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Research on Practice of Blended Teaching in 'Electrical Engineering and Electronics' Based on Outcomes-Based Education Principles

Chen Zhang[a,*], Suxia Xie[b]

School of Mechanical Engineering, University of Shanghai for Science and Technology, 516 Jungong Rd, Shanghai, 200093, China
[a]zhangchen__2020@usst.edu.cn, [b]xsx@usst.edu.cn
[*]Corresponding author

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Abstract: This paper aims to analyze the achievement of course objectives in the "Electrical Engineering and Electronics" curriculum based on Outcomes-Based Education (OBE) principles and to explore strategies for continuous improvement. By clearly defining course objectives and designing corresponding assessment metrics, this study systematically examines student performance in knowledge acquisition, practical skills, and innovative thinking. The results indicate that students demonstrate a high level of proficiency in theoretical knowledge related to direct current (DC) circuit analysis and digital circuit analysis. However, there remains a significant deficiency in their application skills concerning alternating current (AC) circuit analysis and analog circuit design, particularly in areas that are challenging to simulate or experience practically. To address these shortcomings, this paper proposes a series of continuous improvement measures, including optimizing blended teaching methods, increasing practical project opportunities, implementing diversified assessment strategies, and enhancing interaction between instructors and students. Ultimately, this study provides actionable recommendations for curriculum reform based on OBE principles, aiming to contribute to the ongoing development of education in the field of electrical engineering and electronics.

1. Introduction

In the context of global educational reform, cultivating high-quality talent capable of adapting to future societal needs has become a central objective of educational systems worldwide. This is particularly evident in the field of engineering, where foundational courses in electrical and electronic technology play a crucial role. These courses not only provide students with essential theoretical knowledge but also impose higher demands on their practical skills and innovative capabilities. The curriculum encompasses fundamental topics such as circuit analysis, signal processing, and the operating principles of electronic components. This foundational course not only equips students with basic electrical and electronic knowledge but also lays a solid

groundwork for subsequent specialized courses. The engineering principles imparted through this curriculum are vital for understanding more complex engineering challenges, thereby aiding students in developing systematic engineering thinking. Such competencies are critical for future careers in electrical engineering, electronic engineering, and related fields. Moreover, the relevance of electrical and electronic technology extends beyond the realm of electrical engineering, finding applications in diverse disciplines such as computer science, automation, and communications. The reform and modernization of course content can stimulate students' innovative awareness and cultivate their ability to solve real-world engineering problems.

Outcome Based Education (OBE) [1], as a modern educational philosophy, is gradually becoming an important framework for teaching reform in various disciplines. The core of OBE lies in learning outcomes, emphasizing the development of student's abilities, aiming to cultivate their effective application of learned knowledge and skills in the real world, thereby ensuring that they possess specific abilities and qualities upon graduation. According to the principles of OBE, the educational process should be student-centered, value students' initiative in the learning process, and encourage their participation in curriculum design and evaluation [2]. This sense of participation not only enhances students' learning motivation and sense of responsibility but also promotes their more active engagement in learning. In addition, under the OBE framework, the role of teachers has also transformed. They are not only knowledge transmitters, but also guides and supporters of learning. This role shift further emphasizes the necessity of teacher professional development, ensuring that teachers can effectively guide students to achieve learning outcomes.

In modern education, curriculum design must not only emphasize the balance between theory and application but also focus on how to stimulate students' interest in learning and enhance their practical and innovative abilities to achieve the goals of talent cultivation programs [3]. This challenge is a significant issue that all educators must confront. This study aims to explore how to effectively optimize the teaching process of electrical engineering and electronics courses based on the principles of OBE by analyzing the attainment of course objectives. Specifically, the research will establish a more interactive, participatory, and effective blended teaching model through clearly defined learning objectives, the design of project themes closely related to student's future careers, and the implementation of effective formative assessment and reflection mechanisms.

2. Achievement and Analysis of Course Objectives in Electrical Engineering and Electronics

This section takes the achievement degree of the course objectives of the 2022 Mechanical Engineering major at University of Shanghai for Science and Technology as an example. It explores the practical path of reforming the teaching mode of Electrical Engineering and Electronics courses based on the OBD concept. This is done by analyzing the achievement degree of each course objective.

2.1. Course Assessment

2.1.1. Homework grading criteria

The homework score will be included in the final grade at a 50% ratio. The proportion of classroom performance supporting the four-course objectives is 20%, 10%, 10%, and 10%, respectively. According to the specific homework content, Chapters 1, 2, and 5 support course objective 1, Chapters 3 and 4 support course objective 2, Chapters 7, 8, and 9 support course objective 3, and Chapters 10, 11, and 12 support objective 4.

2.1.2. Final Exam Scoring Standards

The main assessment includes Kirchhoff's law, solving DC resistance circuits using the column equation method, solving DC resistance circuits using circuit theorems, sine steady-state circuits, three-phase circuits, transistor amplification circuits, linear analysis of circuits with ideal operational amplifiers, combinational logic circuit analysis, and timing logic circuit analysis. The final examination score is 100 points, and 50% of the score will be included in the final grade. Table 1 shows the assessment items of the course.

Table 1: Course Assessment.

Course objectives	Assessment points	Support for ability development	Assessment and evaluation methods and score ratio (%)					Score ratio (100%)
			Process assessment				Final examination	
			Homework	experiment	Design	Self-testing		
1	Basic Theory of Circuits and Basic Analysis Methods and Transient Analysis of DC Circuits	1. Engineering knowledge	20				12	32
2	Analyzing and calculating AC sinusoidal circuits using the phasor analysis method	1. Engineering knowledge	10				13	23
3	Basic principles and applications of diode transistor devices in analog electronic circuits, analysis, and application of basic operational amplifier circuits	2. Problem analysis	10				13	23
4	Theoretical knowledge, analysis methods, and applications of digital electronic circuits	2. Problem analysis	10				12	22
Amount			50				50	100

2.2. Calculation and Analysis of Course Goal Achievement

Taking the scores of all students in each assessment stage of this course, if the total number of students is N, the achievement degree of the i-th course objective based on the performance assessment method is expressed as:

$$k_i^c = \frac{\sum_{j=1}^{N}\left(\sum\left(\text{Course objective } i \text{ Assessment section score} \times \text{ Proportion of final grade}\right)\right)_j}{N \times \left(\sum \text{ Course objective } i \text{ Assessment phase objective score} \times \text{ Proportion of final grade}\right)}$$

Figure 1 records the statistical situation of the achievement of the 2022 course objectives in Electrical Engineering and Electronics. From the evaluation values of each course objective, the achievement of course objective 1 is the best, while the achievement of course objectives 2, 3, and 4 is at a normal level. In the future, corresponding teaching should be strengthened for course objectives 2, 3, and 4 to improve students' mastery of these objectives. Compared with the

achievement of the 2021 mechanical major course objectives, the evaluation value of course objective 1 decreased by 0.05. Due to the increase in homework content, the proportion of course objectives has increased, and the examination of student's ability to solve and analyze problems using circuit principles, column equation methods, and circuit theorem methods has increased. The previous year was an online exam with slightly simpler questions, while this year's offline courses have increased in difficulty. Due to the large amount of knowledge in this section, the difficulty can be slightly reduced during the exam. The evaluation value of course objective 3 has decreased by 0.1, and the theoretical learning difficulty of transistor amplification circuits is relatively high. The requirements have been raised, and the difficulty of the questions has increased. The teaching team will continue to supplement comprehensive topics such as ideal operational amplifiers on online platforms in the future.

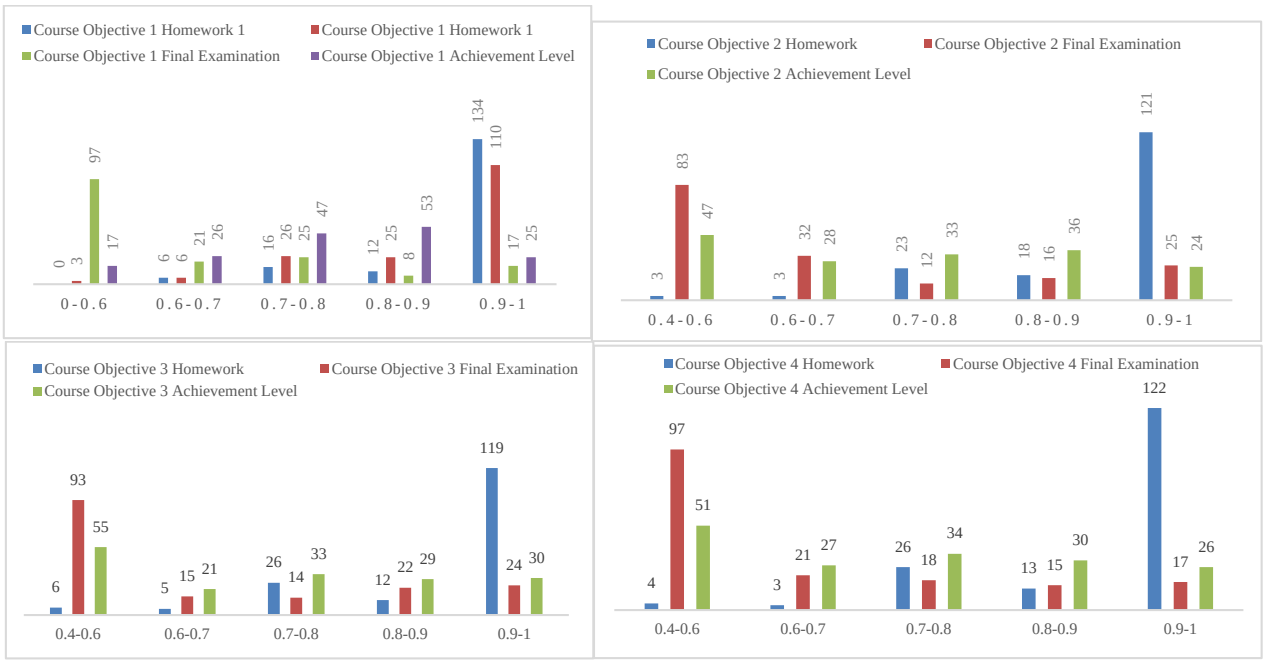

Figure 1: Distribution of Achievement of Course Objectives.

Figure 2 records the achievement of the overall course objectives, and from the evaluation values of each course objective, the achievement of each course objective is relatively balanced. Overall, there has been a significant improvement compared to last year, mainly due to the increase in online content, which facilitates students' learning and consolidation of knowledge points. In response to the low achievement of objectives 3 and 4 in the previous course, the teacher added exercises related to classroom evaluation and homework. The teaching team will utilize various modern means such as online platforms and network resources to strengthen students' theoretical learning of circuit principles and electronic technology and optimize homework and question types.

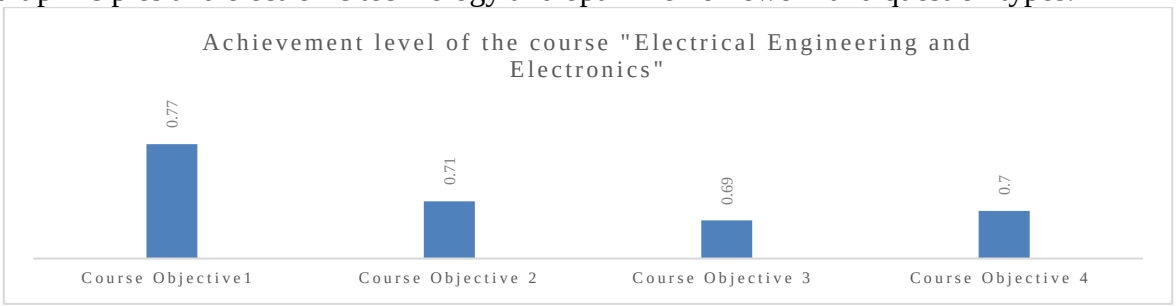

Figure 2: Distribution of overall course objectives achieved.

3. Suggestions for Blended Teaching of "Electrical Engineering and Electronics" Based on the OBE

Based on the analysis of the achievement of the above course objectives, it was found that there was insufficient guidance of teaching objectives throughout the entire teaching process, and there were few training objectives set for students at different levels; Lack of close connection between theory and practice makes it difficult to apply learned theories to practice, and the results orientation is not clear. Therefore, the following specific suggestions are proposed for the mixed teaching reform of "Electricians and Electronics" based on the Outcome Based Education concept:

(1) Clarify learning outcomes

The teaching team will set specific learning objectives: Based on the course content and industry needs, clarify the knowledge, skills, and attitudes that students should master after completing the "Electrician and Electronics" course. For example, students should be able to understand the basic principles of circuit analysis, design simple circuits, and conduct experiments using electronic measuring instruments.

Develop a results-oriented curriculum outline: Incorporate learning outcomes into the curriculum outline, ensuring that each module and lesson corresponds to the predetermined learning outcomes.

(2) Curriculum Design and Teaching Methods

Adopting a blended learning model: combining online and offline teaching, utilizing online learning platforms to provide theoretical knowledge learning, such as video lectures, online quizzes, etc., while conducting practical operations and discussions in the classroom.

Adopting diversified assessment methods: In addition to traditional exams and tests, introducing various assessment methods such as formative assessment and self-assessment to comprehensively evaluate students' learning outcomes in terms of knowledge, skills, and attitudes. This diversified evaluation method can better reflect students' actual abilities. For example, teachers can regularly conduct quizzes to check students' understanding and mastery of recent learning content; evaluate students' understanding and application ability of course content through group discussions or whole class discussions.

Project-driven learning: Teachers can design project-based learning activities that allow students to apply their learned knowledge in practical projects. For example, designing and implementing a simple circuit project can enhance students' hands-on and teamwork skills. Project-based teaching can significantly enhance students' ability to analyze and solve problems, as well as cultivate their experimental skills and teamwork spirit, which helps to exercise their overall ability to solve complex engineering problems.

(3) Continuous improvement and evaluation

Goal-oriented adjustment of achievement evaluation criteria: Teachers can regularly evaluate teaching effectiveness and students' learning outcomes through questionnaire surveys, student feedback, and analysis of learning outcomes; identify problems and make improvements.

4. Conclusions

This article takes the professional basic course "Electricial Engineering and Electronics" as an example, calculates and analyzes the achievement of the course objectives according to the standards of engineering education certification, and obtains clear reports on the achievement of each objective. The achievement of course objective 2, Communication Circuit Analysis, and course objective 3. Analog Circuit Analysis, is relatively low, mainly because students' mastery of various knowledge points is limited to the memory stage, and they cannot conduct hands-on experiments. Therefore, this article proposes a reform of the teaching mode based on the OBE concept, which will improve students' participation through a blended learning mode; On the other

hand, using projects as a guide to stimulate students' enthusiasm for learning, combining theory with practice, and exercising students' overall ability to solve complex engineering problems.

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