World Journal of Educational Studies
Print ISSN: 2959-9989
Online ISSN: 2959-9997
DOI: https://doi.org/10.61784/wjes3170

CASE-DRIVEN EXPLORATION OF TEACHING REFORM IN THE COURSE "ARTIFICIAL INTELLIGENCE AND ECO-ENVIRONMENT"

Long Yu[1], Xin Li[1], Chen Pan[2*], SuHua Wang[1*]
[1]*School of Environmental Science and Engineering, Guangdong University of Petrochemical Technology, Maoming 525000, Guangdong, China.*
[2]*Architecture and Civil Engineering Institute, Guangdong University of Petrochemical Technology, Maoming 525000, Guangdong, China.*
[*]*These authors contributed equally to this work.*
[*]*Corresponding Author: Chen Pan, SuHua Wang*

Abstract: To address the insufficient integration of artificial intelligence (AI) technologies and the limited practical application of research cases in postgraduate courses within the ecological and environmental field, the course *Artificial Intelligence and Eco-Environment* developed a case-driven teaching model consisting of four stages: case introduction, data analysis, model construction, and environmental application. By incorporating research-oriented cases, such as machine learning analysis of fluorescence spectral data, the course integrates real environmental datasets and AI algorithms into the teaching process, thereby strengthening postgraduate students' competencies in environmental data analysis and complex environmental problem-solving. Teaching practice demonstrated that this case-driven approach effectively enhanced students' research practice capabilities and interdisciplinary innovation skills.
Keywords: Artificial intelligence; Case-driven teaching; Teaching reform; Postgraduate education

1 INTRODUCTION

With the rapid development of artificial intelligence (AI), big data, and intelligent sensing technologies, the field of ecology and environmental science is gradually shifting from traditional experience-based analysis toward data-driven decision-making and intelligent management [1]. AI technologies, particularly machine learning and deep learning, have been widely applied in environmental monitoring, pollutant identification, water quality prediction, and ecological risk assessment [2]. Against the backdrop of high-quality postgraduate education and increasing interdisciplinary integration, environmental postgraduate students are expected not only to master solid professional knowledge but also to develop competencies in environmental data analysis, AI model application, and intelligent solutions for complex environmental problems [3].

At present, research on AI-enabled education mainly focuses on general education or computer-related curriculum reform, whereas studies on the construction of "AI + Discipline" courses for postgraduate education in the ecological and environmental field remain relatively limited. Existing teaching practices often suffer from insufficient authenticity of research cases, inadequate integration of environmental application scenarios, and limited cultivation of students' scientific research innovation and engineering practice capabilities [4].

To address these challenges, this study takes the postgraduate course *Artificial Intelligence and Eco-Environment* as an example. By integrating authentic research cases, such as machine-learning-assisted fluorescence spectroscopy analysis, real environmental datasets, AI algorithms, and environmental application scenarios are incorporated into the teaching process. A case-driven teaching model consisting of four stages—case introduction, data analysis, model construction, and environmental application—is established. The proposed approach aims to enhance postgraduate students' abilities in intelligent environmental data analysis, AI technology application, and complex environmental problem-solving, thereby providing a reference for interdisciplinary curriculum development and teaching reform in environmental postgraduate education.

2 OVERALL DESIGN OF THE CURRICULUM REFORM

To meet the emerging demands of interdisciplinary integration between artificial intelligence and ecological-environmental sciences, and to address the limitations of traditional environmental courses, including insufficient incorporation of AI technologies [5], inadequate practical case-based learning, and weak cultivation of students' data analysis skills, the course *Artificial Intelligence and Eco-Environment* was redesigned around the concept of "AI + Eco-Environment" integration. Using authentic environmental problems and research-oriented cases as teaching vehicles, systematic reforms were implemented in terms of course objectives, content structure, and teaching methods. A progressive curriculum framework encompassing theory–data–model–application was established, together with a case-driven teaching model consisting of case introduction–data analysis–model construction–environmental application.

This reform promotes a transition from traditional knowledge-oriented instruction toward the development of data-driven thinking and intelligent analytical capabilities.

2.1 Course Development Background and Teaching Objectives

Under the background of the New Engineering Education initiative and the pursuit of high-quality postgraduate education, the training of environmental postgraduate students requires not only a solid foundation in professional knowledge but also competencies in environmental data analysis, artificial intelligence model development, and intelligent solutions for complex environmental problems [6]. However, traditional postgraduate courses often suffer from insufficient integration of AI technologies, limited incorporation of research-oriented cases into teaching, and inadequate cultivation of interdisciplinary innovation capabilities [7], making it difficult to meet the growing demand for high-level interdisciplinary talents in the ecological and environmental field [8].

To address these challenges, the course *Artificial Intelligence and Eco-Environment* is designed with the goal of enhancing postgraduate students' research competence and interdisciplinary innovation ability. Centered on the development needs of AI–environment integration, the course establishes a teaching framework oriented toward real-world environmental problems. With intelligent environmental data analysis as its core, the course focuses on developing students' abilities in environmental data processing, machine learning model application, scientific problem analysis, and intelligent environmental problem-solving. By integrating faculty research cases, authentic environmental datasets, and AI algorithms into the teaching process, the course promotes a transformation from traditional theory-based learning to a competency-oriented approach characterized by research problem-driven learning, intelligent data analysis, and innovative environmental applications, thereby supporting the cultivation of high-level innovative talents in the ecological and environmental field.

2.2 Construction of the "AI + Eco-Environment" Curriculum Content System

To achieve deep integration between artificial intelligence and ecological-environmental sciences, the course establishes a four-level progressive curriculum content system consisting of theory, data, model, and application, tailored to the knowledge structure and learning needs of environmental science and engineering postgraduate students. At the theoretical level, fundamental concepts of artificial intelligence, basic principles of machine learning, and commonly used algorithms are introduced to provide students with the necessary foundation for environmental data analysis. At the data level, the course focuses on environmental data acquisition, data preprocessing, feature extraction, and data visualization, helping students develop data-driven thinking and analytical skills. At the model level, methods such as principal component analysis (PCA), support vector machines (SVM), cluster analysis, and deep learning are incorporated to strengthen students' capabilities in AI model construction and interpretation. At the application level, practical cases involving environmental pollution identification, water quality prediction, fluorescence spectroscopy analysis, and environmental functional material data analysis are employed to demonstrate the application of AI technologies in ecological and environmental research.

The curriculum design emphasizes problem-oriented learning and interdisciplinary integration. By organically combining AI technologies with environmental monitoring, environmental analysis, and environmental management, the course effectively addresses the common challenge of disconnecting algorithm instruction from professional applications in traditional teaching. In addition, the course fully incorporates faculty research projects and representative scientific research cases into classroom instruction. Topics such as intelligent identification of environmental pollutants, machine-learning-assisted fluorescence spectroscopy analysis, and intelligent processing of environmental data are integrated into teaching activities, enabling students to understand the practical logic of AI applications in authentic environmental contexts. This approach significantly enhances the practical relevance, innovation, and research-oriented nature of the course.

2.3 Design of the Case-Driven Teaching Model

To address the challenges commonly encountered in traditional postgraduate courses, including an excessive emphasis on theoretical instruction, unclear application scenarios of artificial intelligence, and insufficient integration of scientific research and teaching, the course adopts a case-driven teaching model and establishes a four-stage instructional framework consisting of case introduction, data analysis, model construction, and environmental application [9]. Using authentic research cases such as environmental pollution detection, fluorescence spectroscopy analysis, and intelligent environmental data identification as learning contexts, the course organically integrates environmental problems, experimental datasets, and AI algorithms. This approach enables postgraduate students to understand the application logic of artificial intelligence in ecological and environmental fields through the processes of data processing, model development, and result interpretation.

During the teaching implementation process, particular emphasis is placed on integrating scientific research achievements into classroom instruction. Representative cases and real environmental datasets derived from faculty research projects are transformed into teaching resources and incorporated into learning activities. By combining project-based learning with case-based teaching, the course strengthens students' competencies in environmental data analysis, machine learning model application, and complex environmental problem-solving. Consequently, the teaching paradigm shifts from traditional knowledge transmission toward a research problem-driven approach that fosters interdisciplinary innovation and practical research capabilities, as shown in Table 1.

Table 1 Problems in the Course and Corresponding Solutions

Problem Category	Existing Problems	Solutions	Expected Outcomes
Limited AI Integration	Insufficient AI content in the curriculum	Develop a theory–data–model–application framework and introduce AI techniques	Improve AI literacy and environmental data analysis skills
Weak Connection to Environmental Applications	Limited linkage between AI algorithms and environmental scenarios	Incorporate environmental case studies and real -world applications	Strengthen problem-solving and application abilities
Lack of Research-Based Teaching	Insufficient use of authentic research cases and datasets	Integrate research projects, real data, and representative cases	Enhance practical learning and research training
Insufficient Practical and Innovative Skills	Weak data analysis and model application capabilities	Adopt project-based and case-driven learning approaches	Improve research practice and innovation competencies

3 RESEARCH CASE-DRIVEN TEACHING IMPLEMENTATION

To enhance postgraduate students' abilities in applying artificial intelligence technologies and analyzing complex environmental problems, the course adopts intelligent pollutant identification based on machine-learning-assisted fluorescence spectroscopy analysis as a representative teaching case. Authentic environmental datasets derived from faculty research projects are organically integrated with AI algorithms throughout the teaching process, forming a case-driven instructional framework consisting of case introduction, data analysis, model construction, and environmental application. The teaching case focuses on the demand for rapid pollutant identification in complex environmental systems. Through activities including environmental data acquisition, machine learning model training, and result interpretation, postgraduate students are guided to understand the application logic of AI technologies in ecological and environmental research within authentic scientific research contexts. This approach effectively strengthens students' competencies in data analysis, model development, and scientific innovation, while promoting the integration of interdisciplinary knowledge and practical problem-solving skills.

3.1 Case Background and Teaching Objectives

The teaching case is developed in response to the demand for rapid detection and intelligent identification of environmental pollutants, integrating fluorescence spectroscopy analysis with machine learning techniques. Traditional methods for environmental pollutant detection often face challenges such as complex data structures, low analytical efficiency, and strong dependence on subjective interpretation. In contrast, artificial intelligence technologies offer significant advantages in the analysis of complex environmental datasets and pattern recognition. Therefore, a machine-learning-assisted fluorescence spectroscopy case is introduced into the course, combining authentic research data with real environmental problems to guide postgraduate students in applying AI methods for environmental data classification and pollutant identification.

The primary objective of this teaching case is to cultivate postgraduate students' abilities in environmental data analysis, AI model application, and complex environmental problem-solving. Particular emphasis is placed on developing students' understanding of environmental data feature extraction, machine learning model construction, and model result interpretation. Through engagement with authentic research cases, students are expected to master the application strategies and research methodologies of artificial intelligence in the ecological and environmental field.

3.2 Implementation Process of the Teaching Case

During the implementation of the teaching case, the course first introduces the learning content through the practical demand for environmental pollutant detection, guiding postgraduate students to identify challenges associated with complex environmental data processing and thereby enhancing their problem awareness and learning motivation. Subsequently, based on fluorescence spectroscopy experimental data, students participate in training activities involving environmental data acquisition, data standardization, feature extraction, and data visualization, enabling them to master the fundamental workflow of intelligent environmental data analysis.

At the model construction stage, students are guided to apply machine learning techniques, including principal component analysis (PCA), support vector machines (SVM), and cluster analysis, for pollutant classification and identification. Through comparative evaluation and interpretation of model outputs, students gain an understanding of the characteristics, advantages, and applicability of different AI algorithms in environmental data analysis. Meanwhile, the course emphasizes the integration of algorithmic principles with environmental problem-solving, avoiding purely theoretical instruction and enhancing students' ability to utilize AI technologies to address environmental challenges.

At the result analysis stage, students further conduct environmental application analysis and group discussions based on model outputs. Particular attention is given to exploring the relationships between environmental data characteristics and model performance, as well as evaluating the practical value of AI technologies in rapid environmental pollutant detection. Through this process, students' scientific research capabilities, analytical thinking, and interdisciplinary innovation skills are effectively strengthened, as illustrated in Figure 1.

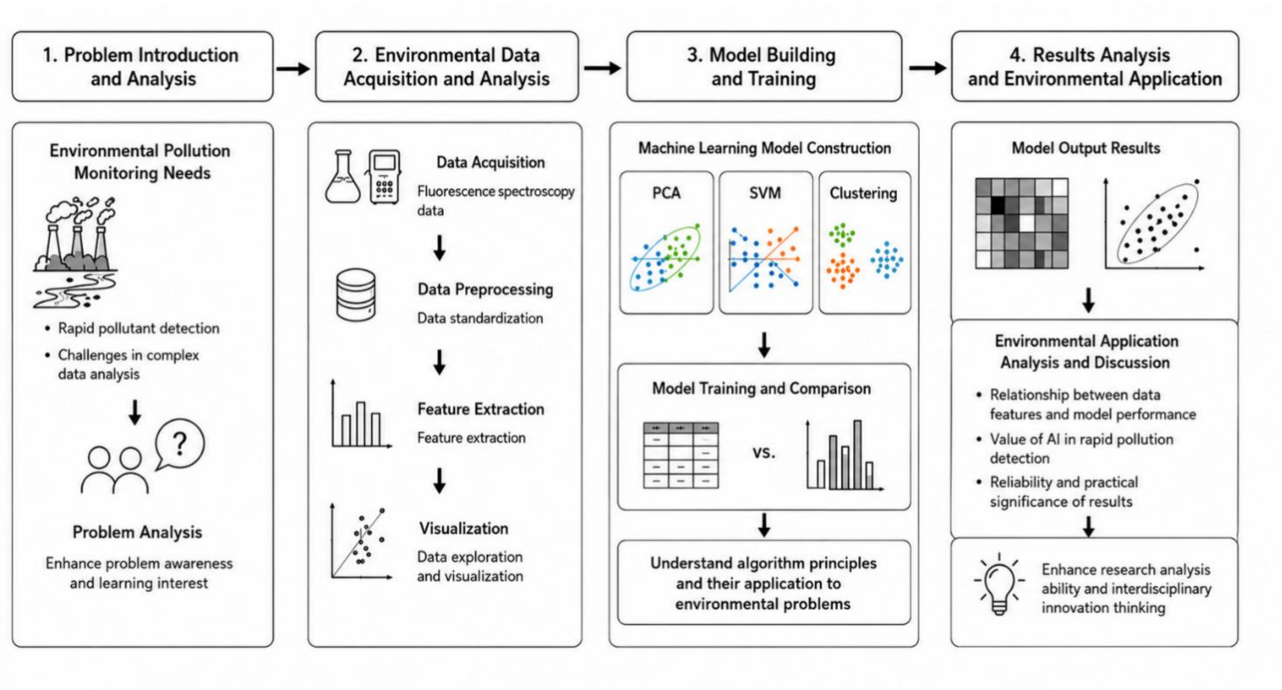

Figure 1 Schematic Diagram of the Teaching Case Implementation Process

3.3 The Characteristics of Case-Based Teaching

This teaching case is built upon authentic scientific research projects and features the deep integration of environmental problems, experimental data, and artificial intelligence algorithms, demonstrating strong research-oriented, practical, and interdisciplinary characteristics. First, real environmental datasets derived from faculty research projects are utilized as teaching resources, enabling research achievements to be effectively integrated into teaching and enhancing the authenticity and cutting-edge nature of the course content. Second, the case-based teaching approach emphasizes the combination of environmental problem-solving with AI technology applications, guiding postgraduate students to understand the practical application logic of artificial intelligence in ecological and environmental fields through data analysis and model development. In addition, the course adopts a combination of project-based and case-based learning strategies, strengthening students' abilities in independent analysis, collaborative discussion, and interdisciplinary problem-solving. This approach promotes a shift from traditional theory-oriented learning toward research problem-driven learning and the cultivation of interdisciplinary innovation competencies.

Through research case-driven teaching, postgraduate students can more intuitively understand the practical value of artificial intelligence in ecological and environmental applications while enhancing their capabilities in environmental data analysis, model construction, and complex environmental problem-solving. These experiences provide a solid foundation for future scientific research and interdisciplinary innovation activities.

4 TEACHING EFFECTIVENESS AND CURRICULUM REFORM OUTCOMES

Since its establishment, the course *Artificial Intelligence and Eco-Environment* has continuously promoted case-driven teaching reform under the framework of **AI–environment integration**. By incorporating authentic research cases, environmental data analysis, and artificial intelligence model training into the postgraduate education process, the course has achieved notable teaching outcomes and curriculum development achievements. Over the past two years, a total of 56 postgraduate students have enrolled in the course, making it one of the most popular professional elective courses within the graduate programs of the college. This reflects the strong demand among postgraduate students for interdisciplinary courses that integrate artificial intelligence with ecological and environmental sciences. In addition, the course utilizes faculty research projects to provide training in intelligent environmental data analysis, thereby strengthening students' research practice capabilities and promoting a transition from traditional theory-oriented learning toward the development of data-driven thinking and intelligent analytical skills.

4.1 Enhancement of Student Competencies and Teaching Effectiveness

The implementation of the course has significantly improved postgraduate students' research capabilities, environmental data analysis skills, and AI application competencies. Through machine learning model training and research-oriented practice in areas such as environmental pollutant identification, fluorescence spectroscopy analysis, and intelligent environmental data processing, students developed stronger abilities in data-driven problem solving and interdisciplinary innovation. Over the past two years, students participating in the course have published seven AI-related SCI papers in fields including intelligent environmental monitoring, machine-learning-assisted fluorescence spectroscopy analysis, and environmental functional material data analysis, with some studies appearing in high-impact journals such as *Sensors and Actuators B: Chemical* and *Journal of Hazardous Materials*.

The case-driven and project-based teaching approach also resulted in high levels of student engagement and learning effectiveness. Course evaluation results showed that 91.3% of students believed that the research-based cases enhanced their understanding of AI applications in ecological and environmental sciences, while 88.6% reported improvements in environmental data analysis and research practice skills. In addition, 85.2% considered authentic research cases effective in stimulating learning interest and problem-solving abilities. The overall course satisfaction rate reached 94.1%, reflecting strong student recognition of the interdisciplinary "AI + Eco-Environment" curriculum and its effectiveness in integrating AI theories with environmental application scenarios.

4.2 Challenges and Future Improvements

Although the curriculum reform has achieved encouraging outcomes, several challenges remain in the course development process. These include significant differences in students' programming and mathematical backgrounds, the complexity of environmental data analysis tasks, and the limited availability of AI practice platforms. Some postgraduate students still experience difficulties in deep learning model development and complex data processing, indicating that their understanding and application of advanced AI algorithms require further improvement.

In future course development, the teaching team will continue to enrich the "AI + Eco-Environment" case repository by incorporating more cutting-edge topics, such as environmental big data analytics, deep learning techniques, and large language model (LLM)-assisted scientific research. In addition, greater emphasis will be placed on multi-level AI practical training and the integration of research projects with course instruction. A course–research–publication integrated training model will be further explored to continuously enhance postgraduate students' research innovation capabilities and interdisciplinary competencies.

5 CONCLUSIONS

The course *Artificial Intelligence and Eco-Environment*, guided by the concept of AI–environment integration, incorporates authentic research cases such as machine-learning-assisted fluorescence spectroscopy analysis to establish a case-driven teaching model comprising case introduction, data analysis, model construction, and environmental application. This approach promotes the deep integration of artificial intelligence technologies into postgraduate education in the ecological and environmental field. Teaching practice has demonstrated that the course effectively enhances students' competencies in environmental data analysis, AI application, and complex environmental problem-solving, while strengthening their research practice and interdisciplinary innovation capabilities. Over the past two years, student participation in scientific research and overall course recognition have increased significantly, leading to the formation of a synergistic course–research–publication training framework. The proposed teaching reform provides a useful reference for the development of interdisciplinary "AI + Discipline" curricula and the cultivation of high-level interdisciplinary talents in environmental postgraduate education.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

FUNDING

The project was supported by Postgraduate Education Innovation Program of Guangdong University of Petrochemical Technology (2024), Educational and Teaching Reform Project of Guangdong University of Petrochemical Technology (ZLGC202546, ZLGC202548), University-Level Professional Knowledge Graph Project of Guangdong University of Petrochemical Technology (ZHKC2025089).

REFERENCES

[1] Jiang Y, Li B. Exploration on the teaching reform measure for machine learning course system of artificial intelligence specialty. Scientific Programming, 2021, 2021(1): 8971588.

[2] Wang X, Wang Z Y, Pan Y R, et al. Problems and Countermeasures of Artificial Intelligence Applications in Water and Environmental Fields in the 21st Century. Bulletin of Chinese Academy of Sciences, 2020, 35(9): 1163–1176.

[3] Han Y. Research on the reform of education and teaching methods in the era of artificial intelligence. 2020 6th International Conference on Social Science and Higher Education (ICSSHE 2020). Atlantis Press, 2020: 338-342.
[4] Leng J, Xie C J, Guo S H, et al. Exploration of AI-Empowered Teaching Reform of Basic Chemistry for Pharmaceutical Majors in Higher Vocational Education. Modern Chemical Research, 2025(24): 168–170.
[5] Das S, Anowar S, Chakraborty S. The integration of AI technology into environmental education. Life as basic science: An overview and prospects for the future, 2024, 1: 223-247.
[6] Ping Q, Li Y M, Shi J, et al. Exploration of Teaching Reform in the Course of Biological Wastewater Treatment Integrated with Machine Learning: A Case Study of Environmental Engineering at Tongji University. Environmental Education, 2026(04): 38–41.
[7] Li L, Huang W, Liu B. A research-oriented model for artificial intelligence education: Integrating multidisciplinary approaches to foster innovation and holistic learning. Proceedings of the 2024 7th International Conference on Educational Technology Management. 2024: 480-485.
[8] Yan L, Bian F F, Qu B Y, et al. Collaborative Cultivation Mechanism of Artificial Intelligence Curriculum and Innovation Capability in an Integrated Undergraduate–Postgraduate Education System: Oriented Toward the Automation Discipline. Education Theory and Research, 2025, 1(7).
[9] Wu W L, Li X, Tong Y C, et al. Development of Teaching Cases for Professional Degree Postgraduate Courses in Polymer Science and Engineering. Polymer Bulletin, 2022, 32(12): 66–70.