Investigation into the Teaching Mode of Introduction to Environmental Protection Course under New Engineering Science Background

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Abstract: Under new engineering science background, cultivating ecological awareness and national identity among engineering students has become a pressing educational priority. This study takes the electrical engineering and automation major as a case study, aiming to address the challenges of integrating environmental education into non-environmental disciplines. By analyzing student learning characteristics, aligning teaching objectives with professional needs, and adopting innovative pedagogical approaches (e.g., case-based learning, flipped classrooms, and interdisciplinary integration), this paper proposes a tailored teaching model. The model emphasizes real-world applications, problem-solving skills, and the cultivation of sustainable development concepts, ensuring graduates meet the demands of the new engineering paradigm.

Keywords: New Engineering Science; Introduction to Environmental Protection; Electrical Engineering and Automation; Teaching Model

1. Introduction

With the rapid advancement of industrialization and economic growth, environmental pollution has emerged as a critical global challenge, prompting significant societal and governmental attention to ecological conservation. In recent years, China has integrated the construction of an ecological civilization into its national development strategies, thereby laying a foundation for building a beautiful nation and achieving the great rejuvenation of the Chinese nation.

To further deepen reforms in engineering education, establish a robust foundation for this field, and support China's economic transformation and upgrading, the Ministry of Education has actively promoted new engineering initiatives that form a "three-part symphony" [1-3]. The "Tianjin University Initiative" and "Beijing Guidelines" underscore the necessity of enhancing national identity and ecological awareness among engineering students. This not only highlights China's commitment to environmental protection but also provides an opportunity for non-environmental majors at colleges and universities to incorporate environmental knowledge into their curricula.

As the primary source of talent in our country, university students' technical skills and cultural literacy directly influence national competitiveness. Higher education institutions serve as crucial hubs for talent development; thus, they must advocate for ecological civilization education. The environmental awareness cultivated among university students significantly affects their future attitudes toward environmental issues in both professional settings and daily life. Therefore, implementing comprehensive courses on environmental protection within non-environmental majors is both important and necessary [4]. This paper explores effective methods for conducting "Introduction to Environmental Protection" teaching within the framework of new engineering by using electrical engineering and automation as examples while discussing corresponding teaching models.

2. Problems Existing in the Course of Introduction to Environmental Protection

2.1 Lack of Sufficient Emphasis on the Curriculum

Statistics indicate that non-environmental majors constitute over 99% of students in Chinese colleges and universities, however, only approximately 10% of these institutions offer courses in environmental education [4]. In 2021, six governmental departments collaboratively issued an action plan aimed at integrating ecological civilization education into the national educational framework, with the course "Introduction to Environmental Protection" playing a pivotal role in promoting ecological awareness and quality education. For students majoring non-environmental fields, if such courses are offered as public electives, they may adopt a mindset focused solely on "earning credits" or merely striving for passing grades (with a score of 60 being deemed sufficient). At our institution's talent training program for electrical engineering and automation, the "Introduction to Environmental Protection" course is classified as compulsory. The graduation requirements stipulate: "Students should be able to understand and evaluate the impact of complex engineering practices on both the environment and social sustainable development." Consequently, it is imperative to establish robust environmental protection curricula that enhance students' environmental consciousness and cultivate principles guiding responsible engineering practice.

2.2 Single Teaching Mode

The traditional teacher-centered approach has resulted in passive knowledge absorption by students through conventional classroom instruction, leading to inadequate interaction and diminished interest in learning. Furthermore, this teaching method predominantly relies on multimedia tools while emphasizing theoretical content at the expense of practical applications; this creates a monotonous classroom atmosphere that undermines teaching effectiveness. Such pedagogical strategies have had minimal success in igniting student enthusiasm or encouraging proactive engagement with their studies; additionally, task-oriented learning contradicts fundamental educational objectives. This course encompassed several relatively abstract knowledge theories, including "environmental management" and "environmental policy". However, the predominant teaching approach primarily focused on introducing concepts without providing corresponding examples or practical instruction. This lack of contextualization heightened the difficulty for students in grasping these abstract notions. Consequently, relying solely on their imagination may lead students to lose confidence in the course and struggle to keep pace with the instructor's progress. In an effort to expedite the curriculum, teachers felt compelled to deliver new information at a faster rate, thereby perpetuating a vicious cycle that intimidates students. Tan et al. [5] designed the "Introduction to Environmental Protection" course specifically for non-environmental majors at applied undergraduate colleges. By incorporating pre-class introductions, immersive in-class learning experiences, and post-class self-reflection activities, they established the IOIS teaching model. This model effectively integrated ideological and political education into every facet of the teaching and learning process, thereby enhancing its effectiveness within the course framework. Addressing prevalent issues faced by safety engineering students enrolled in the Introduction to Environmental Engineering course-such as lack of motivation, subpar learning outcomes, inefficiency, and insufficient environmental protection awareness-Li et al. [6] employed the BOPPPS model. They delineated clear teaching objectives while enhancing content delivery methods and revamping evaluation systems. This approach facilitated a role reversal between instructors and learners; it encouraged autonomous learning habits while fostering keen observation skills and continuous engagement with material ultimately elevating overall student competencies.

Thus, it's essential to thoughtfully design in-class instructional contents that fully mobilize student initiative and enhance their learning experience.

2.3 Insufficient Relevance to the Major

"Introduction to Environmental Protection" is a compulsory course for majors but features a highly theoretical curriculum structure with extensive content covering basic environmental theories, concepts, pollution prevention theories, and methods. It has limited relevance to electrical engineering and automation majors, making it challenging for

students to comprehend and effectively absorb key and difficult knowledge during the learning process. Students often feel confused during the course. Therefore, during the teaching process of the "Introduction to Environmental Protection", it's necessary to organically integrate the course content with the major, enhancing students' sense of identity and participation, and ensuring that students fully realize that environmental protection requires not only the involvement of environmental science students but also active participation from electrical engineering and automation students in their future careers. For example, Zhang et al. [7] undertook curriculum reform and practical implementation for the course "Introduction to Environmental Studies" tailored for non-environmental majors. This research posited that for students in non-environmental majors, the ultimate objective of learning was not to delve into pollution control methodologies, but rather to elevate their environmental awareness. In teaching practice, a teaching case database is established to address the issues of inflexible textbook content and limited relevance to real-world problems. Furthermore, online resources and newspapers are fully utilized, with attention given to environmental protection websites, environmental journals, and environmental news. Typical factual materials are selected to enrich and update the teaching content, with real-time screening and supplementation conducted throughout the course to guarantee the timeliness and relevance of the teaching case database. Su et al. [8] integrated the OBE teaching philosophy into the coursework on environmental protection in the metallurgical industry, emphasizing the unique training focus of environmental engineering majors and aligning with the educational objectives of fostering engineering practice skills and the ability to tackle intricate engineering challenges. By consolidating the curriculum knowledge system and structuring modular teaching content according to teaching objectives, they achieved knowledge integration, steering clear of fragmentation. Through the seamless integration of classroom learning and internship practices, they ensured a smooth transition of knowledge from the classroom to the field, fostering collaborative teaching rather than isolated instruction. By utilizing various assessment methods in flipped classrooms, they provided students with ample opportunities to showcase their abilities, facilitating teacher guidance rather than teacher-centered instruction. The incorporation of the OBE teaching philosophy significantly enhanced teaching effectiveness and met the teaching objectives.

2.4 Cumbersome Knowledge System

This course utilizes Liu Pengyan's book—Introduction to Environmental Protection, published by Chemical Industry Press, 2nd edition. The book consists of 13 chapters, integrating new environmental concepts such as sustainable development, building a resource-saving and environment-friendly society, and adding new contents like cleaner production and low-carbon economy. Despite the abundance of theoretical content, the allocated class hours for this course for electrical engineering and automation majors are only 16. Completing the course teaching within these limited hours requires teachers to prepare extensively in advance and design teaching plans effectively to enhance students' knowledge absorption efficiency. Liu et al. [9] integrated the contemporary environmental and resource issues, the curriculum's knowledge system, and the research project directions of the teaching team to optimize teaching content by constructing different teaching modules. In terms of teaching content, they integrated various types of environmental pollution (such as air, water, solid waste, and soil pollution) into thematic studies, based on the key points of each chapter. They systematically provided specific guidance on pollution phenomena, prevention and control measures, and a certain real-world problem faced by humanity. On this basis, they guide students to learn and think independently. Liu et al. [9] integrated contemporary environmental and resource issues, the knowledge system of the curriculum, and the research project directions of the teaching team to optimize teaching content through the construction of diverse teaching modules. In terms of instructional material, they incorporated various forms of environmental pollution—such as air, water, solid waste, and soil pollution—into thematic studies based on key concepts from each chapter. They systematically provided specific guidance on

pollution phenomena, prevention and control measures, as well as addressing real-world problems faced by humanity. Building upon this foundation, they encouraged students to engage in independent learning and critical thinking. Concurrently, relevant research findings and developmental trends in pertinent theories were presented within the classroom context to align students' learning with cutting—edge research directions while igniting their interest in scientific inquiry. Li et al. [10] conducted a study aimed at reforming general education elective courses on environmental protection for non-environmental majors at colleges and universities. Their objective was achieved by optimizing teaching content, assembling compatible teaching teams, and transforming traditional assessment methods. They closely aligned educational objectives with enjoyable learning experiences while leveraging mobile technologies associated with the "Internet+" era, this approach facilitated widespread dissemination of interdisciplinary popular science knowledge within the fields of energy and environmental protection. A questionnaire survey indicated that this curriculum reform has received substantial support and acclaim from students.

3. Exploration of the Environmental Protection Introduction Curriculum System

3.1 Constructing Course Content Pertinently and Aligning with Professional Development

The Introduction to Environmental Protection course serves as a comprehensive, foundational, and interdisciplinary program with extensive content coverage. However, due to the limited number of class hours available, it's impractical to address all aspects during the teaching process. Therefore, it's essential to effectively integrate professional characteristics and future industry developments in order to construct targeted course content. To begin with, low-difficulty and straightforward textbook materials should be selected as teaching resources while incorporating relevant domestic examples to expand upon the curriculum and resonate with students' experiences. For instance, in the context of electrical engineering and automation instruction, alongside discussing ten global environmental hazards outlined in the textbook, recent water pollution incidents in China can be introduced along with references to films such as "Heroes of Fire" to stimulate student interest during the initial chapter (Environment and Environmental Problems). Subsequently, real-world case analyses—such as that of the Dalian Xingang oil spill incident—can help students recognize the intimate connection between environmental pollution and their daily lives. This approach aims at fostering a strong sense of ownership among students regarding environmental issues. In discussions surrounding sustainable development, analyzing cases like Schneider Electric illustrates how industrial upgrading and enterprise management contribute not only to sustainable industry practices but also towards achieving carbon neutrality goals. This enhances students' sense of participation and identity within these contexts while encouraging them to engage deeply with both course material and their professional knowledge when analyzing problems.

3.2 Update Hot Knowledge and Reshape Knowledge System

Guo Fang, Vice Minister of Ecology and Environment, has announced that China will progressively expand the carbon market to encompass sectors such as chemicals and civil aviation. This announcement highlights recent policy developments, particularly China's strategic initiative to extend the coverage of the carbon market to additional industries by 2025. In educational settings, environmental protection policies and current hot topics evolve rapidly, necessitating that educators adequately prepare prior to instruction in order to master relevant knowledge pertaining to environmental policies and announcements. Educators must refine key knowledge points while integrating domestic and international policies, technological advancements, and practical case studies. They should summarize significant challenges based on course objectives and timely incorporate ideological and political elements to enhance students' learning outcomes. In addressing contemporary hot topics, the author first analyzes student learning situations through questionnaires, identifying major challenges in alignment with teaching goals. Furthermore, a

professional entry point for electrical engineering and automation majors is introduced concerning their role in achieving carbon neutrality goals [11], thereby fostering students' professional confidence as well as national consciousness. Using carbon neutrality as a focal point, an illustrative teaching design concept is presented in Figure 1.

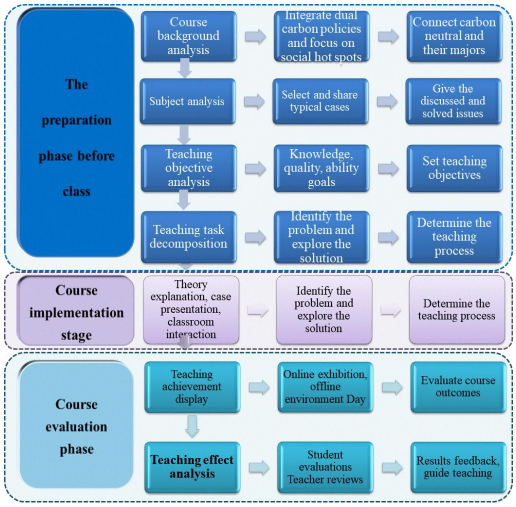

Figure 1. Analysis Diagram of Teaching Design Ideas for Carbon Neutrality

3.3 Innovating Teaching Modes and Enhancing Assessment

The traditional teacher-centered teaching model is increasingly inadequate in meeting the dynamic demands of contemporary classroom instruction. In the context of new engineering education, curriculum design places a heightened emphasis on fostering student engagement, improving learning outcomes, and cultivating comprehensive abilities [12,13]. This course seeks to modernize the conventional "teacher-centered" approach by prioritizing "learning" while supplementing it with effective "teaching". To enhance student participation, methodologies such as flipped classrooms, case-based teaching, and specialized discussions are implemented. For example, at the outset of the course, students are organized into several groups; each group is assigned specific case content related to a chapter for presentation purposes. After class sessions, groups gather materials from textbooks and online resources without restrictions on content scope to present their findings to both peers and instructors in small-group settings. Following these presentations, instructors provide feedback while students engage in peer evaluations. During this feedback process, educators can strategically integrate professional knowledge to guide students' critical thinking processes—clarifying background information and solution strategies—and thereby enhancing their problem-solving skills. Additionally, topics such as air pollution control are addressed.

Furthermore, traditional assessment methods predominantly rely on paper examinations and homework assignments that fail to adequately evaluate students' holistic competencies. This course proposes a dual evaluation framework comprising "process evaluation + result evaluation," which includes components such as homework assignments, class presentations, and comprehensive course reports. In their reports, students will be required to formulate original questions based on literature references while integrating insights gained throughout the course experience. The final component of result evaluation will consist of a written examination administered at the end of the term. Greater emphasis is placed on students' learning abilities, course participation, and knowledge retention, providing valuable insights for the continuous enhancement of teaching quality, refinement of instructional design, and improvement of learning outcomes.

4. Evaluation and Analysis of Curriculum Teaching Reform Outcomes

To gain a comprehensive understanding of students' mastery and satisfaction with the course following the teaching reform, a questionnaire was distributed via Questionnaire Star within the communication group after the "Introduction to Environmental Protection" course to evaluate teaching effectiveness. The analysis of the questionnaire results is presented in Figure 2. Each component has been positively acknowledged by students, particularly sections such as "Breaking Through the 'Haze' in the Blue Sky Defense Campaign" and "Schneider Electric's Sustainable Development Road," which received favorable feedback from participants. This suggests that students are increasingly inclined to relate classroom instruction to their professional backgrounds and real-world contexts. Although the sustainable development segment is abstract and conceptual in nature, integrating case studies

relevant to electrical engineering within this chapter allows students to achieve a deeper comprehension of theoretical concepts while applying them effectively within their field of study.

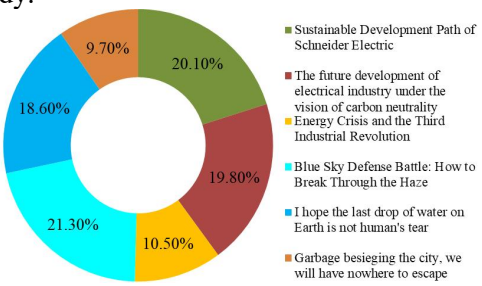

Figure 2. Analysis of Questionnaire Results

Based on the survey and analysis of the teaching quality of the "Introduction to Environmental Protection Course," 89.55% of male students and 10.45% of female students participated in the questionnaire. The results indicate that after completing this course, 71.27% of students expressed their intention to effectively integrate environmental protection with electricity, while 16.04% indicated they would incorporate environmental protection into their daily lives, and 12.69% stated their decisions would depend on job nature. Students believe that graduates from electrical engineering and automation majors can significantly contribute to China's environmental protection efforts in areas such as energy management, power systems, and enhancing power efficiency. In future , the teaching content will extend beyond traditional textbooks and syllabi, it will encompass a comprehensive integration of factual information, current hot topics, and relevant disciplines aimed at broadening students' perspectives. The objective is to identify entry points for rationally optimizing teaching content, increasing student engagement, fostering teacher-student interaction, and establishing an effective feedback mechanism throughout the learning process.

5. Conclusion

Under the context of new engineering science, the Introduction to Environmental Protection course is one of the essential courses established according to the needs of electrical engineering and automation majors and industry development. Given its extensive content and strong theoretical foundation, it is necessary to choose appropriate teaching modes and methods to enhance students' initiative. For electrical engineering and automation students, it is crucial to effectively integrate professional cases, practical hotspots, and environmental protection theories, improving students' enthusiasm and classroom participation through reasonable teaching design, content, ssessment methods, and evaluation mechanisms, thereby enhancing students' knowledge systems. Based on the graduation and training requirements of this major under the new engineering context, this course can meet China's environmental protection and sustainable development needs. During the teaching process, teachers are required to continuously learn, reform teaching methods, establish evaluation systems and feedback mechanisms, organically integrate relevant knowledge of electrical engineering and automation with environmental protection theories, cultivate the concept of ecological civilization and sustainable development, guide students to consider electrical problems from environmental protection and economic perspectives, and develop rigorous and realistic professional ethics among students.

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