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Research on the Optimization of Curriculum System and Teaching Content for Electrical Engineering Majors Under the Background of Engineering Education Professional Certification and Emerging Engineering Education

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Abstract: The "4×4" modern industrial system proposed by Hunan Province poses renewed requirements for the construction of electrical engineering majors in institutions of higher learning. To adapt to the innovative development needs of the modern industrial system, it is imperative to optimize the curriculum system and teaching content of these majors, thereby promoting the comprehensive development of students and enhancing the teaching quality of institutions of higher learning. Currently, electrical engineering majors still face issues such as a disconnection between talent cultivation and industry, as well as curriculum settings that fail to reflect cutting-edge technologies in the field. Based on this, this article, grounded in the context of engineering education accreditation and emerging engineering education, elucidates the reasons for optimizing the curriculum system and teaching content of electrical engineering majors, as well as the problems existing in the development of this major. Furthermore, it proposes specific optimization strategies, hoping to provide useful references for relevant educators.

Keywords: Emerging engineering education; Electrical engineering majors; Curriculum system; Teaching content

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1. Introduction

In 2024, Hunan Province proposed advancing the construction of the "4×4" modern industrial system and issued the Implementation Plan for the Adjustment, Optimization, and Reform of Discipline and Specialty Settings in General Higher Education in Hunan Province, which raised higher requirements for the construction of emerging engineering education. Therefore, against the backdrop of engineering education accreditation and emerging engineering education, the upgrading of educational courses and the optimization of teaching content for

electrical engineering majors in institutions of higher learning have become inevitable pathways for cultivating individuals with good professional qualities and practical abilities, as well as for driving the high-quality development of higher education. Guided by the concepts of engineering education accreditation and based in the context of emerging engineering education, this article aims to explore the development path of electrical engineering majors by focusing on aspects such as the curriculum system and teaching content, hoping to meet the trends and demands of the times.

2. The new concept of "Emerging engineering education + Engineering education accreditation"

Emerging engineering education centers on students, leveraging information technology to build new practical platforms on top of traditional curriculum systems. It integrates teaching resources, stimulates students' autonomy, initiative, and creativity, and fuses classroom teaching with simulated practice to lay the foundation for engineering education accreditation [1]. In the emerging engineering education model, students are the main focus of the classroom, and learning methods are advocated to shift from teacher-centered lectures to student-centered self-study. Teachers transition to guiding learning directions and methods, encouraging students to take the initiative to learn, think, and innovate. The teaching objectives under this concept also shift from simply imparting teaching methods to cultivating students' autonomous learning abilities. For this reason, simulated practical teaching has become a focus of curriculum teaching reform in institutions of higher learning. In the context of emerging engineering education, simulated practical teaching connects classroom teaching with engineering education accreditation, helping students transition from theory to practice, verifying and deepening their scientific theoretical cognition.

Engineering education accreditation aims to strengthen students' practical and hands-on abilities, compensate for the cognitive limitations of textbook knowledge, update existing knowledge systems, and further narrow the gap between school education and the needs of society and enterprises. Engineering education accreditation is the refinement and practice of school curriculum education in the context of emerging engineering education. It serves as a bridge for students from campus to society, consolidating their existing knowledge while also providing a path for them to engage with the corporate environment and initially understand society [2]. Obtaining professional skill certification through assessment constitutes engineering education accreditation. Its concept balances knowledge and skills, promoting the comprehensive development of students. While meeting the talent needs of enterprises, it also shortens recruitment and training cycles. Engineering accreditation focuses on cultivating students' technical practical operation and knowledge application abilities, effectively enhancing their employability competitiveness and having a significant and far-reaching impact on students' personal development and the improvement of social employment rates.

3. Reasons for optimizing the curriculum system and teaching content of electrical engineering majors

The essential requirement of the era of emerging engineering education is to cultivate the practical and innovative abilities of engineering students. However, due to the long-term influence of exam-oriented thinking, most students lack corresponding practical abilities and innovative spirits. Therefore, institutions of higher learning should prioritize the reform of electrical engineering education, reconstruct the curriculum system, and optimize

teaching content to accelerate the pace of innovation in talent cultivation, improve teaching quality and efficiency, and adapt to the industrial revolution of the new era. To align with international standards, institutions of higher learning should include "emerging engineering education" in their key development goals, focusing on national development strategies and talent needs to drive the reform and innovation of electrical engineering majors.

4. Problems existing in the development of electrical engineering majors

4.1. Disconnection between talent cultivation and industrial development

National economic development has driven changes in the power industry. The rise of new energy and microgrids has accelerated the construction of new power systems. In this context, social enterprises have shifted their talent needs, urgently requiring composite talents with both practical and innovative abilities who can solve complex engineering problems [3]. In contrast, there are still some issues in higher education that need to be addressed, such as textbooks with outdated content that do not cover cutting-edge knowledge and technologies; traditional training methods that fail to effectively stimulate students' innovative and practical abilities; and slowly updated knowledge structures that are out of sync with the rapid development of the power industry. These issues make it difficult for higher education to meet the needs of enterprise and industry transformation. Institutions of higher learning need to construct new curriculum systems and make reasonable adjustments, changing talent cultivation models to update knowledge structures and enable the organic integration of teaching with local industries. How to achieve this goal has become a core issue that institutions of higher learning urgently need to consider and address.

4.2. Curriculum design to reflect cutting-edge technology

The curriculum system and syllabus are the core of the formulation and implementation of the training program, directly related to whether the talent training objectives can be achieved. The current curriculum system for electrical engineering majors has obvious drawbacks. In the context of emerging engineering education, artificial intelligence technology is limitedly represented in the curriculum system. Curriculum planning lacks systematic consideration of the connotation of new engineering, and the teaching content is out of step with the development trends of the new power system. The integration of new energy power generation and energy storage technologies is insufficient. Moreover, students have limited exposure to the application of advanced technologies such as robots, drones, cloud computing, and digital twins in the power system, restricting the expansion of their professional scope. Therefore, optimizing the curriculum system for electrical engineering majors has become an inevitable trend [4]. Universities should add courses that embody the concepts of new engineering, update course content, help students master cutting-edge technologies, broaden their professional horizons, and enhance their ability to solve complex engineering problems, thereby enabling students to better adapt to the rapid pace of development in the electric power industry and meet the industry's demand for interdisciplinary talents.

5. Optimization strategies for the curriculum system and teaching content of electrical engineering majors

5.1. Clarify professional teaching objectives and adapt to industry development

In the context of the new era of higher education development and the upgrading of societal demands for professional talents [5], electrical engineering majors need to optimize their curriculum system and teaching

content. Firstly, professional teaching objectives must be clarified. In terms of talent cultivation models, institutions of higher learning should prioritize the cultivation of application-oriented talents and closely align with employment needs. By emphasizing the integration of "work and study," and incorporating actual enterprise projects and industry standards when constructing the curriculum system, students can learn what is immediately applicable [6]. For example, in setting up professional courses, relevant courses on strong and weak electricity should be precisely established based on the job requirements in the electrical industry to ensure that students' knowledge structures meet job requirements. A "six-in-one" practical innovation education platform should be established, centering on the cultivation of application abilities, and regarding basic skill practice, professional skill practice, and comprehensive practice as key links to enhance students' abilities. These include basic circuit experiments to consolidate basic skills, professional practice such as power system simulation to hone professional skills, and comprehensive graduation design projects to achieve a thorough integration of knowledge and skills. A heatmap of the correlation between industry demands and curriculum settings is shown in **Figure 1**.

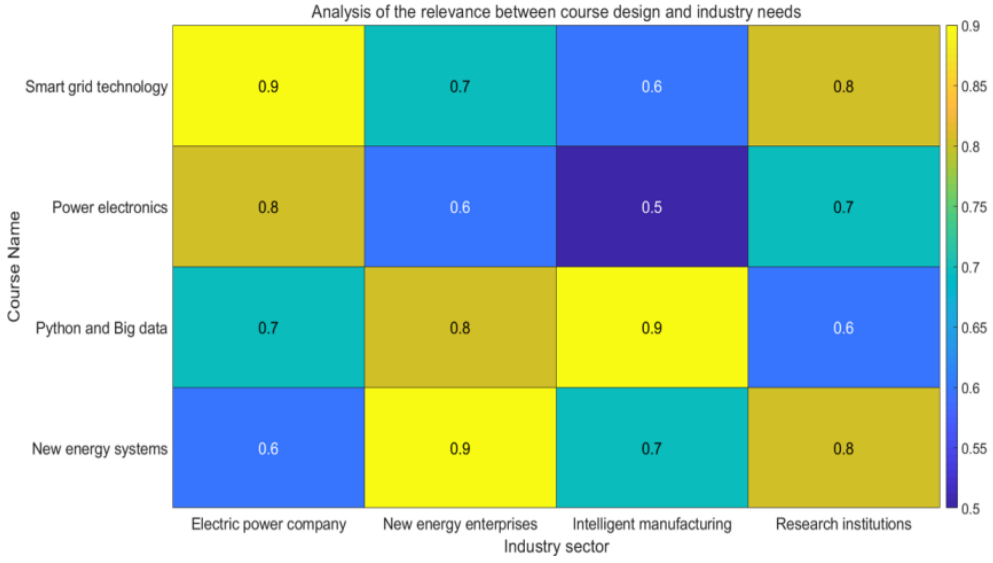

Figure 1. Heatmap of the correlation between industry demands and curriculum settings.

The goal of professional construction focuses on cultivating composite talents who are application-oriented, possess the characteristics of "one person with multiple certificates" and "one specialty with multiple abilities," and can serve the regional economy. Innovatively adopt the "task-driven, real-world education" teaching mode, assigning practical electrical project tasks, and allowing students to complete the entire process from scheme design to implementation in simulated or real work scenarios, thereby enhancing their abilities to solve practical problems and promoting the development of electrical engineering majors in the direction of serving the regional economy and demonstrating leading roles [7].

5.2. Reconstruct the professional curriculum system and adjust course settings

In the context of emerging engineering education and engineering education accreditation, issues such as lagging knowledge structures and cultivation methods in electrical engineering majors, as well as insufficient incorporation of the essence of emerging engineering education, urgently need to be resolved. Therefore, it is imperative to reconstruct the professional curriculum system.

On the one hand, institutions of higher learning need to focus on reforming information-based fundamental

courses. Given the widespread penetration of artificial intelligence and information technology in the electrical field, frontier courses such as artificial intelligence and Python programming can be added to strengthen students' information literacy and better prepare them for future complex and ever-changing work scenarios [8]. At the same time, an interdisciplinary fundamental curriculum system should be constructed. Uniformly expanding or adding relevant courses in computer information and other related fields can effectively consolidate students' foundations, help them break through disciplinary barriers, broaden their disciplinary horizons, and lay a solid foundation for cultivating composite talents. On the other hand, adjustments to professional courses should align with the latest development trends of new power systems, promptly incorporating new technologies and applications in the industry into teaching content to ensure the timeliness and practicality of the knowledge students acquire [9].

The practical innovation module focuses on cultivating students' practical abilities and innovative spirits, with the setting of course experiments, course designs, production internships, graduation designs, innovative entrepreneurship practices, and other links. Through practical operations and project practice, students' abilities to solve practical problems and innovative thinking are enhanced. When adjusting course settings, the proportion of practical courses should be appropriately increased to strengthen students' practical training. At the same time, the scope of elective courses should be expanded to provide diversified elective courses, including professional development courses, interdisciplinary courses, etc., to meet students' individualized development needs and cultivate their interests and specialties.

5.3. Optimize teaching content to align with industry development

To keep teaching content in step with the frontier technological developments in the electrical field, content such as the application of new energy and artificial intelligence in the electrical field should be actively introduced into courses. In power system courses, integrate knowledge on distributed energy access in smart grids, big data analysis and processing in power grids, and intelligent dispatch and control of power systems; in motor control courses, introduce the application of artificial intelligence algorithms in motor speed regulation and fault diagnosis; and in power electronics courses, explain the principles, characteristics, and applications of new power devices such as silicon carbide and gallium nitride, as well as new power electronics technologies such as high-frequency soft-switching technology and multi-level converters [10].

Incorporating actual engineering cases is an important approach to improving students' practical abilities and their ability to solve practical problems. Introduce actual enterprise projects into teaching. For example, in electrical drive control courses, use a motor control system retrofit project from an enterprise as a case study, allowing students to design motor speed regulation schemes, select appropriate controllers and drivers, and conduct system debugging. Teaching these practical cases enables students to understand the techniques and methods used in actual engineering, improving their engineering practical abilities and professional ethics.

5.4. Optimize the practical teaching system to enhance hands-on abilities

Institutions of higher learning should establish close cooperation with local renewable energy enterprises, electric power enterprises, etc., to jointly construct internship and training bases. For instance, cooperate with electric power companies to establish a power system operation internship base, where students can learn knowledge and skills such as the operation and maintenance of substations and power dispatch in actual power systems. Collaborate with electrical equipment manufacturing enterprises to set up an electrical equipment production internship base, allowing students to participate in the production, assembly, debugging, and other aspects of

electrical equipment to understand the manufacturing processes and procedures of electrical equipment [11]. By constructing internship and training bases, a true engineering practice environment is provided for students, enabling them to enhance their professional skills and practical abilities through practice.

Organizing practical projects and competition activities can stimulate students' interest in learning and innovative thinking. Institutions of higher learning should organize students to participate in activities such as electrical design competitions and innovation and entrepreneurship projects, like the National Undergraduate Electronic Design Contest and the "Internet +" College Student Innovation and Entrepreneurship Competition [12]. For example, in electrical design competitions, students need to design and produce electrical systems based on given task requirements. In this process, students can improve their design abilities, hands-on abilities, and team collaboration abilities. In innovation and entrepreneurship projects, students can combine their interests and professional knowledge to propose innovative ideas and transform them into actual projects, cultivating their innovative consciousness and entrepreneurial abilities. These practical projects and competition activities enhance students' practical abilities and innovative thinking, strengthening their overall qualities and competitiveness. A comparison of ability enhancement before and after optimization is shown in **Figure 2** [13].

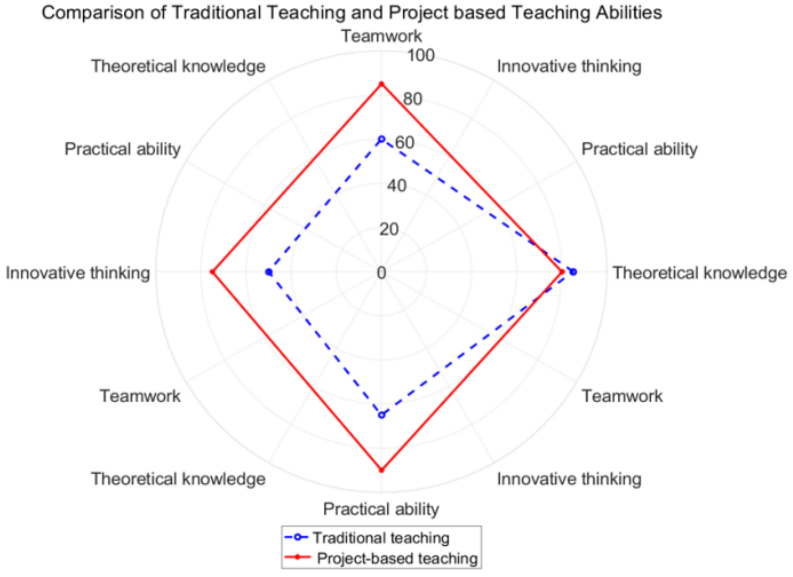

Figure 2. Comparison of ability enhancement before and after optimization.

5.5. Innovate teaching methods to enhance teaching effectiveness

Adopting diversified teaching methods can stimulate students' interest in learning and initiative. Project-based learning is driven by actual projects, allowing students to learn and apply knowledge in the process of completing projects, thereby cultivating their problem-solving and team collaboration abilities. For example, in power electronics courses, assign a project to design a switching power supply, letting students independently design circuits, select devices, fabricate circuit boards, and perform debugging and testing. Through this project, students can not only master relevant knowledge and skills in power electronics but also improve their practical and innovative abilities [14].

Case-based teaching introduces actual engineering cases for students to analyze and solve problems, deepening their understanding and application of knowledge. When explaining power system fault analysis,

introduce an actual fault case that occurred in a power system and ask students to analyze the cause of the fault and formulate a fault handling plan, improving their abilities to analyze and solve practical problems.

Utilizing modern educational technology can expand teaching resources and enhance teaching effectiveness. Virtual simulation experiments utilize computer software to simulate real experimental environments and processes, allowing students to perform experimental operations in a virtual environment without being restricted by time and space, while also reducing the wear and tear on experimental equipment and experimental costs [15]. For example, in power system experiments, utilize virtual simulation software to let students conduct experiments such as power flow calculations and short-circuit fault simulations in power systems, enabling them to better understand the operating principles and characteristics of power systems. Online courses provide abundant teaching resources, allowing students to learn anytime and anywhere. An online course platform for electrical engineering majors should be established, uploading teaching resources such as course videos, courseware, exercises, and cases. Students can engage in autonomous learning based on their learning progress and needs. At the same time, the online course platform can also facilitate teacher-student interaction, question and answer sessions, and other functions, enhancing the flexibility and interactivity of teaching.

6. Conclusion

Against the backdrop of engineering education accreditation and emerging engineering education, electrical engineering majors in institutions of higher learning should prioritize the cultivation of application-oriented talents. By clarifying professional teaching objectives, optimizing teaching content, enhancing the practical teaching system, and innovating teaching methods, among other multi-dimensional strategies, the curriculum system and course content can be optimized. This will improve students' practical abilities and innovative abilities, cultivating high-quality professional talents who can adapt to industry development.

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Disclosure statement

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