanical operation, lacking independent design and innovative practice, which makes it difficult to stimulate learning interest and innovative potential. This paper systematically explores the integration and application of EDA technology in electronic technology practical training courses, proposing reform pathways from aspects including teaching content restructuring, pedagogical model innovation, evaluation system reform, and second-classroom expansion, so as to provide reference for the high-quality development of such courses under the context of "New Engineering Education" [2].

2. Analysis of the Current Status of Electronic Technology Practical Training Courses

2.1. Outdated Training Content and Disconnection from Vocational Competency Requirements

At present, the electronic technology practical training in most universities still centers on manual soldering, with the assembly of traditional kits such as radios and multimeters as the main content. These kits generally use plug-in discrete components, whereas modern electronic products widely adopt surface-mount technology and miniaturized packaging; students consequently lack necessary skills in identifying, soldering, and debugging surface-mount devices[3]. Different majors have significantly different needs for electronic process skills, yet the course content and teaching modes are largely identical, failing to reflect disciplinary characteristics. Moreover, the course has not incorporated new technologies and processes in a timely manner, and the coverage of multiple skills-such as printed circuit board fabrication and complete unit assembly-is limited, resulting in a considerable gap with vocational job competency requirements [4].

2.2. Monotonous Teaching Methods and Lack of Information-Based Teaching Means

Traditional teaching generally adopts a streamlined mode of "teacher explanation and demonstration-student imitation and operation-submission of experimental reports." The learning process is passive, lacking active exploration and merely mechanical imitation, which makes it difficult for students to truly internalize knowledge and skills. Within the limited class time, teachers cannot provide refined guidance to every student, and group experiments often suffer from the "free-rider" phenomenon [5]. The application of information-based teaching methods is seriously insufficient; digital resources such as micro-lectures and virtual simulations are scarce. Students have no access to preview materials before class and lack platforms for after-class expansion. Experimental reports are mainly handwritten on paper, consuming a significant amount of time in transcription, which reduces their engagement in thinking about and exploring the experimental content [6].

2.3. Weak Ideological and Political Education Resources and Insufficient Educational Function

Curriculum ideological and political education (IPE) is an important approach to implementing the fundamental task of fostering virtue through education. Electronic technology practical training courses have inherent advantages in cultivating craftsmanship spirit and patriotism in science and technology, but the IPE function is currently underexplored [7]. Teachers tend to focus on skill transmission, neglecting systematic cultivation of professional ethics, safety awareness, and other vocational competencies. The development of IPE teaching resources is inadequate, lacking cases that integrate breakthroughs in domestic chip technology and the deeds of master craftsmen, thus failing to form an integrated education pattern of "major + post + course + IPE."

2.4. Lack of Innovation Capability Cultivation and Insufficient Thinking Training

The training content is dominated by verification and replication operations. Students only need to solder components at designated positions without delving into circuit principles or optimizing parameters, thus failing to develop engineering design thinking. The experimental projects are of a single level, mostly limited to basic soldering and complete assembly, lacking design-oriented and comprehensive experiments. Students have no opportunity to independently design circuit schemes or conduct systematic debugging. Moreover, the course has not been effectively linked with academic competitions, so students lack channels to apply their skills to innovative practice [8].

2.5. One-Sided Assessment Methods and Inability to Comprehensively Evaluate Students' Comprehensive Abilities

Current assessment and evaluation suffer from four problems: first, single evaluation criteria, mostly relying on whether the product functions as the sole indicator; second, excessive weight on summative evaluation, with final practical examinations dominating, while insufficient attention is paid to the learning process; third, process-oriented evaluation lacks quantitative standards and often depends on subjective impressions; fourth, the evaluation of competency objectives is missing-professional qualities such as safety operation awareness and craftsmanship spirit are not included in the assessment, making it difficult to measure the effectiveness of virtue-based education.

3. Reform Measures Based on EDA Technology

In response to the prominent issues in electronic technology practical training courses, this paper proposes a systematic teaching reform scheme centered on the integration of EDA technology, conducting comprehensive reforms from five dimensions: teaching content, teaching model, ideological and political education, evaluation system, and second classroom.

3.1. Restructuring Training Content to Align with Vocational Competency Requirements

EDA technology is systematically integrated into each teaching stage, forming a three-tier project-based teaching content system.

Fundamental Module – Verification Experiments. Basic core content is retained, including component identification and testing, manual soldering (including through-hole and surface-mount components), use of common instruments and meters, and circuit schematic analysis. Multisim simulation is introduced as an auxiliary tool. Before actual soldering, students first build and simulate circuits in the Multisim environment, observe waveforms and node parameters, and understand circuit principles at the theoretical level. This achieves the concept of "simulation first, practice following," effectively reducing operational error rates.

Advanced Module – Design-Oriented Experiments. This module constitutes the core of EDA integration. Students learn the basic use of Quartus Prime software, the syntax and design methods of Verilog HDL, and ModelSim simulation tool operations. Teaching content covers the HDL description and design methods for combinational logic circuits (e.g., decoders, data selectors, adders) and sequential logic circuits (e.g., flip-flops, counters, shift registers). Students independently complete the entire process from logic design, code writing, and simulation verification to FPGA hardware download and verification. The experimental platform adopts DE10-Standard development boards, allowing students to compare abstract hardware description language with actual hardware operation effects, thereby gaining a profound understanding of digital circuit working mechanisms.

Comprehensive Module-Comprehensive Experiments. This module adopts project-based tasks, with topics including multi-function waveform generators, practical digital clocks, traffic light controllers, and intelligent buzzer systems. Students individually or in groups complete the entire process from topic selection, scheme design, circuit simulation, PCB layout, component selection, soldering and assembly, hardware-software joint debugging, to final acceptance. EDA tools are employed throughout: Multisim for functional simulation, Quartus for digital logic design, and Altium Designer for PCB layout. Finally, students submit design reports, simulation files, and physical prototypes, and deliver presentations and defenses, fully embodying the engineering education concept of "virtual-real integration and design-manufacturing-debugging integration."

Course content follows industry development trends and aligns with the requirements of the National Vocational Skill Standard-Electronic Assemblers for Broadcasting, Television and Communication Equipment (2019 Edition), covering professional ethics, basic circuit knowledge, PCB fabrication, wiring processes, and complete unit assembly. At the same time, digital integrated circuit knowledge is introduced, incorporating projects such as digital electronic clocks and simple calculators into the training system.

3.2. Innovating Teaching Models and Promoting Blended Online-and-Offline Teaching

A course resource pool is established using platforms such as Xuexitong (Chaoxing Learning Platform) and Smart Vocational Education, including EDA software operation videos, simulation demonstrations, teaching micro-lectures, soldering animations, and outstanding student works displays. Before class, preview materials are pushed to students, who are required to watch videos and complete pre-class tests; the viewing records and test results are taken as references for usual performance, thus moving the traditional "in-class lecture" forward to "pre-class preview."

Class time is reallocated: teachers focus on elucidating key points, alerting to common problems, and highlighting error-prone issues, while students spend most of the time on hands-on operation and design. Teachers provide roaming guidance and individualized tutoring. Experimental reports are completed online: students upload photos, simulation waveforms, data analyses, etc., reducing mechanical transcription and devoting more energy to analysis and reflection. Teachers grade online and, based on platform data, understand students' learning situations, assign targeted exercises, or push additional resources, achieving closed-loop teaching management.

The learning behavior data accumulated on the platform supports instructional improvement. Teachers can monitor students' progress, test scores, question frequency, and report quality in real time, accurately identifying struggling students and weak areas, and adjusting teaching strategies promptly. At the end of the semester, data comparisons are used to evaluate the reform's effectiveness, providing a basis for continuous optimization.

3.3. Deeply Exploring Ideological and Political Education and Strengthening Professional Competency Cultivation

Systematic design is conducted from three dimensions: basic professional post competencies, IPE teaching resources, and IPE teaching guidelines. Corresponding ideological and political elements are integrated into each module: in manual soldering teaching, quality awareness is emphasized to cultivate craftsmanship spirit; in component identification, the history of China's semiconductor development and the "bottleneck" dilemma are introduced, and stories of scientists' patriotic dedication inspire patriotic feelings and self-reliance awareness; in PCB fabrication, Made in China 2025 and Huawei's independent innovation cases are cited to guide students to recognize the importance of core technologies; in instrument use, the history of oscilloscopes is introduced to stimulate scientific interest; in installation and debugging, the case of Zhang Ruimin smashing refrigerators at Haier is used to illustrate that process quality determines product quality.

Ideological and political education is not simply "labeling"; rather, value guidance is naturally integrated into the entire professional teaching process through case introduction, classroom discussion, and assignment reflection. In EDA tool teaching, the current development status of domestic EDA software can be compared to guide students to consider the importance of technological self-reliance. In project acceptance, students are required to truthfully report differences between simulation and measured data and analyze the reasons, cultivating an attitude of seeking truth from facts and rigorous scientific inquiry.

3.4. Constructing a Multi-Faceted Evaluation System to Comprehensively Reflect Learning Outcomes

A multi-faceted evaluation mechanism spanning the three dimensions of "knowledge-skills -competencies" is established. The evaluation system emphasizes process-oriented assessment supplemented by summative evaluation, employing multi-stakeholder evaluation methods combining student self-assessment, peer assessment, teacher evaluation, and platform data, covering all three stages of pre-class, in-class, and after-class.

The overall grade composition is as follows: experimental reports (including simulation files and data analysis) account for 20%, classroom performance (including operational standardization and participation) accounts for 20%, after-class exercises (including online tests and extension tasks) account for 10%, and the final comprehensive practical examination (including EDA programming and hardware debugging) accounts for 50%. Usual performance accounts for 50%, fully reflecting the importance of process-oriented evaluation.

Specific criteria are refined: experimental report evaluation shifts from "whether copying is complete" to "whether analysis is thorough, data are complete, and reflection is adequate"; classroom performance covers attendance, interaction, operational standardization, and collaboration; after-class exercises assess mastery of basic knowledge and EDA tool operation; and the final examination focuses on hardware description language proficiency and comprehensive ability in digital system design. The concept of value-added evaluation is introduced, focusing on the magnitude of student ability growth rather than final levels only. An intelligent system automatically tracks learning trajectories, promptly alerting and assisting students who rank low or show diminished value-added, thus truly achieving "evaluation to promote learning and teaching."

3.5. Expanding the Second Classroom and Deepening Industry-Education Integration

Academic competitions, such as the National Undergraduate Electronic Design Contest, serve as important platforms for fostering students' innovation capabilities and engineering practice abilities. This course introduces digital technology application scenarios from such competitions into after-school extension projects, selecting outstanding students to form research groups guided by full-time teachers for pre-competition training and project development. During the preparation process, students comprehensively apply multiple skills, including EDA design, circuit soldering and debugging, and hardware-software joint debugging, which are highly aligned with the course's teaching objectives, forming a virtuous cycle of "course-competition integration and competition-driven learning."

Deepening industry-education integration and strengthening school-enterprise cooperation are crucial approaches to improving vocational education quality. Full-time teachers regularly conduct enterprise visits to understand industry trends and specific talent needs, bringing back engineering cases and technical problems to the classroom. Enterprise engineers are invited to deliver technical lectures or co-supervise training projects. Relying on school-enterprise collaborative projects, teachers lead capable students to participate in enterprise horizontal research and development, such as in the design of intelligent fast-charging power supplies for batteries. Students are involved throughout the entire process, from scheme demonstration, circuit design, PCB layout, to prototype debugging, applying EDA skills learned in class to real engineering scenarios, effectively enhancing comprehensive practical abilities and professional adaptability.

4. Practical Effects and Conclusion

Over the past two years, our School of Electronic Engineering has piloted the above teaching reform scheme in majors such as Internet of Things Engineering. Through comparative analysis between the reform experimental class and ordinary classes in the 2025–2026 academic year, the reform outcomes are evident: the average practical training score of the reform class increased from 79 to 85, and course satisfaction ratings rose from 89% to 94%. Students generally reported that the introduction of EDA tools made circuit design "visible and tangible," effectively lowering the threshold for understanding and enhancing learning confidence, while project-based tasks provided space for independent exploration, stimulating design interest and innovative willingness.

In terms of academic competitions, the student teams participating in the reform have performed excellently in events such as the National Undergraduate Electronic Design Contest, with significantly improved award levels and numbers compared to previous years. Employer feedback indicates that graduates who received EDA-integrated training demonstrate obvious advantages in adaptability, design capability, and problem-solving skills.

5. Conclusion

This paper addresses the core problems of traditional electronic technology practical training courses—outdated teaching content, disconnection from vocational posts, monotonous teaching methods, insufficient ideological and political resources, lack of innovation capability cultivation, and unreasonable assessment methods—and proposes a systematic teaching reform scheme led by EDA technology integration. Through the reconstruction of a three-tier project-based teaching content system, the promotion of blended online-and-offline teaching modes, the deep excavation of ideological and political elements, the establishment of a three-dimensional multi-faceted evaluation system, and the expansion of the second classroom, the course has been fundamentally transformed from "skill transmission" to "competency cultivation."

Practice demonstrates that the deep integration of EDA technology and electronic technology practical training courses not only effectively resolves many disadvantages of traditional teaching but also significantly enhances students' hands-on practical abilities, innovative design capabilities, and comprehensive professional competencies, providing a feasible pathway for cultivating application-oriented innovative talents under the context of "New Engineering Education." In the future, the research team will continue to improve the course resource pool, deepen school-enterprise cooperative project development, explore the application of new technologies such as artificial intelligence-assisted simulation teaching, and further promote the high-quality development of electronic technology practical training courses, thereby making greater contributions to nurturing high-quality technical talents that meet the needs of the modern electronics industry.

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