Exploration on the Synergistic Path of "Curriculum Ideological and Political Education" and Blended Learning in Air Pollution Control Engineering under the Background of Emerging Engineering Education

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Abstract: *In recent years, with the continuous advancement of environmental protection efforts in China, significant achievements have been made in air pollution control. However, the cultivation of environmental engineering professionals still faces new challenges. Based on the concepts and framework of Emerging Engineering Education, this paper explores synergistic strategies for integrating curriculum-based ideological and political education with blended learning in the course "Air Pollution Control Engineering." By analyzing the shortcomings of current teaching models, it proposes the organic integration of ideological and political elements into professional education and the optimization of teaching resources through informatization technologies to enhance teaching effectiveness. The paper designs three instructional phases: self-directed learning before class, inquiry-based learning during class, and reflective learning after class. The effectiveness of this strategy is validated through specific teaching practices. Research indicates that the blended learning model not only strengthens students' professional knowledge and practical abilities but also effectively guides them in establishing correct values, outlooks on life, and worldviews, fostering their sense of social responsibility and innovative spirit. This study provides a useful reference for the teaching reform of environmental engineering courses and holds significant theoretical and practical implications.*

Keywords: *Emerging Engineering Education; Curriculum-Based Ideological and Political Education; Blended Learning; Air Pollution Control Engineering*

Introduction

In recent years, with the rapid development of China's economy, environmental issues have become increasingly prominent, and environmental protection efforts have garnered growing attention. China has carried out solid work in environmental protection, achieving remarkable results and significantly improving environmental quality[1]. Particularly in the field of air pollution control, China has gone through stages such as declaring war on smog, winning the Blue Sky Protection Campaign, and fighting critical battles for environmental protection. At present, to further improve air quality, China has proposed the strategic goal of continuing to deepen the fight for blue skies. Against this backdrop, there is an increasingly urgent demand for high-quality application-oriented talent in the environmental sector. How to cultivate environmental engineering professionals with expertise, a sense of social responsibility, and innovative capability has become a crucial task for institutions of higher education[2].

In accordance with the spirit of the Guidelines for Curriculum-Based Ideological and Political Development in Higher Education Institutions issued by the Ministry of Education of the People's Republic of China, comprehensively advancing curriculum-based ideological and political education is a strategic measure for fulfilling the fundamental task of fostering virtue through education. These guidelines set forth clear requirements for the development of curriculum-based ideological and political education in higher education institutions, specifying that such efforts in engineering courses should emphasize strengthening engineering ethics, the spirit of craftsmanship for national development, patriotism, and a sense of mission and responsibility[3-4].

"As a core course in the environmental engineering major, Air Pollution Control Engineering plays

a vital role in cultivating professionals for environmental protection. The course aims to equip students with the fundamental theories and technologies for monitoring emissions of air pollutants, understanding their transport and dilution, and mastering purification techniques, as well as to help them comprehend the impacts of air pollution on the environment and human health. This course not only covers extensive professional knowledge but also requires guiding students to establish environmental awareness and a sense of social responsibility, while fostering their innovative and practical abilities. However, traditional teaching models exhibit notable shortcomings in several aspects, including insufficient resources, incomplete teaching processes, inadequate use of information technology, limited classroom interaction, and superficial integration of curriculum-based ideological and political education, making it difficult to meet the requirements of curriculum-based ideological and political education and the reform of emerging engineering education in the new era[5-6]. Therefore, there is an urgent need under the current circumstances to innovate the course teaching model, introduce information-based teaching methods, and incorporate the value guidance of curriculum-based ideological and political education."

1. Necessity of Integrating Curriculum-Based Ideological and Political Education with Blended Learning under the Framework of Emerging Engineering

In response to the current new situation of air pollution, the course Air Pollution Control Engineering needs to realign its objectives based on the actual demands of air pollution prevention and control enterprises. This involves organically integrating professional education with ideological and political education, strengthening engineering ethics training, and cultivating students' craftsmanship spirit and commitment to serving the nation through science and technology. However, traditional teaching models suffer from shortcomings such as insufficient resources, incomplete teaching processes, inadequate use of information technology, limited classroom interaction, and superficial integration of ideological and political education. These deficiencies make it difficult to meet the requirements of curriculum-based ideological and political education and the reform of emerging engineering education in the new era. Therefore, under the background of emerging engineering, the necessity of synergistically advancing curriculum-based ideological and political education and blended learning becomes particularly prominent.

Emerging Engineering Education emphasizes "new concepts, new structures, new models, new quality, and new systems," with a key component being the cultivation of students' sense of social responsibility and mission through curriculum-based ideological and political education. By integrating moral education and affective education, curriculum-based ideological and political education can effectively guide students to establish correct values, outlooks on life, and worldviews. The introduction of a blended learning model enables the organic integration of ideological and political content with professional knowledge through rich multimedia resources, vivid case analyses, and interactive teaching methods, thereby enhancing the appeal and effectiveness of instruction. Furthermore, Emerging Engineering Education also aims to cultivate high-quality application-oriented talents with innovative awareness and entrepreneurial spirit, which requires the support of new teaching methods and models. Online teaching provides abundant learning resources and flexible learning approaches, while offline teaching focuses on interaction and practice. The combination of both can effectively improve the quality and outcomes of education.

The deep integration of Emerging Engineering Education and curriculum-based ideological and political education relies on the essential tool of information technology. By utilizing modern teaching platforms and tools, blended information-based teaching methods can collect students' learning data in real time and provide personalized instructional guidance and support. At the same time, through interactive approaches such as online discussions and virtual experiments, students' sense of engagement and experiential learning can be enhanced, contributing to the cultivation of their innovative and practical abilities. Blended learning can optimize the allocation of teaching resources and compensate for the shortage of high-quality educational resources. By incorporating authoritative domestic and international course teaching resources and combining them with specific teaching practices, a high-quality teaching resource repository can be established, offering students broader and deeper learning materials. Additionally, teachers can use information platforms to share and exchange teaching resources, thereby improving the overall quality of instruction.

Under the framework of Emerging Engineering Education, the synergistic advancement of curriculum-based ideological and political education and blended learning is an essential pathway to enhance the quality of both teaching and talent cultivation. Through the organic integration of these

two aspects, a deep fusion of professional education and ideological-political education can be achieved, giving full play to the educational function of curriculum-based ideological and political education. This approach fosters students' innovative spirit and practical abilities, thereby meeting the nation's demand for high-quality application-oriented talents in the new era.

2. Design of Curriculum-Based Ideological and Political Education and Blended Teaching Activities for the Course "Air Pollution Control Engineering" under the Framework of Emerging Engineering

To align with the overarching requirements of curriculum-based ideological and political education and Emerging Engineering Education, and in consideration of the learning characteristics of contemporary university students, course instruction should emphasize the value guidance of ideological-political education and Emerging Engineering. It should also integrate high-quality digital resources, promote collaborative models, foster positive teacher-student interaction, and highlight the role of practical training to cultivate the comprehensive competencies of high-quality Emerging Engineering students with a strong sense of purpose. "Air Pollution Control Engineering" incorporates these principles into both online and offline teaching processes. It implements the "student-centered, outcome-oriented" philosophy and addresses the talent demands recognized by the environmental protection industry in the atmospheric field. The course strives to establish an intelligent teaching model characterized by visualization, auditory engagement, collaboration, and interactivity. By fully leveraging the mutual enhancement and complementary advantages of online and offline teaching, it aims to foster the progressive improvement of students' abilities in problem correlation, research and development, and engineering design, thereby enhancing teaching effectiveness.

The design of online-offline blended teaching activities for "Air Pollution Control Engineering" primarily consists of the following components:

2.1 Pre-Class Self-Study Phase

2.1.1 Learning Analysis

By utilizing historical student data and survey questionnaires from the smart teaching platform, which provide insights into students' learning situations, homework performance, and examination results, teachers can accurately obtain first-hand information on students' learning status and determine the teaching objectives for the lesson.

2.1.2 Resource Distribution

Based on the course teaching objectives, graduation requirements, application-oriented talent cultivation goals, and learning analysis, teachers distribute rich-media preview materials (such as micro-lectures, courseware, images, and texts) to students. Concurrently, preview assessment content is provided, with task points designed to be as detailed and practical as possible in relation to the knowledge points. The development of blended teaching resources for the Air Pollution Control Engineering course, primarily based on the Xuexitong platform, mainly includes the course standards or syllabus, micro-videos (micro-lectures) for segmented and restructured knowledge points (or checklists), interactive discussion topics, online exercises, and course tests. According to the content and the fundamental knowledge and skills students are required to master, teachers can design several learning-task scenarios for the Air Pollution Control Engineering course. Subsequently, based on these learning tasks, they can outline the knowledge points-what students should master, know, and be able to do-along with methods to achieve the objectives, and specify the online and offline assessment methods as well as the weight of assessment scores for each learning scenario or task.

2.1.3 Student Preview

Students preview the materials distributed in advance by the teacher, complete and submit the related assignments, and record any questions or difficulties encountered during the preview process.

2.1.4 Pre-Class Discussion

Based on the issues identified in the preview, valuable knowledge topics are extracted. Students are then guided to engage in related discussions on forums or platforms, where they can raise questions or share their perspectives.

2.1.5 Teaching Design

Teachers revise the teaching design plan based on the results of the learning analysis, the teaching objectives, the content of instruction, as well as the statistical analysis of students' preview assessments and the outcomes of the discussions.

2.2 In-Class Inquiry-Based Learning Phase

The in-class phase adopts a blended "online + offline" teaching model, making full use of the network resources from the Xuexitong platform. This approach fosters an active classroom atmosphere and yields effective instructional outcomes. Within the context of Emerging Engineering Education, the "Air Pollution Control Engineering" course comprehensively enhances students' professional knowledge and comprehensive abilities by introducing teaching model innovations that incorporate programming thinking. The design of the in-class inquiry-based learning process is guided by curriculum-based ideological and political education. It forms a complete teaching chain through six main components: case introduction, course analysis, group discussion, task evaluation, knowledge summarization, and ideological-political elevation. The specific content of the inquiry-based learning is as follows:

2.2.1 Case Introduction Phase

The course is introduced through practical cases to stimulate student reflection, combined with value guidance from curriculum-based ideological and political education. Students are guided to pay attention to national ecological and environmental policies and achievements in environmental protection, thereby fostering environmental awareness and a sense of social responsibility.

2.2.2 Theoretical Analysis Phase

The course content is analyzed in depth, incorporating the latest policy and technological developments in line with the practical needs of national ecological and environmental protection. Through ideological and political education, students are guided to understand the importance of national ecological civilization construction, enhancing their sense of mission and responsibility.

2.2.3 Group Discussion Phase

Students are divided into groups for discussions, engaging in in-depth exploration of professional knowledge and practical cases. Through the analysis of ideological and political cases, students' patriotism and sense of responsibility are inspired. Group discussions not only promote cooperation and communication among students but also deepen and broaden the scope of ideological and political education.

2.2.4 Task Evaluation Phase

Dual tasks are designed, including professional knowledge tasks and ideological-political tasks. After completing the tasks, students conduct self-evaluations and peer evaluations, while teachers provide feedback based on task performance. Through this approach, students not only consolidate their professional knowledge but also achieve emotional and value-based growth through the ideological-political tasks.

2.2.5 Knowledge Summarization Phase

The teacher systematically summarizes the course content, organically integrating professional knowledge with ideological and political education to help students deepen their understanding of the material. Through this summary, ideological and political elements are incorporated into the review and consolidation of professional knowledge, further strengthening the effectiveness of curriculum-based ideological and political education.

2.2.6 Ideological and Political Elevation Phase

At the end of the course, students' thinking and emotions are further elevated through discussions on the legacy of revolutionary traditions and the future prospects of professional development. Students are guided to apply the knowledge they have acquired to practical contexts, contributing to the nation's ecological and environmental protection and sustainable development efforts, thereby inspiring their dedication to serving the country through science and technology and reinforcing their sense of social responsibility.

Furthermore, throughout the in-class teaching process, curriculum-based ideological and political

education is consistently interwoven, explaining knowledge points in an accessible and engaging manner to foster deep and active learning. A programming-inspired "yes" or "no" approach is employed to assess teaching effectiveness, deconstruct knowledge points, and enhance teacher-student interaction. This is achieved through a model where the teacher explains and the students summarize, ensuring that instruction is delivered effectively and absorbed by students during the class session.

2.3 Post-Class Reflection and Practice Phase

Given that this course is a specialized engineering subject, we highlight its distinct applied nature, enabling students to genuinely appreciate and recognize the importance and practicality of the course. During the post-class learning process, the course organizes and implements the "Three Ones" project for labor education: conducting one campus air particulate monitoring project, carrying out one formaldehyde testing project for teachers who have newly decorated homes, and organizing one community science outreach activity on air quality and health. The implementation of these post-class projects adopts an "immersive" approach to curriculum-based ideological and political education, inspiring students from within to engage in labor and contribution grounded in their professional knowledge. This enhances their professional identity and promotes the effective implementation of ideological and political education through the curriculum.

2.3.1 Implementation of Course-Related Projects

Innovation and entrepreneurship projects related to air pollution control engineering are established and released on the Xuexitong platform for students to choose and participate in, leveraging the synergistic educational effect of promoting teaching through competition and integrating research with learning.

2.3.2 Personalized Distribution

Based on students' classroom performance, teachers assign personalized post-class homework to each student, setting task points and distributing learning resources accordingly.

2.3.3 Completion of Assignments

Students complete their post-class assignments and submit them to the teacher in a timely manner, receiving immediate feedback on objective questions.

2.3.4 Grading of Assignments

Teachers grade subjective questions, provide comments, and distribute the feedback to students.

2.3.5 Summary and Discussion

After class, students review instructional videos and PowerPoint presentations to consolidate the synchronous classroom content online. They summarize what they have learned, post reflections and questions on the platform or forum, and engage in online discussions and exchanges with teachers and peers. Instructors utilize tools such as QQ groups and Xuexitong to address students' questions and provide guidance.

3. Conclusion

Under the framework of Emerging Engineering, the course Air Pollution Control Engineering has achieved significant improvements in both teaching quality and talent cultivation through the synergistic advancement of curriculum-based ideological and political education and the blended learning model. Guided by the values of ideological and political education, students have not only enhanced their professional knowledge but have also established correct values, outlooks on life, and worldviews, strengthening their sense of social responsibility and mission. During the in-class inquiry-based learning process, the introduction of a teaching model incorporating programming thinking-through phases such as "case introduction, course analysis, group discussion, task evaluation, knowledge summarization, and ideological-political elevation"-has effectively integrated professional knowledge with ideological and political education, comprehensively improving students' overall capabilities. The design of the pre-class self-study phase, featuring precise learning analysis, abundant resource distribution, detailed task settings, and targeted pre-class discussions, ensures that students can efficiently absorb and apply knowledge in the classroom. The in-class inquiry-based learning phase, utilizing a blended online-offline teaching model along with programming thinking and information

technology, enhances classroom interaction and student engagement, thereby increasing teaching effectiveness. The post-class reflection and practice phase, through initiatives such as the "Three Ones" labor education project and personalized resource distribution, further deepens the educational impact of curriculum-based ideological and political education. This helps students consolidate and apply what they have learned in practice, fostering their innovative spirit and practical abilities.

The organic integration of curriculum-based ideological and political education with the blended learning model has not only addressed issues inherent in traditional teaching models, such as insufficient resources, inadequate use of information technology, and limited classroom interaction, but has also cultivated high-quality application-oriented talents with innovative awareness and a sense of social responsibility through systematic ideological-political education and advanced teaching methods. In the future, as Emerging Engineering Education continues to advance, further deepening the synergistic innovation between curriculum-based ideological and political education and blended learning will cultivate more outstanding talents for China's environmental protection and ecological civilization construction efforts, contributing to the realization of high-quality development and the grand vision of a Beautiful China.

Fund Projects

This research was supported by the Provincial "Four New" Initiatives Project, titled "Research on the Multidimensional 'Curriculum Ideological and Political Education +' Teaching Reform for the Environmental Engineering Major from the Perspective of Emerging Engineering Education" (Project No. 2023sx084), and by the Institutional-level Teaching Quality Project of Anhui Science and Technology University, the "Modern Industrial College Construction Project" (Project No. xj2025103).

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