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Reconstruction of Professional Curriculum Ideological and Political Education in Environmental Science and Engineering

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Abstract: *Curriculum-based ideological and political education (CPIE) is a critical component of fostering moral and intellectual growth and implementing holistic education. In particular, professional courses require specialized attention to integrate CPIE effectively. As a discipline closely aligned with the goals of ecological civilization, Environmental Science and Engineering must tailor its CPIE framework to support students' diverse academic and career trajectories.Adopting the Outcome-Based Education (OBE) approach, a targeted, integrated CPIE framework should be developed to address these varying pathways. This includes designing a foundational CPIE logic system inspired by the 5E model. By extending the course narrative, this system redefines the logical connections between subject content and ideological elements across different courses within the discipline.To evaluate the effectiveness of CPIE in professional courses, a "two-step, three-all, and four-perspective" evaluation standard is proposed. This framework clearly delineates evaluation structures and establishes proportionate weightings. By deeply integrating CPIE with professional courses, the framework promotes a dual advancement, where disciplinary expertise enhances ideological values, and ideological education reciprocally strengthens professional knowledge.*

Keywords: *Environmental Science and Engineering, Professional Curriculum Ideological and Political Education, 5E Model, OBE, Evaluation Framework*

1. Introduction

The report of the 20th National Congress of the Communist Party of China emphasizes that "the essence of education lies in fostering virtue." It calls for the comprehensive implementation of the Party's educational policies, upholding the fundamental task of moral education, and cultivating well-rounded socialist builders and successors with sound moral, intellectual, physical, aesthetic, and labor development. In the new era of socialism with Chinese characteristics, higher education faces new demands. The fundamental mission of developing education in China lies in fostering virtue, especially in engineering disciplines that emphasize both theory and practice[1]. It is vital to strengthen moral education in these fields, fully promote CPIE, and guide students from science and engineering backgrounds to solidify their ideals and beliefs. This approach aims to nurture a new generation of individuals with both professional expertise and a strong sense of national responsibility, dedication, and moral integrity. By doing so, we fully implement the fundamental educational goals of nurturing talent for the Party and the nation, building a robust foundation for cultivating China's future backbone workforce.

To effectively carry out CPIE, particularly for engineering students, it is essential to adhere to the principle of "holistic education", integrating ideological and political education seamlessly across all staff, processes, and dimensions. Professional CPIE remains the weakest yet most critical area to address within ideological and political education. CPIE must achieve an effect akin to "salt dissolving in water," where its presence is pervasive yet unobtrusive. Achieving the moral education goals of engineering disciplines cannot rely solely on foundational courses like Marxist philosophy or ideological and political theories, nor on the work of counselors. To cultivate high-quality professionals, it is imperative to harness the role of CPIE in professional courses, ensuring that professional education and ideological cultivation progress in tandem and develop synergistically.

In 2022, the State Council issued the "14th Five-Year Comprehensive Work Plan for Energy

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Conservation and Emission Reduction," emphasizing the necessity of achieving energy conservation and emission reduction goals to lay a solid foundation for carbon peaking and neutrality. The discipline of Environmental Science and Engineering aligns closely with these development objectives and the moral education standards of the nation. The professional traits of this field, such as the craftsmanship required in engineering, the mission of harmonizing human-nature relationships, the challenges of overcoming research difficulties, and the need for collaborative problem-solving, inherently embody rich ideological and political education elements.

2. Design Logic for the Comprehensive Ideological and Political Education of Environmental Science and Engineering Courses

2.1 Design logic of the course

Under the requirements of the "14th Five-Year Plan" for energy conservation and emission reduction, China's new era of ecological civilization construction imposes higher standards and more urgent tasks. Environmental Science and Engineering, as a discipline directly linked to carbon peaking and neutrality goals, encompasses a curriculum structure that progresses from foundational disciplines to specialized engineering subjects and ultimately to academic writing. This sequence not only enhances students' professional competencies step by step but also facilitates their transition from foundational theories to practical application and research. The key challenge in this developmental process is achieving the organic integration of talent cultivation and moral education. Designing the direction for ideological and political education in Environmental Science and Engineering courses must focus on nurturing virtue through talent and fostering talent with virtue, thereby equipping students to become high-quality professionals.

The purpose of ideological and political education is to "nurture individuals," while the role of professional courses is to "cultivate talent." To maximize the impact of professional CPIE, it is crucial to avoid rigid applications or neglecting the intrinsic educational stance of professional courses[2]. Special attention must be given to how CPIE is integrated, ensuring it does not become an additional learning burden. Instead, CPIE should closely align with professional instruction, serving as a transformative addition that enhances the effectiveness of classroom teaching. By functioning as a supportive tool, CPIE can amplify the role of professional courses, achieving a synergistic effect where "1+1>2."

2.2 Integration of Professional Courses with CPIE

The integration of professional courses with CPIE in engineering disciplines must emphasize the central role of professional courses while embedding relevant ideological elements and aligning them with well-designed curriculum plans. Key aspects include enhancing students' engineering ethics education by fostering national responsibility and mission commitment, encouraging the integration of thought and action, and inspiring exploration and innovation. At a deeper level, this integration aims to cultivate precision-focused craftsmanship, unwavering professionalism, and the resilient spirit necessary for overcoming research challenges.

These foundational principles form the core of CPIE in Environmental Science and Engineering. They must be interconnected with professional courses, focusing on student-centered growth. The emphasis is on extending and expanding from professional knowledge, enabling seamless coupling between professional courses and CPIE. By addressing this from three perspectives—principles, practice, and research—this approach overcomes potential incompatibilities, extracts and refines ideological elements within the professional knowledge system, builds a coherent ideological framework, subtly embeds CPIE themes, and effectively conveys its values.

From the very first class, a strategic foundation should be established by introducing the origins and history of courses in the context of China’s ecological civilization achievements and struggles. Theoretical courses should not only clarify fundamental principles but also go beyond textbook limitations by connecting with contemporary industry challenges, such as critical technological bottlenecks. This approach broadens students’ professional horizons, enhances their scientific mission, and instills pride in their work. Various practical teaching methods, including group projects, individual assignments, experimental operations, and production internships, should be employed. Evaluations and course content must be detailed, with group projects encouraging collective effort and clearly defining individual roles to develop versatile students who can lead and collaborate effectively.

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Practical opportunities like production internships and experiments should incorporate fundamental Marxist principles, such as dialectical materialism and the unity of truth and value. This not only fully realizes the goals of CPIE but also motivates students to focus on experiments and understand production processes. Research requires a solid theoretical and experimental foundation, and students should be encouraged to engage actively in laboratory work. Successful research necessitates careful hypotheses, rigorous validation, and the perseverance to overcome repeated failures. Faculty must lead by example, using implicit education to foster students' professional and ideological growth, achieving holistic development in both domains.

3. Improved CPIE System Construction for Environmental Science and Engineering

3.1 OBE-Based Integrated CPIE Framework

This paper categorizes students into two primary development paths: professional workplace-oriented talent and research-oriented specialists. Although these paths differ on the surface, they ultimately converge in the shared goal of cultivating high-caliber professionals for Environmental Science and Engineering. The curriculum structure is designed to support both categories and even develop talents who excel in both domains. Guided by these objectives, the integrated CPIE framework emphasizes the central role of professional courses, refines ideological elements, and tailors approaches to students' innate strengths. For workplace-oriented students, the focus is on competitions, while research-oriented students prioritize scientific inquiry. However, the foundational curriculum remains similar for both, progressing from introductory theoretical courses, such as engineering drawing, to professional courses emphasizing practice (e.g., Water Treatment Engineering) and theory (e.g., Air Pollution Control Engineering). These foundational courses serve as critical platforms for embedding CPIE. The integrated structure based on the OBE model is shown in Figure 1.

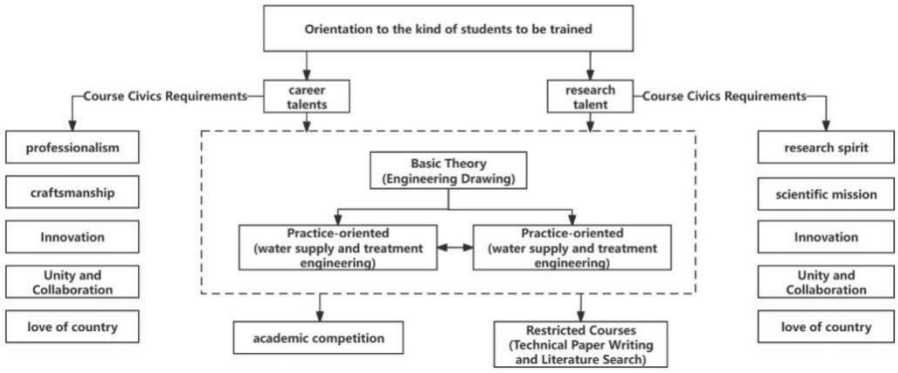

Fig. 1 Civic and political structure of the integrated professional program based on the OBE model

The progression in Environmental Science and Engineering—from basic engineering drawing to specialized engineering courses and academic writing guidance—is intentionally structured to develop students with both practical skills and academic excellence.

For students with strong practical abilities, participation in various practical projects and competitions should be encouraged. Engaging in real-world production, hands-on experimentation, and team collaboration fosters mutual encouragement and shared growth. This process cultivates innovation and entrepreneurial capabilities, helping students thrive in competitive environments. Such experiences develop students into high-quality professionals who excel in teamwork, articulate their ideas clearly, and balance technical proficiency with professional competence.

For students inclined toward research, efforts should focus on guiding them into laboratories, encouraging them to immerse themselves in foundational experiments, literature reviews, independent experiments, and eventual research outputs. These students should be inspired to hold steadfast to their ideals, persist through setbacks, and adopt a rigorous scientific approach that combines bold hypotheses with careful validation. This process nurtures patriotic researchers with a strong sense of scientific mission and advanced research capabilities.

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3.2 Foundational CPIE Logic Design Based on the 5E Model

Drawing inspiration from the 5E model, the foundational logic design for CPIE emphasizes the centrality of students. The goal is to ensure active student participation by addressing key questions: How to engage students in the course content? How to encourage inquiry into course design? How to address students' challenges in learning and practice? How to transition and deepen these experiences into CPIE themes? Finally, how to evaluate these processes for deeper improvement?

Taking Environmental Science and Engineering as an example, foundational courses like Engineering Drawing emphasize developing core technical and professional skills. Students are expected to master the fundamental principles of CAD, methods for representing three-dimensional objects on a two-dimensional plane, and the skills for creating and interpreting engineering drawings. These activities foster spatial visualization, engineering expression, technical proficiency, and research capabilities. Additionally, teamwork through collaborative projects develops communication skills, cooperative spirit, and a rigorous, pragmatic scientific perspective rooted in dialectical materialism. Such courses aim to instill a spirit of scientific inquiry and realism in students.

Courses like Water Treatment Engineering are practice-oriented, focusing on water properties, water quality indicators, pollution, and mitigation methods[3]. The curriculum covers theoretical and practical aspects of water treatment, including engineering principles, design calculations, and system technologies for water and wastewater management. Through well-designed group projects, theoretical guidance, practical demonstrations, and authentic experimental environments, students cultivate teamwork, analytical skills, problem-solving abilities, and independent learning skills, preparing them with a comprehensive professional competence.

In contrast, theory-heavy courses like Air Pollution Control Engineering begin with an introduction to the history and principles of air pollution, tying these themes to ecological civilization goals and the "14th Five-Year Plan" for energy conservation and emission reduction. The curriculum integrates current political and environmental policy requirements with theoretical teaching and career development, ensuring CPIE themes resonate deeply with students. Advanced topics such as atmospheric pollution meteorology, gaseous pollutant control technologies, and dust removal devices align with cutting-edge industry developments. These topics encourage a transition from basic principles to in-depth exploration of modern technologies, engaging students actively and bridging professional content with historical technological challenges in China. This approach inspires independent thinking and fosters a commitment to contributing to national scientific endeavors.

The logic design based on the 5E model is illustrated in Figure 2, showing how the framework systematically integrates professional content with CPIE themes, ensuring a seamless connection between learning, practice, and ideological development.

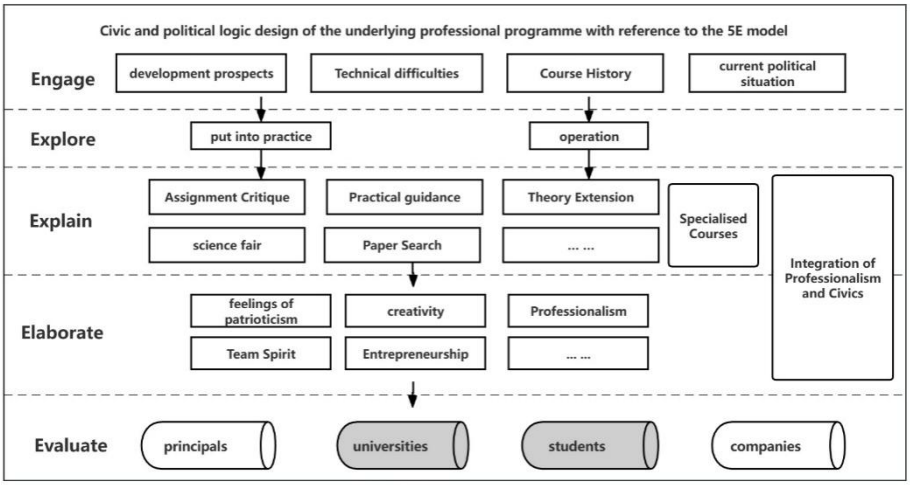

Fig. 2 Logical design of the underlying professional program Civics concerning the 5E model

3.3 "Two-Step, Three-All, Four-Perspective" CPIE Evaluation Standards

The CPIE evaluation framework in this study is designed around the "Two-Step, Three-All, Four-

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Perspective" approach. The two-step evaluation includes process evaluation and outcome evaluation, with a weighting ratio of 2:1:2. Process evaluation focuses on teaching plans, student surveys, and practical activities, while outcome evaluation combines students' course grades, completion of practical projects, and additional achievements such as competitions, research projects, and academic papers.

The implementation of CPIE requires adherence to the "Three-All" principle, ensuring full participation by teachers, students, schools, and industries. CPIE must be thoroughly integrated into various professional courses, with long-term efforts to combine CPIE with professional education. The "Three-All" requirement demands comprehensive coordination and evaluation by colleges and universities, ensuring effective implementation at all levels.

In addition to visible, written evaluation standards, subjective evaluation from the "Four Perspectives" is equally critical. Students, as both the main participants and beneficiaries of CPIE, provide valuable experiences and feedback for refining the integration of CPIE into professional courses. Teachers, as primary practitioners, have first-hand insights into resource needs and the integration of CPIE with professional curricula, although their primary responsibility remains professional teaching. Their resource requirements and feedback on teaching quality are essential for improvement. Schools, serving as both facilitators and coordinators, offer an external perspective that oversees the overall implementation and effectiveness of CPIE. Industries provide objective feedback on students' abilities and the impact of CPIE, offering a practical measure of the effectiveness of the educational approach.

By integrating objective and subjective feedback across these dimensions, this comprehensive evaluation framework ensures that CPIE remains dynamic and adaptable. It provides actionable insights for enhancing CPIE content and improving its application in professional education.

The evaluation framework, illustrated in Figure 3, highlights how the "Two-Step, Three-All, Four-Perspective" approach systematically integrates quantitative and qualitative data to refine CPIE implementation continuously.

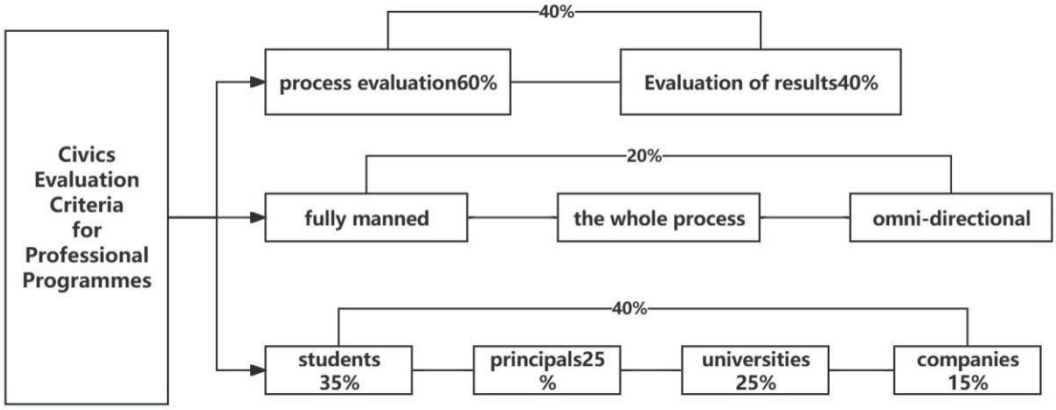

Fig. 3 Evaluation standard of professional program's ideology and politics

4. Conclusions

This study focuses on cultivating students by integrating the unique characteristics of professional courses to identify and incorporate relevant CPIE elements. By aligning these elements with appropriate teaching methods, the paper establishes a foundational "Goal-Implementation-Evaluation" framework for CPIE in professional courses. This framework is tailored to the specific attributes of Environmental Science and Engineering while allowing for continuous updates and adjustments to align with new content and contemporary developments. It emphasizes the seamless integration of CPIE into professional courses, ensuring that professional education and ideological development complement and reinforce each other effectively.

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