Exploration and Practice of Postgraduate Course Reform in "New Energy Development and Application" under the Background of "Dual Carbon"

Chunzhen Qiao*, Weijiao Chen, Yuqing Zhao

School of Civil Engineering, North China University of Technology, Beijing, 100144, China
*qcz@ncut.edu.cn

Abstract. Against the backdrop of the national "dual-carbon" strategy and the construction of new engineering disciplines, cultivating high-level new energy talents' scientific research innovation and engineering practice capabilities is crucial for national energy security and industrial transformation and upgrading. However, current postgraduate courses still suffer from pain points such as a disconnect between theory and practice, lagging research enlightenment, and insufficient academic writing skills. This paper takes the postgraduate course "New Energy Development and Application" as the reform target and proposes an innovative teaching model of "Frontier Perception—Research Enlightenment—Collaborative Improvement—Result Output." By introducing "Weekly Energy Broadcast" before class to strengthen frontier perception and international perspective, and promoting "Final Paper Idea Discussion" during class to deepen research enlightenment and team collaboration, this model comprehensively empowers postgraduate students' academic literacy and innovation capabilities. Practice shows that this teaching model significantly improves students' satisfaction with teaching evaluations, academic literacy, innovation capabilities, and ability to solve complex engineering problems, providing a practical and feasible teaching reform paradigm for cultivating top-notch innovative talents.

Keywords: New energy development and application, closed-loop teaching, teaching reform

1 Introduction

With global warming and the crisis of fossil fuel depletion, the carbon peaking and carbon neutrality (referred to as "dual carbon") strategy has become an inevitable requirement for the high-quality development of my country's economy and society [1].The Outline of the 15th Five-Year Plan for National Economic and Social Development of the People's Republic of China calls for the in-depth implementation of the new energy security strategy, accelerating the construction of a clean, low-carbon, safe, and efficient new energy system, and building a strong energy nation [2]. As a typical strategic emerging industry, the new energy industry involves a wide range of disci-

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plines, including power engineering and engineering thermophysics, chemical engineering, electrical and power electronics technology, and automation control, exhibiting high-level, application-oriented, and interdisciplinary characteristics [3]. Postgraduate education, as a core component in cultivating innovative and top-notch engineering and technological talents, bears the important mission of implementing the strategies of invigorating the nation through science and education and strengthening the nation through talent [4]. Postgraduate coursework is a key feature of the postgraduate education system, playing a comprehensive, integrated, and fundamental role in helping students transition from "knowledge transmitters" to "knowledge producers [5]."

Currently, the Ministry of Education and the State Council have successively issued relevant action plans and programs, clearly emphasizing the need to innovate talent cultivation models and guide the high-quality, intrinsic development of postgraduate education by upgrading curriculum and teaching objectives [6]. To break the deadlock of traditional postgraduate training that emphasizes theory over practice and rote learning over discussion, this paper explores in-depth teaching reforms for the postgraduate course "New Energy Development and Application" based on front-line teaching practice. It proposes a four-in-one core closed-loop concept of "frontier awareness—research enlightenment—collaborative improvement—results output," and creatively introduces two innovative approaches: "weekly energy broadcasts before class" and "in-class discussion of paper ideas at the end of class." By reconstructing teaching content and diversifying assessment mechanisms, it closely integrates academic frontier orientation with engineering practice, comprehensively empowering the cultivation of high-quality, interdisciplinary talents in the energy field.

2 Teaching Pain Points and Reform Ideas

2.1 Core Pain Points of the Traditional Teaching Model

Through long-term postgraduate teaching and mentoring practices, as well as literature review, it is not difficult to see that energy-related postgraduate courses such as "New Energy Development and Application" generally face the following core pain points:

a. The teaching content is outdated and lacks integration of cutting-edge topics.

New energy technologies (such as high-energy-density lithium-ion batteries, hydrogen energy and fuel cells, and non-steady-state wind-solar hybrid power generation) are developing at an extremely rapid pace and have a very short iteration cycle [7]. However, existing graduate textbooks have long compilation cycles, and classroom lectures are often limited to classic, well-established basic theories, lacking the introduction of the latest findings from top international academic journals and the latest technological bottlenecks in industry. This results in students lacking proactive awareness of academic frontiers and failing to develop a keen scientific research sense.

b. The teaching methods are monotonous, and the "cramming" style of instruction stifles innovative thinking.

Some teachers in graduate classes still follow the "large lecture-style" teaching model used in undergraduate programs, focusing on theoretical derivation and formula

explanation, and lacking heuristic, inquiry-based, and discussion-based teaching methods [8]. Graduate students generally reported that the coursework was tedious and monotonous, making it difficult to spark research enthusiasm in the classroom, thus failing to fulfill the intended "research guidance" role during the introductory stage.

c. The assessment mechanism is merely a formality, lacking dynamic incentives for the entire learning process.

Traditional assessment mechanisms overemphasize final papers or closed-book exams (i.e., "final grade-only"), failing to quantitatively evaluate students' "process learning." Students often only need to submit a superficial review as their final assessment, lacking rigorous training in project justification, technical route design, and standardized academic narrative. This singular evaluation system cannot comprehensively assess graduate students' teamwork skills, critical thinking, and ability to apply interdisciplinary knowledge to solve complex engineering problems [9].

2.2 The Proposal of the "Four-in-One" Closed-Loop Teaching Reform Approach

To address the aforementioned pain points, the teaching team of this course adheres to the educational philosophy of focusing on capacity building and being guided by national strategies, and has proposed a "four-in-one" closed-loop teaching reform approach of "cutting-edge perception - scientific research enlightenment - collaborative improvement - output of results".

Breaking the limitations of textbooks in terms of time and space, this course brings the latest global developments in new energy technologies, national policy benefits, and industry pain points into the classroom in real time, achieving a vertical integration of teaching content and cutting-edge research. Based on the course content, it guides students to shift their thinking from "passively absorbing knowledge" to "actively discovering problems and proposing scientific hypotheses," embedding standardized academic training into classroom teaching to complete their research enlightenment. Through group collaboration, multi-perspective questioning, and interdisciplinary exchanges, it conducts comprehensive seminar-style learning, achieving multi-skilled development and mutual promotion. The final assessment goal of the course is transformed from a simple "exam paper" or "rough review" into a high-quality research proposal or preliminary academic paper with "rigorous argumentation, clear narrative, and relevance to engineering or academic practice," comprehensively enhancing the adaptability of value transformation.

3 Overall Design and Implementation Path of the Teaching Model

To ensure the effective implementation of the "four-in-one" closed-loop concept, this course has undergone a comprehensive restructuring of its overall syllabus, teaching process, and time allocation. The specific overall design framework is shown in Table 1.

Table 1. Overall Framework of Innovative Teaching Model for "New Energy Development and Application"

teachLearning process	Corresponding closed-loop stage	Core innovation points and implementation platforms	Main teaching objectives and competency support
Before class (weekly)	Frontier Sensing	Weekly Energy Report(Students take turns hosting, with everyone participating in interactive commentary)	Develop the ability to retrieve, extract, and express academic literature; cultivate a keen international perspective and a broad vision.
During the first half of the lesson	Course Explanation (Introduction to Scientific Research)	Teaching that integrates theory and case studies(Embedded with the mentor's latest research results and engineering cases)	Strengthen the foundational knowledge of new energy across multiple disciplines; inspire an engineering systems perspective and transfer innovative thinking.
During the second half of the lesson	Collaborative Improvement	Discussion on the ideas for the final paper(Individual reports, inter-group questioning, and cross-debate between teachers and students)	Training focuses on topic selection and technical route design; overcoming technical details and logical flaws through brainstorming.

The "Frontiers Perception" section allows students to understand the latest developments and trends in the new energy field, thereby establishing a holistic perspective and forward-looking awareness. First, reviewing classic theories, the connection between sustainable development theory and new energy development trends forms the theoretical foundation of this section. Sustainable development theory emphasizes meeting the needs of the present without compromising the ability of future generations to meet their own needs. Second, in terms of factor comparison, energy reporting is closely linked to the Sustainable Development Goals. Energy reporting content should cover new energy policies, technological developments, and market dynamics to reflect the latest progress in the new energy field.

The in-class paper discussion sessions play a crucial role in cultivating students' scientific research awareness. The curriculum emphasizes the integration of theory and practice, highlighting training in research methods. The course content covers new energy policies, technological developments, and market dynamics, aiming to provide students with a comprehensive knowledge system. The current state of research in the new energy field determines the feasibility of graduate students' research directions and

thesis topics. Analyzing the current research status also helps students recognize research gaps and potential innovation points in the new energy field, thereby stimulating their research interest and innovative abilities.

The original purely theoretical lecture hours have been scientifically reduced in this teaching model, while significantly increasing learning methods such as classroom presentations, discussions, inter-group brainstorming, and case analysis. The teaching process is no longer a linear, one-way output, but an iterative, high-frequency interactive process.

To effectively complete the overall design of the new teaching content, the following specific implementation path has been formulated.

(I) Implementation path of "Weekly Energy Broadcast" before class

This course breaks with convention by featuring a fixed 10-15 minute segment before each week's regular classes – "Weekly Energy Broadcast." Each broadcast consists of a reporting group of 2-3 students, who take turns serving as the "Chief Energy Broadcaster." The content must be diverse, focusing on one of three dimensions: international academic frontiers, national strategies and industrial policies, or major engineering case studies and technological bottlenecks. The content should be sourced from publications within the last three months.Nature Energy, Energy & Environmental ScienceMajor breakthroughs in new energy materials, devices, or systems published in top international journals, as well as the latest policies, regulations, industry standards, or strategic roadmaps from the National Development and Reform Commission and the National Energy Administration regarding new energy storage, green hydrogen production, and grid connection of non-fossil energy.

The broadcasting team needs to review a large amount of Chinese and English literature and news a week in advance to extract the core scientific questions or technological innovations and produce the broadcast.Prepare a concise 5-10 slide presentation for class. Using highly refined and rigorous academic language, deliver a 5-minute talk show-style presentation, highlighting the key challenges this cutting-edge work addresses, the core methodologies employed, and the implications for the class.Finally, the instructor will organically link the broadcast content with the system theory to be taught in this lesson.

(II) Implementation Path of "Discussion on the Ideas for the Final Paper" during Class

As the most significant innovation of this course, the "Final Paper Idea Discussion" is scheduled for the latter part of the semester (approximately weeks 12-16). This part aims to completely abandon the perfunctory assessment of the past, where "students would simply cobble together a literature review for the final exam, and the teacher would glance at it and give a grade," and instead promote intensive academic publication and defense simulation exercises. The goal of the discussion is not for students to produce a perfect, mature paper on the spot, but to focus on the "core framework" of the paper—the rationale for the topic selection, the core scientific/engineering problem, and the proposed research methods and technical routes.

The specific implementation path strictly follows a three-stage, step-by-step approach:

- **Phase 1: Individual Topic Selection and Research Proposal Writing (Pre-Class Preparation)** Students, drawing upon their own research direction within their research group and the engineering systems perspectives they have learned in this course, such as new energy multi-energy complementarity and cascade utilization, will select a specific research topic. They will then write a 3000-word "Thesis Proposal/Outline" and create a PowerPoint presentation for class, clearly outlining: ① the background of the chosen topic and a literature review; ② the key scientific problems or engineering challenges to be addressed; and ③ a detailed design of experimental/simulation techniques.
- **Phase Two: Large-class "Fishbowl Method" Reporting and Comprehensive Questioning (Explosion During Class)** The classroom was transformed into a standard international academic conference setting. Each student gave an 8-minute presentation of their ideas, focusing on showcasing their technical roadmap. Following the presentation, a 7-minute Q&A session was held with all students asking impromptu questions, which the presenter answered on the spot. To enhance interaction, students from different research groups were required to critique each other's work and identify weaknesses. This cross-disciplinary approach often allowed the presenter to immediately spot fatal flaws in their proposal, such as working in isolation or being overly theoretical.
- **Phase Three: Reflective Revision and Final Submission (Post-Lesson Outcomes)** After rigorous questioning from classmates and insightful comments from the instructor, students were required to write a detailed "Reflection Report on the Paper Writing Process." This report meticulously outlined the challenges encountered in value creation and logical construction, addressed the questions raised by various parties, and provided targeted revision strategies. Ultimately, the students transformed their ideas into a high-quality scientific paper that truly met the requirements.

4 Evaluation and Reflection on Teaching Effectiveness

4.1 Analysis of the Effectiveness of Teaching Reform

This innovative teaching model has been implemented in the course "New Energy Development and Application" taught by the author for three cycles since 2023, achieving remarkable results, but it has also triggered some sober reflections on future reforms.

According to anonymous online course evaluation data from three consecutive academic years, the overall course evaluation score has been rising year by year, with the rate of excellent grades ranking among the top. Students generally reflected that...Through a semester of rotating presentations, I not only completed my own intensive literature reporting training, but also frequently absorbed dozens of cutting-edge hot topics compiled by other groups, which greatly alleviated the dilemma of "suspended and confined research vision" caused by a closed-minded direction and long-term fixation on my own narrow topic.More than 80% of the students said that the course completely freed them from the fatigue of traditional political courses, allowing

them to truly experience the joy of scientific research and thus stimulating their initiative in self-directed learning. Some students even upgraded their course reflection reports directly into their master's thesis proposals, successfully passing their thesis defenses and achieving a perfect closed loop of "teaching-learning-research-application".

4.2 Teaching Reflection and Future Improvement Directions

This course adheres to the principle of respecting the individual interests of graduate students. However, in practice, it has been found that some students who have already joined research groups and received excellent innovative training during their undergraduate studies are able to thrive in this model and produce truly remarkable results. On the other hand, a small number of students with relatively weaker foundations are prone to feeling overwhelmed or even anxious when faced with presentations and highly demanding classroom questioning. Future development requires designing more tiered guidance strategies, providing more abundant and differentiated pre-class supplementary literature, and offering personalized support.

Meanwhile, with the explosive popularization of generative artificial intelligence (AI) technology, a small number of students are overly reliant on large language models to generate presentation outlines or review drafts. This, to some extent, weakens students' ability to think independently and tackle complex literature. Future teaching should proactively introduce AI tools to assist in energy system modeling optimization and literature retrieval, while also establishing extremely strict red lines to prevent academic misconduct and a fully transparent reporting mechanism for AI-assisted collaborative creation, ensuring that technology serves as an "empowering crutch" rather than a "substitute for thinking."

5 Conclusion

Against the backdrop of building a strong education nation and the "dual-carbon" strategy, the upgrading of postgraduate course teaching should not merely be a matter of changing the form, but should be deeply rooted in the essence of "enhancing research capabilities." This paper constructs an innovative teaching model for "New Energy Development and Application," which strengthens cutting-edge awareness through "weekly energy reports" and facilitates research enlightenment through "discussions on thesis ideas," achieving a logical closed loop from "cutting-edge awareness" to "output of results." This model not only cultivates students' ability to "solve real problems," but also enables postgraduate students to grow into outstanding innovative talents in the field of new energy with a strong sense of national responsibility and capable of shouldering great responsibilities, guided by the philosophy of "moral education and talent cultivation." Future teaching reforms should further break down disciplinary barriers and continuously iterate in the wave of digitalization and intelligentization, providing a solid talent guarantee for the low-carbon transformation of my country's energy structure.

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References

1. Gao Wa. Exploration of postgraduate training model in new energy field under the background of "dual carbon" strategy [J]. Journal of Kaili University, 41(2): 119-123(2023).
2. Outline of the 15th Five-Year Plan for National Economic and Social Development of the People's Republic of China [EB/OL]. https://www.gov.cn/yaowen/liebiao/202603/content_7062633.htm, 2026/03/13.
3. Yang Zhonghua, Zhou Bo, Ning Baokuan, et al. Exploration of the practice of cultivating the research and innovation ability of professional postgraduates for the new energy industry - based on the integration of government, industry, academia, research and application [J]. Journal of Higher Education, 10(23): 19-22(2024).
4. Bai Fuchen, Wu Chunmeng. Research on the influence mechanism of postgraduate scientific research innovation ability: based on the perspective of meaning construction theory [J]. Heilongjiang Education (Theory and Practice), 76(1):27-29(2022).
5. Han Heyou, Hou Shun, Zheng Xuegang. An Exploration of the Reform and Construction of Postgraduate Course Teaching in the New Era [J]. Degree and Postgraduate Education,(1): 15-20(2016).
6. Bie Dunrong. Upgrading of postgraduate course teaching objectives in my country under the background of building a strong education nation [J]. Degree and Postgraduate Education,(6): 1-11 (2025).
7. Huang Guoyong, Qu Chenwei, Wang Chunxia. A preliminary study on the teaching reform of the postgraduate course "Design and Preparation of New Energy Materials" under the background of new engineering disciplines [J]. Heilongjiang Education (Higher Education Research and Evaluation), (4): 1-3(2022).
8. Hu Cuiyun, Sun Lei, Guo Song, et al. Exploration and practice of seminar-style teaching in postgraduate courses - taking cloud computing security course as an example [J]. University Education,(10): 67-71(2025).
9. Qi Ronghui, Cai Rongrong. Teaching design and practice of project-based course "Energy System: Multi-energy complementarity and cascade utilization" [J]. Journal of Higher Education, 10(17): 46-49(2024).

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