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Research and Practice on the Reform of Analog Electronic Technology Curriculum System Based on the OBE-CDIO Concept

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Abstract: *This paper summarizes the reform and practical experience of the analog electronic technology curriculum system based on the Outcome-Based Education (OBE) and Conceive-Design-Implement-Operate (CDIO) concept. Initially, it identifies the issues inherent in traditional analog electronic technology courses, such as the disconnect between theory and practice, monotonous teaching methods, and the lack of practical projects. Subsequently, the paper elaborates on the reconstruction and overall design of the curriculum content, which includes the introduction of cutting-edge technological content, the integration of real-world cases, the fusion with specialized knowledge, the adoption of modern teaching methods, and the incorporation of ideological and political education within the curriculum. In terms of practical teaching, a project-driven approach is employed, emphasizing experiments and hands-on practice, while competitions are leveraged to promote teaching and learning. Regarding the reform of assessment and evaluation, diverse evaluation, skill assessments, a course feedback mechanism, real-time interactive assessment, and course effectiveness evaluation are introduced. Finally, the paper discusses the creation of a teaching environment to support the reform of the curriculum system. Through these innovative practices, remarkable teaching outcomes have been achieved in this curriculum reform.*

Keywords: *OBE-CDIO Concept, Analog Electronic Technology, Teaching Reform, Teaching Practice*

1. Issues Existing in Traditional Analog Electronic Technology Courses

In traditional analog electronic technology courses, several common problems are observed:

(1) **Disconnection Between Theory and Practice:** Traditional courses tend to focus excessively on theoretical knowledge transmission while paying less attention to practical operations and experimental practices, resulting in students having relatively weak capabilities in practical applications.

(2) **Homogeneous Teaching Methods:** Traditional teaching often adopts homogeneous methods, such as theoretical lectures and experimental demonstrations, lacking diverse teaching tools and strategies to cater to the different learning styles and needs of students [1].

(3) **Lack of Practical Projects:** Traditional courses may be devoid of actual engineering projects and practical tasks, making it difficult for students to apply theoretical knowledge to solving real-world problems, thereby limiting their practical skills and innovative thinking [2].

(4) **Outdated Teaching Environment:** Laboratory equipment and teaching environments may be outdated, with the wiring methods of test boxes failing to meet the demands of modern technology for talent, thus restricting students' hands-on experience and learning effectiveness.

(5) **Homogeneous Evaluation Methods:** Traditional assessment methods primarily rely on written tests, failing to comprehensively evaluate students' practical abilities and innovative thinking, and lacking a comprehensive evaluation system [3].

(6) **Inadequate Ideological and Political Education in Disciplines:** Traditional courses may neglect ideological and political education within disciplines, failing to guide students in understanding the social impact of technological development and cultivating their sense of social responsibility and innovative spirit [4].

These issues may lead to decreased student engagement in courses, limited application abilities of professional knowledge, and a lack of profound understanding of the industry and society. To address these problems, a teaching experimental research paradigm was adopted, focusing on the issues and

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conducting targeted innovative practices.

2. Reconstruction and System Design of Course Content Based on the OBE-CDIO Concept

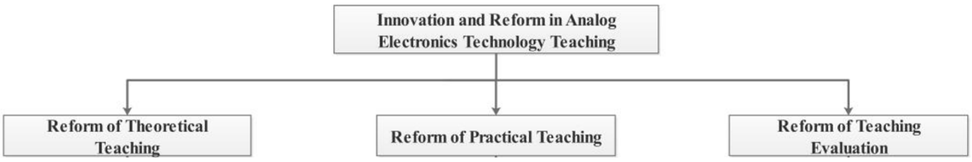

Figure 1: Innovative Teaching Reform System for Analog Electronic Technology Courses

To address the issues of students' lack of interest in traditional textbook content and difficulty in active learning [5], we have reconstructed the course content based on the Outcome-Based Education (OBE) concept [6] and adopted a series of innovative instructional designs (as illustrated in Figure 1). The main reforms are as follows:

2.1. Theoretical Teaching Reform

Introduction of Cutting-Edge Technology Content: Update the course content by incorporating knowledge from the latest frontier technological fields, such as artificial intelligence, the Internet of Things, and embedded systems. By introducing these emerging technologies, students can stay informed about the latest industry trends and cultivate sensitivity to future development trends.

Integration of Practical Cases: In theoretical classrooms, combine theoretical knowledge with practical applications by introducing real engineering cases and successful application examples. By analyzing the problem-solving processes of actual cases, students' interest in knowledge is stimulated, and their practical application abilities are enhanced.

Fusion with Professional Knowledge: Integrate analog electronic technology with other professional technical knowledge, such as combining the bandwidth of low-frequency circuits with communication principles. By fusing with professional knowledge, students' knowledge boundaries are expanded, enabling them to more comprehensively understand and apply analog electronic technology, thereby increasing their interest in learning [7-8].

Modern Teaching Methods: Increase student interest and deepen their understanding of principles by updating textbooks and teaching technologies. This reform project utilizes AR interactive animations and H5 interactive pages to deepen students' understanding of the microscopic concepts of analog electronic technology. Additionally, micro-lecture videos from new textbooks help students sort out key and difficult knowledge points, breaking the temporal and spatial boundaries of learning.

Integration of Ideological and Political Education: Guide students to consider the social responsibility of analog electronic technology and prompt them to understand the impact of technological development on society. By discussing ethics, regulations, and other issues, students' sense of social responsibility and innovative spirit are cultivated. For example, by examining the internal circuit design of basic chips such as integrated operational amplifiers, the rapid development and potential strength of China's microelectronics technology are emphasized.

2.2. Practical Teaching Reform

Project-Driven Teaching Method: In experimental classrooms, adopt the CDIO concept, emphasizing a project-driven teaching method [9,10]. Redesign and organize practical experimental projects, allowing students to engage in hands-on operations in team collaboration, thereby cultivating their engineering practice abilities and innovative thinking [11].

Enhancement of Experiments and Practices: In experimental sessions, further optimize experimental projects by adding simulation and training sessions to strengthen practical operation components. Update laboratory equipment, introduce advanced technological tools, and create a teaching environment with an engineering practice atmosphere to improve students' practical abilities.

Promotion of Teaching and Learning through Competitions: During extracurricular periods, guide students to utilize their theoretical and practical knowledge to participate in various professional

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skills competitions (such as the Blue Bridge Cup and Intelligent Car Competitions), further enhancing their hands-on abilities, deepening their understanding of theoretical knowledge, and improving their practical skill training and learning [12,13].

2.3. Assessment and Evaluation Reform

Assessment and evaluation reform plays a crucial role in analog electronic technology courses [14]. Traditional single evaluation methods are insufficient to comprehensively reflect students' learning situations. Through comprehensive evaluation, a more comprehensive understanding of students' learning situations can be obtained, stimulating their learning enthusiasm. Specific measures include diversified evaluation, skill assessment, course feedback mechanisms, real-time interactive assessment, and course effectiveness assessment [15]. These reforms can provide more effective student feedback and promote the improvement of teaching quality. The following measures have been specifically implemented in this course reform:

Diversified Evaluation Methods: Introduce various evaluation methods, including but not limited to experimental reports, classroom performance, simulation exams, practical exams, final exams, and midterm exams. Diversified evaluation methods can more comprehensively understand students' learning situations and ability development, stimulating their learning enthusiasm.

Introduction of Skill Assessment: Assess practical operation skills, including the use of instruments and equipment, conducting experiments, debugging circuits, etc. Practical operation skill assessments can be completed through experimental reports, practical operation demonstrations, and other methods.

Course Feedback Mechanism: Establish a course feedback mechanism to regularly collect students' opinions and suggestions on the course. Based on student feedback, teaching methods can be timely adjusted and improved, enhancing the course's adaptability and attractiveness.

Real-Time Interactive Assessment: Utilize modern technological tools to establish a real-time interactive assessment system. Through online Q&A, voting, and other methods, real-time understanding of students' comprehension of course content can be obtained, allowing timely adjustment of the teaching pace [16].

Course Effectiveness Assessment: Take advantage of engineering certification opportunities to revise the syllabus and use target achievement as a method for course effectiveness assessment. Combined with course goals and expectations, conduct an overall assessment of course effectiveness. Comprehensive assessments are conducted through multiple aspects such as students' theory and project practice to better understand the actual effects of the course.

Through the above content reconstruction and syllabus revision, the analog electronic technology course can better adapt to the requirements of contemporary technological development, improving students' practical application abilities and innovative consciousness. This innovative model aims to stimulate students' interest, cultivate their practical abilities, and enable them to better adapt to future technological development needs.

3. Innovation in Teaching Methods Based on the OBE-CDIO Concept

In response to students' indifference towards traditional theoretical teaching methods and their lack of practical skills, this project adopts the CDIO concept, emphasizing a project-driven teaching approach [17,18]. By designing practical projects, students are encouraged to collaborate in teams, thereby cultivating their engineering practice abilities and innovative thinking [19]. Practical teaching methods enable students to better understand abstract theoretical knowledge and enhance their practical skills. This is specifically reflected in the following aspects:

(1) **Project-Driven Teaching:** By adopting a project-driven teaching approach and introducing actual projects (Table 1), students learn and apply analog electronic technology knowledge while solving real-world problems. Projects can originate from industrial collaborations, scientific research, or actual societal needs. Through project completion, students gain a deeper understanding of theoretical knowledge.

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Table 1: Analog Electronic Technology Practice Projects

Serial Number	Project Name	Serial Number	Project Name
1	Use of Common Electronic Instruments and Simulation Software	4	Negative Feedback Amplifier Circui
2	Single-Transistor Amplifier Circuit	5	Classic Integrated Operational Amplifier
3	Differential Amplifier	6	RC Sine Wave Oscillator

(2) CDIO Engineering Education Concept: Utilizing the CDIO engineering education concept, each practical aspect is designed in a forward-thinking manner. CDIO stands for Conceive, Design, Implement, and Operate. It takes the lifecycle from product development to product operation as the carrier, enabling students to learn engineering in an active, practical, and interconnected manner across courses. In the reform of analog electronic technology courses, the Conceive phase involves using theoretical analysis methods of analog circuits to analyze the functions of actual circuits; the Design phase uses Multisim software simulation to verify the rationality of circuit design, allowing for timely adjustments to the circuit design scheme; the Implement phase adopts practical training, where circuits are actually constructed through welding or breadboarding, establishing a practical testing platform; finally, the Operate phase involves conducting practical measurements of the project, following the requirements of the practical training manual to deepen the understanding of theoretical principles (Figure 2).

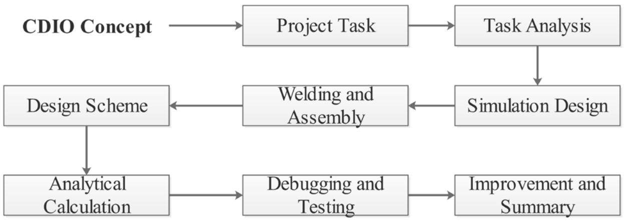
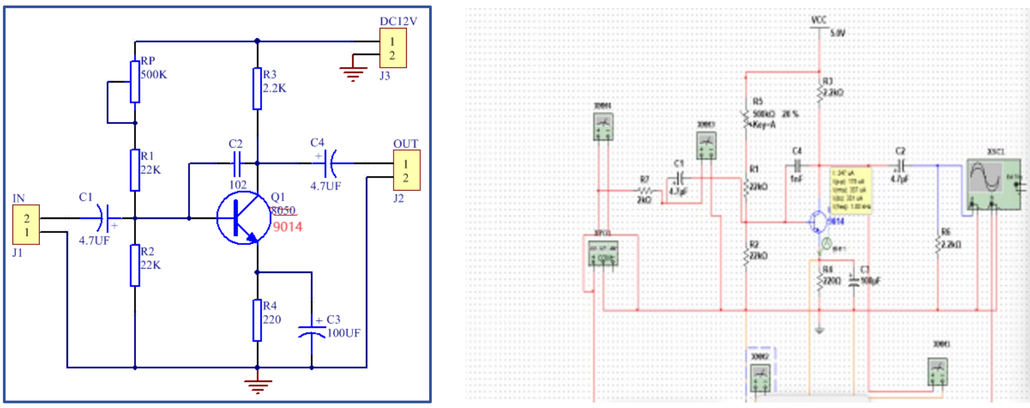


Figure 2: Design of Analog Electronic Technology Teaching Projects Based on the CDIO Concept

(3) Flipped Classroom Teaching: Students are encouraged to independently learn relevant knowledge and conduct project practical training in advance, followed by problem discussions, case analyses, and other activities in the classroom. This flipped teaching model can stimulate students' autonomous learning abilities and deepen their understanding of knowledge.

(4) Combination of Simulation and Practice: Utilizing virtual laboratories and simulation tools, students conduct simulation experiments and design circuits on computers. They then proceed to practical training rooms to build and debug circuits. This method not only reduces the cost of experimental equipment but also makes it easier for students to grasp the general project workflow (Figure 3), deepen their understanding of analog electronics principles, and improve experimental efficiency.



(a)Schematic Diagram *(b) Simulation Diagram*

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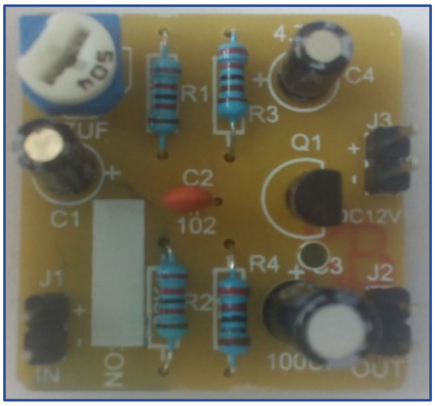
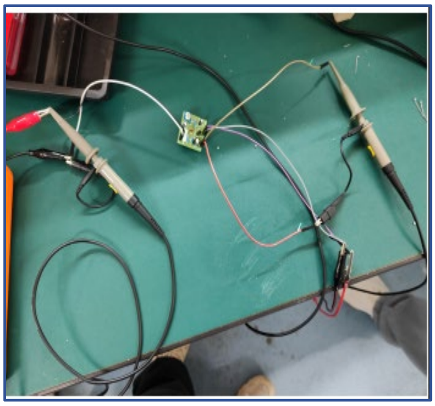
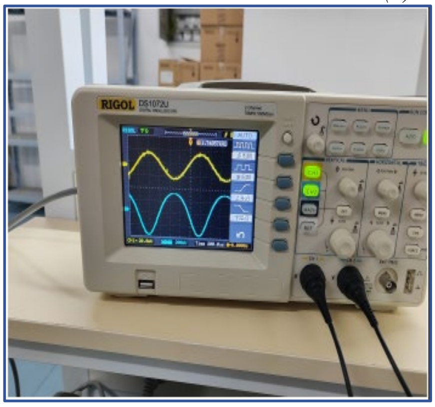


(c) Welding



(d) Testing Wiring



(e) Debugging Results

Figure 3: Project Practice Case: Single-Transistor Amplifier Circuit

(5) Collaborative Learning and Team Projects: Students are encouraged to engage in collaborative learning and form groups for team projects. Through group collaboration, students can face challenges together, share experiences, and cultivate team collaboration and communication skills. This approach simulates the cooperative environment in actual work.

Through the above innovative teaching methods, students' interest in analog electronic technology can be better stimulated, their practical application abilities improved, and their innovative spirit and team collaboration skills cultivated.

4. Creation of the Teaching Environment

The traditional teaching environment fails to meet students' needs for practical operation, limiting the cultivation of their practical abilities. To address this, a teaching environment with an engineering practice atmosphere has been created, involving the updating of experimental equipment and the introduction of advanced technological tools. In this improved experimental environment, students can engage in deeper and more extensive practical activities, enhancing their practical operation skills. The specific improvements and methods for creating the teaching environment for analog electronic technology courses are as follows:

(1) Updating and Upgrading Equipment in Training Rooms: Update the equipment in training rooms to ensure they align with current technological advancements and can support the latest analog electronic technology experiments. Introduce advanced instruments and equipment, such as oscilloscopes and signal generators, to improve training effectiveness and students' hands-on experience (Figure 4).

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(a)Signal Generator *(b) Voltage Source* *(c) Oscilloscope*

Figure 4: Equipment in Training Rooms

(2) Construction of Virtual Laboratories: Introduce virtual laboratory technology into the laboratory environment, enabling students to conduct simulation experiments on computers (Figure 5). This enhances the utilization of laboratory resources, reduces experimental costs, and allows students to conduct experiments anywhere.

(a) Training Room *(b) Simulation Laboratory*

Figure 5: Training Room and Simulation Laboratory

(3) Course Material Sharing Platform: Establish a course material sharing platform using Chaoxing Learning Tong , enabling teachers and students to conveniently share course-related learning materials, experiment reports, course project resources, etc., promoting information sharing and collaboration.

Through the creation of the above environments, a teaching environment conducive to students' learning and practice is provided, facilitating their deeper and more comprehensive understanding and mastery of analog electronic technology knowledge.

5. Analysis of Teaching Implementation Effects

(1) Significant Improvement in Achievement of Teaching Objectives

By introducing the Outcome-Based Education (OBE) concept, curriculum design has become more focused on student learning outcomes. Teaching objectives are clear and explicit, covering multiple dimensions such as knowledge mastery, skill application, and attitude cultivation. After the reform, the achievement rate of course objectives has significantly increased. According to teaching feedback data statistics, over 80% of students achieved passing grades or above in the final exam, with an increase in the excellent rate by 15 percentage points compared to previous years.

(2) Enhanced Practical Abilities and Innovative Consciousness of Students

Through the improvement of practical aspects emphasized by the CDIO concept, project-driven teaching methods have effectively enhanced students' engineering practical abilities. Students have demonstrated stronger hands-on abilities and innovative consciousness when participating in actual projects. For example, in experimental projects, students can actively design and optimize circuit schemes, and successfully complete the design and implementation of complex circuits such as single-tube amplifiers and differential amplifiers. Additionally, some students have applied their learning outcomes to various professional skills competitions, such as the "Blue Bridge Cup" and the "National Undergraduate Electronic Design Contest," winning multiple awards.

(3) Increased Student Interest and Participation

The introduction of modern teaching methods such as AR interactive animations, H5 pages, and virtual laboratories has enhanced the fun and interactivity of the course. Post-class surveys indicate that about 90% of students have shown increased interest in the Analog Electronic Technology course; attendance rates and homework completion rates have increased by over 20%. Classroom interaction and discussion sessions have also become more lively, with a significant increase in the number of students actively asking and answering questions.

(4) Effects of a Diversified Assessment System

A diversified assessment system more comprehensively reflects students' learning outcomes and ability levels. Traditional single-method written exams have been replaced by multi-dimensional evaluation methods such as skill assessments, experimental reports, and classroom performance, stimulating students' potential for comprehensive development. Experimental report scores have increased by an average of 10%, and classroom performance scores have increased by 15%. Especially in skill assessments, students' practical abilities and problem-solving skills have been comprehensively tested.

(5) Improved Teaching Quality and Student Satisfaction

The success of the teaching reform is not only reflected in the improvement of student learning outcomes but also in student satisfaction with the course. According to questionnaires, 95% of students approve of the new curriculum system, believing that the course content is close to practical applications and that the teaching methods are novel and attractive. Furthermore, students generally report that through their studies, they have gained a deeper understanding of career development in fields related to analog electronic technology.

6. Conclusions

Through comprehensive reform of the Analog Electronic Technology course, this project has achieved remarkable results in teaching methods, content design, practical teaching, and assessment and evaluation. The curriculum content has been reconstructed to be closer to cutting-edge technology, and practical cases have been introduced to increase the attractiveness of the discipline. Practical teaching methods are driven by projects, cultivating students' engineering practical abilities through hands-on operations. A diversified assessment and evaluation system allows students to fully demonstrate their learned knowledge and skills in various aspects.

In terms of creating a teaching environment, by updating experimental equipment, introducing virtual laboratory technology, and establishing a course material sharing platform, a teaching environment more suitable for contemporary technological demands has been provided. Ultimately, the successful practice of the innovative model demonstrates that this teaching reform has promotional value and can be extended to other majors and universities, potentially improving the overall discipline level and cultivating talents with stronger practical application abilities and innovative spirits.

Acknowledgements

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