Research and Practice on Project-Based Teaching Reform of the Course "Fundamentals of Analog Electronics Technology" in Higher Education Institutions

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Abstract: This paper focuses on the project-based teaching reform of the course "Fundamentals of Analog Electronics Technology" in higher education institutions. By analyzing the shortcomings of traditional teaching modes, it expounds the necessity and significance of project-based teaching reform. Research is carried out from aspects such as the setting of reform objectives, the restructuring of the curriculum system, the innovation of teaching methods, the integration of teaching resources, the construction of the teaching staff, and the improvement of the evaluation system. The aim is to enhance the quality of course teaching, cultivate students' practical and innovative abilities, and provide references for the teaching reform of relevant courses in higher education institutions.

1. Introduction

1.1 Research Background

"Fundamentals of Analog Electronics Technology" is an important technical foundational course for electrical engineering majors in higher education institutions, playing a pivotal connecting role for majors such as electrical engineering, automatic control, computer science, and electronic information. This course is highly abstract and professional, and students' mastery of it directly affects their subsequent professional course learning. However, traditional teaching modes have numerous problems and are difficult to meet the talent cultivation needs of the new era. Therefore, carrying out project-based teaching reform holds significant practical significance[1].

1.2 Research Objectives and Significance

This study aims to solve problems in traditional teaching such as the disconnection between theory and practice, low student learning enthusiasm, and insufficient innovation ability through project-based teaching reform. It aims to improve students' understanding and application ability of analog electronics technology knowledge, cultivate their practical operation skills, teamwork abilities, and innovative thinking, enhance the quality of talent cultivation in higher education institutions, and supply more high-quality applied technical talents to society[2].

2. Analysis of the Current Teaching Situation of the Traditional Course "Fundamentals of Analog Electronics Technology"

2.1 Single Teaching Method

Traditional teaching mainly involves teachers imparting disciplinary knowledge, relying excessively on textbook learning and ignoring the value of discovery-based, inquiry-based, and action-oriented learning for students' development. Teachers extensively explain theoretical knowledge in class, and students passively receive information, lacking information feedback and participation. This easily affects students' learning enthusiasm and is not conducive to their active learning[3].

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2.2 Abstract Course Content

In academic education, abstract course content poses a significant challenge, especially in specialized fields. This content is highly professional and abstract, formed by carefully selecting and simplifying fundamental theories from undergraduate electronics technology courses. To master it, students need a relatively high level of math, as it's the language for analyzing electrical circuits and signal processing, and a solid physics foundation to understand the governing principles of electronic systems. Yet, for a number of current students, grasping this content is tough when traditional teaching methods are used. Traditional lectures, with their one - way communication, can be ineffective for those with different learning styles or struggling with abstract ideas. The lack of interactivity may reduce engagement and motivation, making it hard for students to visualize electrical phenomena and connect theory with real - world applications. Also, the fast pace in large - class settings, due to the need to cover a large amount of material in limited time, can overwhelm students, causing them to fall behind and harming their academic performance and confidence[4].

2.3 Disconnection between Theory and Practice

In the current educational landscape, particularly in fields that heavily rely on experimental and practical learning, a significant issue that has emerged is the pronounced disconnection between theory and practice. Experimental teaching, which is supposed to be an integral and complementary part of theoretical instruction, often finds itself in a subordinate position. The content of experimental courses tends to be outdated, failing to keep pace with the rapid advancements in technology and industry. There is an over - reliance on verification - type projects, where students are simply asked to confirm pre - established theories or principles through repetitive experiments. These projects lack innovation and creativity, offering little room for students to explore new ideas or approaches.

During the experimental sessions, students are typically provided with detailed experimental instruction manuals. They are then required to follow these step - by - step guides to complete simple circuit construction and debugging tasks. A substantial amount of their energy and time is consumed in mastering these basic operations, such as connecting wires correctly, setting up equipment, and performing routine measurements. As a result, they have limited opportunities to delve into more complex systems. Verifying complex systems demands a deep understanding of theoretical concepts and the ability to apply them in a flexible and integrated manner. However, due to the nature of the current experimental setup, students struggle to make this connection. They find it difficult to transfer the theoretical knowledge they have learned in the classroom to real - world practical scenarios, leading to a serious gap between what they know in theory and what they can actually do in practice. This disconnection not only hampers their overall learning experience but also affects their future career prospects, as many professions require a high level of practical and problem - solving skills[5].

2.4 Unreasonable Assessment Method

The existing assessment method in educational settings, especially in courses that involve both theoretical and practical components, is far from being reasonable and effective. Currently, the assessment system mainly places emphasis on theoretical assessment. It focuses on evaluating students' memory and understanding of textbook knowledge through traditional means such as written exams, quizzes, and assignments. While these methods can test students' grasp of basic concepts and theories to a certain extent, they overlook an essential aspect of learning: the development of practical and innovative abilities.

In many cases, students can achieve high scores in theoretical assessments by simply memorizing formulas, definitions, and procedures without truly comprehending the underlying principles or being able to apply them in real - life situations. This one - sided assessment approach fails to provide a comprehensive and objective reflection of students' actual learning situations. It does not take into account their hands - on skills, problem - solving abilities in practical contexts, and their capacity for innovation. As a result, students may lack the motivation to improve their practical operation skills. They know that as long as they can perform well in theoretical exams, they can get good grades, regardless of their performance in practical tasks. Moreover, the lack of emphasis on innovative

abilities in the assessment method stifles students' creativity and their willingness to explore new ideas and approaches. In the long run, this unreasonable assessment method not only limits students' personal growth and development but also has a negative impact on the overall quality of education, as it fails to cultivate well - rounded individuals who are equipped with both theoretical knowledge and practical skills to meet the demands of the modern society.

3. Necessity of Project-Based Teaching Reform for the Course "Fundamentals of Analog Electronics Technology"

3.1 Adapting to Social Needs

With the rapid development of science and technology, employers have increasingly higher requirements for employees. They not only need to have solid professional abilities but also must possess strong methodological, social, and innovative spirits. Project-based teaching enables students to learn in practice, cultivate their comprehensive abilities and professional qualities, and make them better adapt to social needs for talents.

3.2 Improving Teaching Effects

Project-based teaching improves learning outcomes by embedding theoretical knowledge in practical projects, enabling students to visualize abstract concepts through hands-on tasks like circuit design or sensor development. This active learning approach fosters critical thinking, creativity, and problem-solving as students troubleshoot, optimize, and innovate under real-world constraints. Collaborative projects enhance teamwork and communication, while iterative cycles of prototyping and feedback cultivate adaptability. By aligning assessments with project milestones, instructors reinforce retention and higher-order thinking, ultimately motivating students through the tangible relevance of their work to professional and societal contexts.

3.3 Cultivating Innovation Ability

Project-based teaching cultivates innovation by challenging students to solve real-world problems through interdisciplinary exploration, iterative experimentation, and collaborative teamwork. This process fosters divergent thinking, risk-taking, and resilience, as students brainstorm solutions, adapt to constraints, and learn from failures. By integrating industry trends and societal issues into projects, instructors inspire purpose-driven creativity, equipping students with an innovation mindset—marked by curiosity, adaptability, and a proactive approach—essential for addressing future technological and global challenges.

4. Objective Setting for Project-Based Teaching Reform of the Course "Fundamentals of Analog Electronics Technology"

4.1 Knowledge Objectives

Through project-based teaching (PBL), the program aims to equip students with a rigorous and practical understanding of analog electronics technology, enabling them to bridge theoretical knowledge with real-world applications. Students will systematically master fundamental concepts, including circuit analysis theories (e.g., Ohm’s Law, Kirchhoff’s Laws), signal processing principles, and semiconductor physics, while developing a deep comprehension of core principles such as amplification, filtering, feedback, and oscillation. They will gain hands-on expertise in the characteristics and applications of common electronic components, including resistors, capacitors, inductors, diodes, transistors, and operational amplifiers, through laboratory experiments and component-level design tasks. Furthermore, students will become proficient in designing and analyzing analog circuits, such as amplifier circuits, oscillator circuits, power supply circuits, and sensor interfaces, by applying circuit simulation tools (e.g., Multisim, LTspice) and prototyping techniques. Emphasis will be placed on cultivating systematic problem-solving skills, enabling students to troubleshoot circuit faults, optimize performance parameters, and innovate circuit

topologies. By integrating these knowledge domains, the program ensures students build a solid theoretical foundation while enhancing their practical engineering capabilities, preparing them for advanced coursework in fields like embedded systems, communication engineering, and instrumentation, as well as careers in electronics design, R&D, and technical maintenance..

4.2 Ability Objectives

The program aims to cultivate students' practical, analytical, and collaborative competencies essential for engineering success. Students will develop robust practical operation skills through hands-on training in circuit design, installation, debugging, and testing, utilizing industry-standard tools and safety protocols to ensure precision and efficiency. They will enhance problem-solving abilities by applying interdisciplinary knowledge to analyze and resolve complex engineering challenges, fostering critical thinking through case studies, simulations, and project-based learning. Teamwork and communication skills will be strengthened via collaborative projects, role coordination, and presentations, preparing students for dynamic workplace environments. Additionally, the program encourages innovation and autonomous learning by integrating emerging technologies (e.g., AI, IoT) into curricula, supporting self-directed research, and promoting iterative design processes. These objectives collectively equip students to adapt to evolving industries, think creatively, and take ownership of their professional growth.

4.3 Quality Objectives

The program strives to shape students into ethical, socially responsible, and innovative professionals with strong scientific and engineering foundations. Students will cultivate scientific and engineering qualities through rigorous training in experimental design, data analysis, and systematic problem-solving, while adhering to ethical standards and professional integrity. Comprehensive qualities such as responsibility, dedication, and teamwork will be nurtured via community engagement, internships, and cross-cultural projects, emphasizing accountability and empathy in real-world contexts. The program also aims to produce high-quality applied talents with an innovative spirit, encouraging students to address global challenges (e.g., sustainability, healthcare) through entrepreneurship, leadership initiatives, and ethical technology development. By aligning technical expertise with societal needs, graduates will emerge as visionary leaders capable of driving progress while upholding principles of social responsibility and lifelong learning.

5. Implementation Strategies for Project-Based Teaching Reform of the Course "Fundamentals of Analog Electronics Technology"

5.1 Curriculum System Restructuring

Break the traditional disciplinary curriculum structure and establish a curriculum structure centered on "work tasks" and carried by "projects." The analysis of professional job tasks yields the areas of job tasks, specific tasks, competency requirements, and professional quality standards needed to formulate "project-based" task sheets. It integrates the course content according to projects, with each project covering relevant theoretical knowledge and practical skills, making the course content more in line with actual work needs.

5.2 Teaching Method Innovation

Adopt the project teaching method, and each teaching unit is carried out according to the "five-step teaching method" of the "information stage - planning stage - implementation stage - comprehension stage - evaluation stage." In the information stage, teachers assign tasks and help students understand task requirements; in the planning stage, students work in groups to find information related to the tasks and formulate work plans; in the implementation stage, students complete the tasks as required and make written records; in the comprehension stage, problems are identified and theoretical issues are solved through discussion and explanation; in the evaluation stage, students present their work results, and teachers evaluate students' learning situations in this project. At the same time, combine multimedia teaching, simulation teaching, case teaching, and other

teaching methods to improve teaching effects.

5.3 Teaching Resource Integration

Strengthen the construction of experimental and training rooms, equip them with advanced experimental equipment and instruments, and provide students with a good practical operation environment. Build a virtual simulation experimental platform, use virtual reality technology to simulate the actual circuit working environment, and enable students to carry out circuit design and debugging in a virtual environment, reducing experimental costs and improving experimental safety. Integrate online teaching resources, establish a course website, and provide abundant teaching materials, courseware, videos, etc., to facilitate students' autonomous learning.

5.4 Teaching Staff Construction

Strengthen teachers' practical training, encourage teachers to undergo on-the-job training in enterprises, accumulate practical engineering experience, and improve teachers' practical guidance abilities. Introduce engineering and technical personnel with enterprise work experience as part-time teachers to enrich the teaching staff and optimize the teaching staff structure. Organize teachers to carry out teaching research and teaching reform activities, encourage teachers to explore new teaching methods and means, and improve teachers' teaching levels and innovation abilities.

6. Guarantee Measures for Project-Based Teaching Reform of the Course "Fundamentals of Analog Electronics Technology"

6.1 Organizational Guarantee

To ensure systematic and effective implementation of teaching reforms, the school will establish a Teaching Reform Leading Group comprising senior administrators, academic affairs leaders, and experienced professional teachers. This group will serve as the core decision-making body, responsible for strategizing, coordinating, and overseeing all stages of the reform process, from planning and execution to monitoring and evaluation. Its key duties include aligning reform goals with institutional missions, allocating resources efficiently, and resolving cross-departmental challenges. To clarify accountability, detailed responsibility matrices will be developed, defining roles for academic departments, administrative offices, and individual faculty members. For instance, the academic affairs department will oversee curriculum design and quality control, while professional teachers will lead hands-on implementation in classrooms and labs. Regular progress reviews, feedback mechanisms, and adaptive adjustments will ensure reforms stay on track, fostering a collaborative culture where all stakeholders contribute to shared objectives.

6.2 Institutional Guarantee

To institutionalize teaching innovations, the school will revise and strengthen its teaching management frameworks, introducing standardized guidelines for project-based learning (PBL) and other reform initiatives. These norms will cover project design criteria (e.g., alignment with industry needs, interdisciplinary integration), implementation protocols (e.g., timelines, student-teacher interaction models), and assessment metrics (e.g., skill competency rubrics, peer evaluations). By codifying best practices, the institution ensures consistency and scalability across programs. Concurrently, a teacher incentive system will be launched to recognize and reward excellence in reform participation. This includes performance-based bonuses, career advancement opportunities, and public acknowledgment through awards or media features. For example, faculty who design award-winning PBL modules or publish research on pedagogical innovation may receive grants for professional development. Such measures not only motivate educators but also cultivate a culture of continuous improvement, where experimentation and creativity are valued. Together, these institutional safeguards create a sustainable ecosystem for reform, ensuring long-term adherence to high standards and alignment with evolving educational trends.

6.3 Financial Guarantee

To ensure financial sustainability for teaching reform, the school must increase institutional investment in experimental equipment, virtual simulation platforms, and faculty training while diversifying funding through industry partnerships. Prioritizing upgrades to labs and training facilities ensures alignment with industry standards, while virtual platforms reduce costs and expand accessibility. Faculty development programs, supported by corporate sponsorships or international exchanges, enhance curriculum relevance. Proactive collaboration with enterprises via MOUs can unlock donations, endowed positions, and shared R&D projects, complemented by alumni networks and government grants. Establishing a dedicated fundraising office to streamline partnerships and transparency will strengthen long-term financial resilience.

This dual approach—bolstering internal budgets and leveraging external resources—creates a sustainable ecosystem for delivering practice-oriented, globally competitive education.

7. Conclusion and Prospects

Through the research and practice of project-based teaching reform of the course "Fundamentals of Analog Electronics Technology," many problems in traditional teaching have been solved, and the teaching quality and students' learning effects have been improved. Project-based teaching has stimulated students' learning interest and initiative, cultivated their practical operation abilities, problem-solving abilities, teamwork abilities, and innovation abilities, and enhanced their comprehensive qualities, providing an effective way for higher education institutions to cultivate high-quality applied talents. Future research can further optimize project design, continuously update and improve project content according to industry development trends and actual needs to make projects more targeted and practical. Strengthen the integration with other courses, build a more perfect curriculum system, and achieve the systematicness and coherence of knowledge. Explore more effective assessment and evaluation methods to comprehensively and objectively evaluate students' learning processes and learning outcomes. At the same time, strengthen international exchanges and cooperation, learn from advanced foreign teaching concepts and teaching methods, and continuously improve the teaching level of the course "Fundamentals of Analog Electronics Technology" in Chinese higher education institutions.

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