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Practice of Electrical Specialty Curriculum Reform from the Perspective of Engineering Certification

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Abstract: This paper first emphasizes the close relationship between the curriculum and the specialty, and focuses on the construction and development of the specialty according to the certification standards. It further details the online and offline mixed teaching reform practice, taking the core curriculum group of electrical engineering and automation specialty as an example. It pays special attention to the successful flipping case of the course "Principles of Power System Relay Protection," and emphasizes the importance of flipping classroom and hybrid teaching. The article also describes in detail a successful flip case, a small class discussion class with the theme of ' large-scale setting calculation ', which promotes students ' positive thinking and discussion, and improves the learning effect. Through the analysis of the achievement of the course objectives from the perspective of volume performance and engineering certification, the article demonstrates the positive effects of the curriculum reform and provides useful experience for deepening the talent training model. By analyzing the achievement of graduation requirements supported by the curriculum, this paper highlights the key to the teaching reform of the professional core curriculum group.

1. Introduction

The development of the curriculum is inseparable from the foundation of disciplines and majors; conversely, the development of the curriculum can also strongly support the development of majors [1]. Our university's Electrical Engineering and Automation major is constructed and developed according to engineering certification standards, and successfully passed the certification in 2022. The analysis of the achievement of graduation requirements supported by the curriculum in the perspective of engineering certification shows the significant contribution of continuous efforts in the teaching reform of the core curriculum group of the major.

The focus of the curriculum reform in this article is the core curriculum group of this major, especially "Fundamentals of Power Systems" and "Principles of Power System Relay Protection," which are the only two core compulsory courses in the major. In addition, "Introduction to Electrical Engineering," "Power Electronics Technology," and "Power Transmission Control Systems" are elective courses covering all students. "Power Systems and Automation" is an elective course.

2. Practice of Blended Teaching Reform Both Online and Offline

In this round of reform, cohesive resources such as a series of microcourses focusing on key course knowledge points are created. The reform combines online guidance and interaction through a network community with offline teaching and communication in traditional classrooms, timely realizing "flipped" learning for some crucial knowledge points [2].While face-to-face teaching remains the main approach of points beyond the series of microcourses, personalized guidance is provided through a blended approach both online and offline, ensuring students' mastery of key content [3].

Flipped classrooms and blended teaching significantly enhance the interaction between teachers and students, maximizing mutual learning [4].Besides, the teaching elements of themed interactions and Q&A in the online discussion area, discussions in offline classrooms are undoubtedly the most challenging barrier to overcome in the reform [5]. The author's team delves into exploring discussion topics and forms of interactive discussions. Taking the core course "Principles of Power System Relay Protection" as an example, five knowledge points are selected for practical implementation of the "flipped classroom" teaching approach. The following introduces one relatively successful "flipped case": a small-group discussion class on engineering problems with "Large-scale Setting Calculation" as the carrier, applying the knowledge to practical use.

Table 1: Teaching Design Case of "Flipped Classroom" and "Small Group Discussion" Lesson —"Three-Section Current Protection Setting Calculation"

Teaching Objectives	Master the calculation of three-section current protection settings.	
Teaching Design	Student Tasks	Teacher Tasks
Pre-class Tasks	1. Watch five micro-lesson videos on three-section current protection. 2. Take notes: Summarize the basic setting methods.	1. Review student video-watching statistics and notes to grasp the basic learning situation. 2. Identify the key points for the discussion class based on the review.
In-class Tasks	1. Student questions and discussions. 2. Solve problems on the spot using "smart pens." 3. Student representative summarization.	1. Teacher introduction: Experience the "four basic requirements of relay protection" in the process of "three-section current protection setting calculation." 2. Clarify knowledge points: Setting adjustment, time adjustment, and sensitivity verification of three-section current protection. 3. Feedback and summary: Provide feedback on the students' problem-solving process presented on the large screen.
Post-class Tasks	1. Discuss and summarize in the online discussion forum. 2. Independent review and practice calculations.	1. Online discussion forum feedback. 2. Process performance evaluation.

Considering the characteristics of this course, setting calculation of relay protection is its focus and difficulty, and it is also the ultimate foundation for solving practical engineering problems in power systems. Completing such comprehensive large-scale calculations requires a solid grasp and flexible application of relevant knowledge points, as well as rigorous logic and standardized routines [6]. Based on experience, this is often challenging for beginners to master comprehensively in a short period, requiring extensive practice. Therefore, a series of comprehensive large-scale setting calculations is chosen as the main content for small-group discussions. The specific teaching design is shown in Table 1.

Equipped with advanced teaching instruments such as electronic whiteboards in our small-group discussion classrooms, teachers can easily inspire and organize the calculation process. Students using advanced smart pens can share their calculations in real-time on a large screen, facilitating teachers to provide comments and summaries to the entire discussion group. This teaching method is more appealing to learners than traditional blackboard writing or direct playback of PowerPoint presentations in a classroom. Simultaneously, as learners actively engage in continuous thinking and enthusiastic discussion throughout the process, the effectiveness of learning is significantly enhanced.

3. Evaluation of Blended Learning Effects

Taking the "Principles of Power System Protection" course as an example, this paper evaluates the learning outcomes through the surface scores of two classes, one from 2016 (before the reform) and the other from 2018 (after the reform), as detailed in Table 2.

Table 2: Analysis of Surface Scores for Two Grades

Grade	Number of Students	Average Score	Standard Deviation	Excellent Rate (%)
2016	78	86.12	10.33	3.72
2018	84	88.03	8.7	13.51

The surface exams were randomly selected from the exam question bank by the Academic Affairs Office, and the difficulty levels of different sets of questions in the question bank were not significantly different, a fundamental principle in compiling the question bank. Therefore, the data in this statistical table has a relatively objective practical significance. From Table 2, it can be observed that the average score has slightly increased each year, indicating a stable improvement in student learning outcomes with the continuous deepening of the reform. The decrease in standard deviation implies a reduction in the extent of score differences among students.

In summary, after the implementation of curriculum reform, the teaching mode has become more flexible, the teaching content more practical, teaching resources more abundant, and the assessment methods are more scientific, achieving good teaching results.

4. Analysis of Achievement of Graduation Requirements Supported by the Course from the Perspective of Engineering Certification

Taking the "Power System Protection" course as an example, the course objectives are as follows:

(1) The objective of this study is to understand the basic tasks and requirements of power system protection; be aware of the historical development and cutting-edge technology of relay protection [7]. (Supports graduation requirement 2-1/M)

(2) The objective of this study is to master the basic principles, setting principles, influencing factors, and solutions of current protection, distance protection, and series protection for lines;

understand the working principles and coordination with the protection of automatic reclosing; be familiar with the basic principles of protection for components such as transformers, generators, and busbars [8]. (Supports graduation requirement 1-4/H)

(3) The objective of this study is to understand the design principles and general methods of relay protection devices; master experimental methods for the protection principles of specific protection objects; possess the ability to analyze and solve complex engineering problems in relay protection [9]. (Supports graduation requirement 4-3/M)

The overall achievement of course objectives 1, 2, and 3 for the 2016 and 2018 grades is illustrated in Figures 1 and 2, respectively.

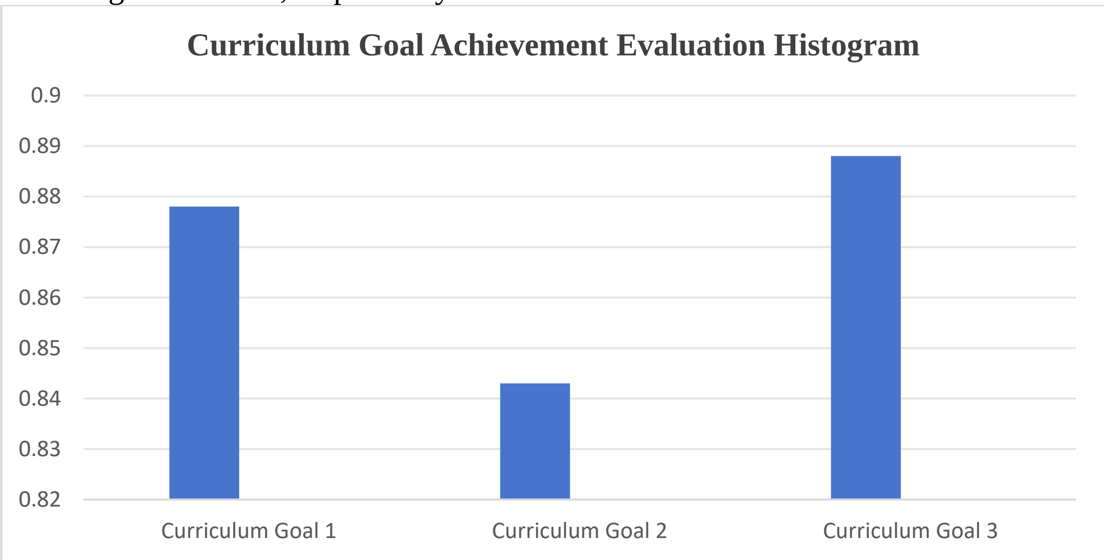

Figure 1: Overall Achievement of Curriculum Goals for the Grade 2016

The achievement of curriculum goal 1 for grade 2016 is 0.878, for curriculum goal 2 is 0.843, and for curriculum goal 3 is 0.888. With a passing standard of 0.6, all three curriculum goals are achieved.

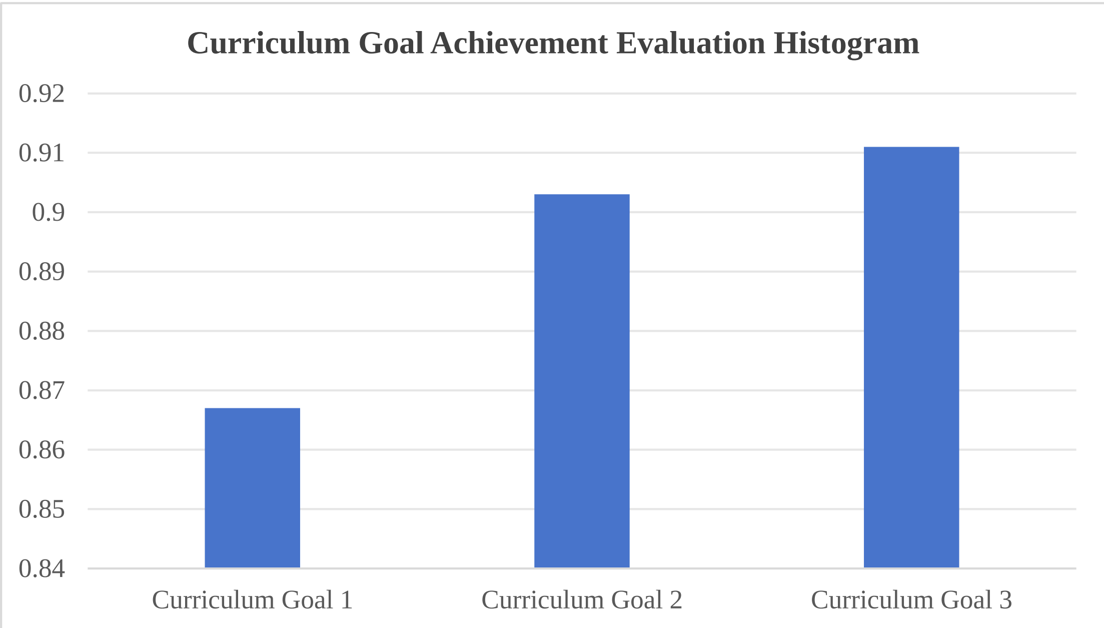

Figure 2: Overall Achievement of Curriculum Goals for the Grade 2018

The achievement of curriculum goal 1 for grade 2018 is 0.867, for curriculum goal 2 is 0.903, and for curriculum goal 3 is 0.911. With a passing standard of 0.6, all three curriculum goals are achieved.

By comparing Figure 1 and Figure 2, it is evident that grade 2018 showed a significant improvement in the achievement of curriculum goals 2 and 3 compared to grade 2016 after the implementation of curriculum reform. From this perspective, curriculum reform has played a significant supporting role in the development of professional teaching.

5. Conclusion

Based on engineering certification standards, this paper focuses on a typical core course in electrical engineering for reform. Utilizing advanced information technology, optimizing teaching content, and integrating "new energy" and other emerging industry technologies, the curriculum resources have been enriched with a three-dimensional online open course [10]. The introduction of flipped classrooms, small group discussions, and the exploration of a blended teaching model combining online and offline methods under the background of "Internet+" have been undertaken. Continuous improvements in talent development models and methods are made, aiming to enhance the level and quality of talent cultivation. Collaboration with similar universities to promote the application of reform results, in order to achieve complementary advantages, resource sharing, mutual benefit, and win-win common development of new engineering characteristics.

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