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AI-Empowered Ideological and Political Education in Water Pollution Control Engineering Courses at Applied Undergraduate Institutions

Jiao Chen[1], Mingjiang Peng[1], Yixin Lu[1], and Xiaochun He[2,*]

[1] School of Materials and Environmental Engineering, Chengdu Technological University, Chengdu 611730, China

[2] Chengdu Keya Wastewater Treatment Co., Ltd., Chengdu 610200, China

[*]Corresponding Author

ABSTRACT

With the growing emphasis on ideological and political education in the field of education and the rapid development of artificial intelligence (AI) technology, integrating AI into ideological and political education at applied undergraduate institutions has become an important area of exploration. Taking the Water Pollution Control Engineering course as an example, this study analyzes the value and challenges of AI-enhanced course-based ideological and political education. It explores its implementation pathways from multiple dimensions, including enhancing teachers' AI literacy and ideological and political education capabilities, establishing a diversified AI-enhanced course-based ideological and political education resource system, innovating teaching methods and practical teaching components, and establishing a scientific evaluation system. It provides valuable references and insights for the development of course-based ideological and political education at applied undergraduate institutions.

KEYWORDS

Course-Based Ideological and Political Education; AI; Applied Undergraduate Institutions; Water Pollution Control Engineering; Pathways.

1. INTRODUCTION

With China's heightened emphasis on ecological and environmental protection and the continuous advancement of educational reforms, the role of course-based ideological and political education in higher education has become increasingly prominent [1,2]. As a core course in the Environmental Science and Engineering major at applied undergraduate institutions, Water Pollution Control Engineering must not only impart specialized knowledge and skills but also cultivate students' sense of social responsibility, environmental awareness, and professional ethics through course-based ideological and political education [3]. This prepares them to become professionals capable of contributing to the nation's ecological and environmental development. In recent years, the rapid advancement of Artificial Intelligence (AI) technology has brought new opportunities and challenges to the education sector [4]. The application of AI in teaching can effectively enhance the personalization and intelligence of instruction, offering novel approaches and methods for implementing course-based ideological and political education within courses [5,6]. How to organically integrate AI technology with the ideological and political education of the Water Pollution Control Engineering course at applied undergraduate institutions has become an urgent issue in the development of this course.

In light of this, this paper first elucidates the value of AI-empowered course-based ideological and political education in the Water Pollution Control Engineering course at applied undergraduate institutions. It then analyzes the current challenges in this development model and explores feasible implementation pathways. This study aims to provide new insights and methodologies for applied undergraduate institutions in AI-empowered course-based ideological and political education development, thereby promoting the deep integration of ideological and political education with professional education.

2. VALUES OF AI-EMPOWERED COURSE-BASED IDEOLOGICAL AND POLITICAL EDUCATION

2.1. Enhancing the Relevance of Course-Based Ideological and Political Education

AI technology can collect and analyze multidimensional data on students' professional backgrounds, interests, and ideological trends, providing educators with comprehensive student profiles. Instructors can design more closely aligned course-based ideological and political education content with students' actual circumstances based on the characteristics and teaching objectives of the Water Pollution Control Engineering course. For instance, when introducing new technologies and processes in water pollution control, educators can share stories of Chinese researchers' dedicated efforts in this field and their contributions to national environmental governance for students interested in scientific innovation, thereby igniting their passion for research and fostering patriotism. For students inclined toward corporate careers, emphasis can be placed on enterprises' social responsibilities and environmental awareness in water pollution control, guiding them toward sound professional values.

2.2. Course Positioning and Objectives

AI can enrich the presentation formats of teaching resources by creating vivid instructional materials, animating simulations of water pollution treatment processes, and establishing virtual or augmented reality practice scenarios, making ideological and political education more intuitive and engaging. Simultaneously, AI-driven intelligent learning platforms can provide personalized learning paths and guidance recommendations. For students struggling with ideological and political theory, the platform can push relevant explanatory videos, case analyses, and other resources, along with targeted exercises and assessments. For students excelling in professional practice but lacking ideological awareness, the platform can guide them to identify ideological elements within their practical work, promoting balanced development in both professional knowledge and ideological literacy.

2.3. Cultivating Students' Patriotic Sentiments and Sense of Social Responsibility

Through text mining, data analysis, and other methods, AI technology can assist educators in more comprehensively and deeply uncovering these ideological and political elements, organically integrating them into teaching content (as shown in Table 1). Simultaneously, leveraging AI's information acquisition and analysis capabilities, educators can collect and organize real-time data on domestic and international water pollution incidents, environmental policy developments, and related information. This information is then presented to students through case studies, group discussions, and other interactive formats. Students are guided to apply their specialized knowledge to analyze these real-world issues, examining the causes, hazards, and mitigation strategies of water pollution. This process fosters a profound understanding of the interdependence between environmental protection and socioeconomic development, cultivates their awareness of societal concerns and commitment to public service, and inspires their determination to contribute to solving practical environmental challenges.

Table 1. Identification of Ideological and Political Elements (Partial List)

Chapter	Knowledge point	Corresponding ideological and political education element	Type of ideological and political education element
Physical treatment of sewage	a. Grates and screens b. Fundamental principles of sedimentation c. Grease separators, dissolved air flotation tanks	a. Start small, manage meticulously b. Stay focused and patient, build momentum gradually c. Collaborate and achieve mutual benefits	a. Work attitude and conduct b. Personal cultivation and growth c. Teamwork spirit
Activated sludge process	a. Fundamental concepts of activated sludge b. Development of the activated sludge process c. Gas transfer principles and aeration d. Denitrification and phosphorus removal activated sludge process	a. Unity and collaboration, shared goals b. Innovation and progress, serving the nation through technology c. Precise selection, efficiency first d. Environmental stewardship, ecological responsibility	a. Teamwork spirit b. Innovation and sense of responsibility c. Professional competence and attitude d. Environmental awareness and responsibility
Biofilm method	a. Biofilm structure and purification mechanism b. Common processes and principles of the biofilm method	a. Unity and collaboration, shared goals b. Innovation and progress, serving the nation through science and technology	a. Teamwork awareness b. Innovation and patriotic dedication
Anaerobic biological treatment of sewage	a. Principles of anaerobic biological treatment b. Anaerobic biological treatment process	a. Circular regeneration, green development b. Innovative practice, high efficiency and energy saving	a. Environmental protection philosophy b. Technological and innovative capabilities

2.4. Stimulating Students' Innovative Thinking and Practical Skills

AI technology can simulate various complex water pollution scenarios and cutting-edge remediation case studies, creating an open and innovative learning environment for students. Furthermore, AI plays a vital supporting role in practical teaching components of Water Pollution Control Engineering, such as course design and internships. For instance, intelligent monitoring devices and data analysis platforms can collect and analyze real-time data from water pollution treatment projects, including water quality changes and equipment operating parameters. By analyzing and processing this data, students can apply AI algorithms for optimization design and fault diagnosis, enhancing the efficiency and accuracy of practical operations.

3. CHALLENGES IN INTEGRATING COURSE-BASED IDEOLOGICAL AND POLITICAL EDUCATION INTO WATER POLLUTION CONTROL ENGINEERING COURSES VIA AI

3.1. Insufficient AI Literacy and Ideological Education Capabilities Among Faculty

Most faculty teaching Water Pollution Control Engineering at applied undergraduate institutions primarily focus on teaching and research within their specialized fields, lacking systematic training

and practical experience in AI technology. They lack in-depth understanding of AI principles, application scenarios, and how to organically integrate AI with course-based ideological and political education. This prevents them from fully leveraging AI's advantages during instruction, thereby impacting the quality and effectiveness of course-based ideological and political education. Additionally, some instructors lack familiarity with the theoretical foundations of ideological education and methods for identifying ideological elements. When implementing course-based ideological and political education in their courses, they often merely piece together ideological content with professional knowledge without achieving organic integration or deep exploration. This results in course-based ideological and political education becoming superficial, failing to achieve the desired educational outcomes.

3.2. Lags in Building Teaching Resources for AI-Empowered Course-Based Ideological and Political Education

Currently, teaching resources integrating course-based ideological and political education with AI technology for the course Water Pollution Control Engineering remain relatively scarce. While some general ideological and political case libraries and AI teaching resource platforms exist, these resources lack alignment with the course content and fail to meet teachers' personalized teaching needs. Simultaneously, existing resources exhibit significant variations in content accuracy, depth of ideological and political element integration, and appropriateness of AI application, creating considerable challenges for instructors when selecting teaching materials. Due to the relative isolation of teaching resources across institutions and the absence of effective sharing platforms and collaborative mechanisms, high-quality teaching resources struggle to achieve widespread dissemination and sharing among applied undergraduate universities.

3.3. Variations in Student Acceptance of AI-Empowered Course-Based Ideological and Political Education

Students at applied undergraduate institutions exhibit significant variations in learning habits and preferences. Some students are more accustomed to traditional teaching models and show lower acceptance of new teaching technologies and methods, such as AI-enhanced course-based ideological and political education. They perceive these technologies as complicating the learning process and increasing academic burdens. Conversely, other students demonstrate curiosity and enthusiasm toward novel approaches, actively engaging in AI-based course-based ideological and political education learning. However, the proportion of such students remains relatively low. Students' information literacy levels directly impact their effectiveness in utilizing AI technology for course-based ideological and political education. Due to varying levels of prior IT education before enrollment, significant gaps exist in their abilities to leverage AI tools for knowledge acquisition, problem analysis, and participation in ideological discussions. Students with lower information literacy may feel overwhelmed when encountering AI-enhanced course-based ideological and political education, struggling to fully harness the advantages of AI technology. This hinders learning outcomes and diminishes their recognition of the value of course-based ideological and political education.

3.4. Lack of a Scientific and Effective Evaluation System

The objectives of course-based ideological and political education in the course Water Pollution Control Engineering encompass multiple dimensions including students' cognitive understanding, emotional attitudes, and value systems. These objectives possess inherent implicit and long-term characteristics, making them difficult to accurately evaluate through traditional quantitative metrics such as exams and assignments. Simultaneously, the effectiveness of AI technology in course-based ideological and political education requires comprehensive consideration of multiple dimensions

including student engagement, learning experience, and enhancement of ideological and political literacy, further increasing the complexity and difficulty of evaluation. Currently, most applied undergraduate institutions have yet to establish a comprehensive evaluation framework specifically tailored for AI-enhanced course-based ideological and political education. Such frameworks are even rarer in the context of the Water Pollution Control Engineering course. Existing evaluation metrics predominantly focus on students' mastery of professional knowledge, with limited attention paid to the achievement of ideological and political education objectives or the rationality and effectiveness of AI technology application. Consequently, these metrics fail to provide a comprehensive and objective reflection of the actual impact of AI-enhanced course-based ideological and political education.

4. IMPLEMENTATION PATHWAYS

After clarifying the multifaceted value of AI-empowered course-based ideological and political education in the Water Pollution Control Engineering course and analyzing the numerous challenges currently faced, this study explores how AI technology can enhance the implementation of course-based ideological and political education in this course. This exploration is approached from key dimensions such as improving teacher competence, building resource systems, innovating teaching methods, and refining evaluation mechanisms (as shown in Figure 1).

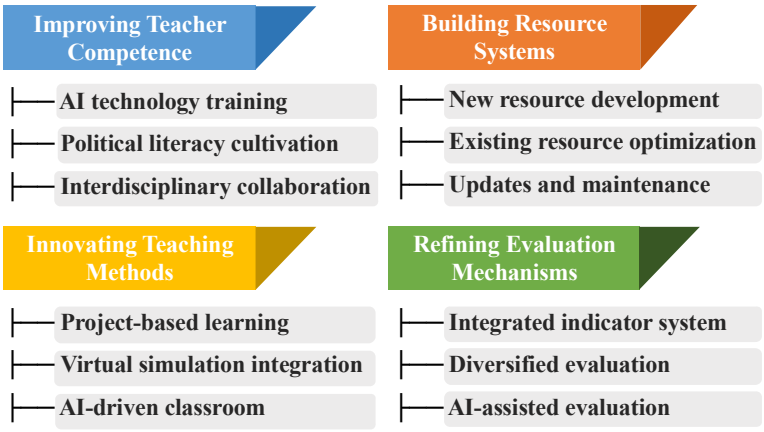

Figure 1. Pathways for AI-empowered course-based ideological and political education

4.1. Enhancing Faculty AI Literacy and Course-Based Ideological and Political Education Capabilities

Applied undergraduate institutions should regularly organize faculty teaching the course Water Pollution Control Engineering to participate in AI technology training programs. Experts in the AI field and corporate engineers should be invited to deliver instruction covering fundamental AI theory, common algorithms, tool applications, and innovative AI practices in education. By integrating theoretical learning with hands-on practice, faculty will gain a grasp of AI technology's basic principles and application methods, laying the groundwork for incorporating it into course-based ideological and political education.

4.2. Building a Diversified System of AI-Empowered Course-Based Ideological and Political Education Resources

Based on the syllabus and ideological and political education objectives of the Water Pollution Control Engineering course, and considering the practical circumstances of students at applied

undergraduate institutions, a faculty team was organized to independently develop a series of AI-empowered course-based ideological and political education teaching resources. Existing course-based ideological and political education case libraries and AI teaching resource platforms were integrated and optimized. Resources highly relevant to the Water Pollution Control Engineering course and of high quality were selected, adapted, and supplemented to better align with the course's teaching requirements.

4.3. Updating Teaching Methods and Practical Teaching Components

In the Water Pollution Control Engineering course, project-based learning is implemented by dividing students into groups to study and research real-world water pollution treatment projects. Throughout project implementation, instructors guide students to identify ideological and political education elements within the projects, achieving deep integration of professional knowledge with ideological and political education. AI technology builds virtual simulation platforms for practical training, replicating diverse scenarios in water pollution control engineering, such as wastewater treatment plant design and operation, and aquatic ecosystem restoration projects. Ideological and political education content is integrated into practical training, emphasizing safety awareness, environmental laws and regulations, and cultivating students' practical skills, professional ethics, and legal consciousness. AI-driven classroom interaction tools, including intelligent quizzing systems and online discussion platforms, enhance student engagement and participation in class.

4.4. Establishing a Scientific Evaluation System

To address the characteristics of AI-enhanced course-based ideological and political education in the Water Pollution Control Engineering course, a comprehensive evaluation indicator system has been established. This system encompasses multiple dimensions, including students' mastery of professional knowledge, improvement in ideological and political literacy, and the effectiveness of AI technology application. The teaching effectiveness of course-based ideological and political education is evaluated through a combination of quantitative and qualitative assessment methods, as well as formative and summative evaluation approaches. AI technology is employed to analyze and process teaching evaluation data for course-based ideological and political education in the Water Pollution Control Engineering course, thereby enhancing the efficiency and accuracy of the evaluation process.

5. SUMMARY

The application of AI technology in education is undergoing rapid development, holding immense potential to transform course-based ideological and political education while also facing numerous challenges. By exploring and implementing pathways such as enhancing teacher capabilities, establishing a diversified resource system, innovating teaching methods and practical components, and developing a scientific evaluation framework, current challenges can be effectively addressed. This approach will fully leverage the advantages of AI technology in course-based ideological and political education, providing robust support for cultivating environmental engineering professionals with solid expertise, noble moral character, and a strong sense of social responsibility. It will further drive the high-quality development of curriculum-based ideological and political education in applied undergraduate institutions.

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