

Research and Practice of a Case-based Teaching Model Using Project-Based Problem Chains in Curriculum

Enhai Liu¹, Xin Huang^{1*}, Xia Xu¹, Xianghe Liu², Mingguo Peng^{1*}

¹School of Urban Construction, Changzhou University, Changzhou, China, ²School of Petroleum and Natural Gas Engineering, Changzhou University, Changzhou, China

*Corresponding Authors: Xin Huang: 534977853@qq.com; Mingguo Peng: jdcx1018@163.com

ABSTRACT

This study explores a teaching model that integrates case-based teaching with project practice, guiding students to investigate solutions and strategies for problem-solving during practical processes. By constructing scenarios and task-driven approaches based on practical cases, an “innovation-driven motivation” is fostered. Guided by the outcome-based education (OBE) philosophy, typical “chain-question” teaching cases are designed, preliminary case studies are conducted, and the curriculum teaching model is optimized. With questions as the link to drive the advancement of students’ thinking and strengthen reflective learning, students are motivated to engage in independent innovation and inspire creative ideas. The purpose of this model is to enhance the cultivation of students’ innovative thinking abilities, improve the efficiency and effectiveness of course learning, restructure course teaching content, and ultimately provide feedback and enhance classroom teaching quality. The results indicate that the excellent rate of students’ academic performance and the achievement rate of course objectives have increased significantly, with the growth range ranging from approximately 3.48–4.84%. Students have achieved excellent results in practice and innovation-related modules (including practical training and competitions). The annual employment rate in the industry has increased by about 2.01%. Employers’ satisfaction with graduates has been continuously rising, demonstrating good effectiveness and high professional matching degree.

KEY WORDS: Collaborative education, industry-education integration, problem-driven, project-based case teaching, teaching reform

INTRODUCTION

With the rapid development of the global economy and engineering education, the role of innovative talents in social and economic development as well as the industrialization process has become increasingly prominent. Cultivating innovative talents has thus emerged as an urgent requirement for national strategic development in the current era. Based on the university-enterprise collaborative innovation platform, this study constructs a scientific system for cultivating students’ scientific and technological innovation capabilities, and explores a project-based chain-question curriculum case teaching model. It guides students to explore solutions and strategies for problem-solving during practical processes, enhances their thinking abilities and knowledge application skills, and thereby ensures the comprehensive improvement of students in terms of “knowledge, competence, and quality.” To guide students to think deeply, carefully polish the knowledge points of the “problem chain,” and explore and learn the “problem chain,” it is necessary to pay attention to the hierarchical and logical design of the questions, to stimulate students’ higher-order thinking, and promote the improvement of their practical abilities (Zhu and Wei, 2025). Taking chemistry course teaching as an example, based on the confusion and confusion encountered by students in the

learning process and other related knowledge modules, a summary of the interrelated types of “question chains” can help guide students’ understanding of textbook knowledge and effectively improve the efficiency of classroom teaching (Wang, 2010). Conducted in-depth research on the core literacy improvement strategies of problem chain and experimental inquiry, aiming to solve practical problems and improve students’ innovative thinking and inquiry abilities (Du et al., 2025). Based on the course teaching process, question chains and experiment strings are used to collaboratively promote scientific reasoning, strengthen students’ awareness of connecting theory with practice, and promote their thinking development (Jin et al., 2024). The design of high-quality problem chains is of great significance for improving students’ innovative thinking abilities, promoting the development of their scientific thinking, cultivating their pioneering and innovative spirit, stimulating their learning interest and enthusiasm, and enhancing the effectiveness of classroom teaching. To promote the improvement of individual cognitive ability and cultivate the elemental literacy of individual new learning ability, we discussed high-quality questions that promote the formation of individuals based on thinking, and used question chains to demonstrate the new quality attributes of problem thinking (Shen, 2025). In view of the design strategy of educational prompts to promote individual high-awareness

learning, the model design of educational prompts is discussed, and a problem-based thinking structure is constructed. The research results help to promote the development of individual cognitive abilities and stimulate individual learning interest, help individuals achieve high-awareness learning, and improve the efficiency of continuous learning (Zhao et al., 2024). Based on the current research status and development trend of the deep integration of industry and education between universities and enterprises, proposed that universities should match the practical needs of talents in the industry field in terms of talent training and accurately connect with industrial demands (Cheng, 2024). Based on the curriculum case teaching model, proposed to integrate hydraulic energy-saving technology into the classroom teaching and scientific research of mechanical engineering courses, which helps cultivate students' practical and innovative thinking abilities and guide them to explore solutions and strategies for problem-solving (Gao et al., 2024). Through case statistics on the thermal environment adaptation of students studying in two different types of classrooms, the results show that there are significant differences in individual comfort indicators and learning effects (Mishra and Ramgopal, 2015). Relevant literature discusses the applicability of immersion teaching methods in course teaching and emphasizes the importance of practice, aiming to make students have a deeper understanding of professional knowledge (Shou et al., 2012). Based on the analysis of existing literature, relevant scholars at home and abroad have discussed the strategy optimization and implementation effect of curriculum teaching according to curriculum characteristics, teaching models, and teaching methods and conducted in-depth research to improve classroom teaching efficiency and quality. Based on the new quality productivity drive, it is proposed to deepen the integration of school-enterprise industry and education and build an interdisciplinary knowledge system, and conduct in-depth research, which will help lead students to explore problem-solving solutions and strategies during the practical process, and cultivate students' innovative consciousness and practical ability (Xue, 2025). Focusing on task-driven scientific research project cases, implementing classified and hierarchical teaching, and expanding the "chain-case practical teaching" system help guide students to explore solutions and strategies for problem-solving in the practical process, acquire relevant information of professional knowledge, and enhance the cultivation of students' practical and innovative thinking abilities. Through empirical analysis, exploring the key links of educational intelligence empowering project-based learning will help improve the effectiveness and efficiency of classroom teaching (Jin, 2025). Guided by the outcome-based education OBE concept, constructed a project-driven curriculum teaching system centered on students' abilities, giving full play to students' thinking abilities and learning initiative, which can effectively motivate students to carry out independent innovation and stimulate their creativity (Luo et al., 2025). Based on the background of engineering education professional certification, exploring the course teaching process and focusing on the importance of cultivating

students' practical ability and innovative thinking ability will help improve classroom teaching efficiency and teaching quality (Yuan et al., 2024). Based on teachers' exploration and experience in project-based learning, the key features and teaching implementation strategies of project-based learning are discussed, aiming to inspire and guide students' case-finding thinking, enhance students' innovation ability, and stimulate students' creativity (Hang, 2024).

Based on the platform of industry-education integration and university-enterprise collaborative innovation, this paper takes the problem-chain case teaching practice of the course Refrigeration Technology for Freezing and Cold Storage as an example, explores a system that conforms to the characteristics of the education system and can stimulate independent innovation in universities, proactive self-development of teachers, and independent exploration and innovation of students. It also explores a demand-oriented "project-based problem chain" curriculum case teaching model, promotes the deep integration of discipline (major) chains, talent chains, innovation chains and industrial chains, and helps improve and optimize the training mechanism of high-quality innovative talents for educational innovation, knowledge innovation and technological innovation.

TEACHING PHILOSOPHY AND REFORM APPROACH

Course Orientation, Teaching Philosophy and Course Instruction

Curriculum teaching is the most basic work of talent training. In the implementation process, it is based on "curriculum positioning, teaching philosophy and curriculum teaching," adhering to the principle of "student-centered, outcome-oriented and continuous improvement," and strengthening "competence orientation and promotion of industry-education integration." The creation of project-driven "problem chain" scenarios can give full play to students' thinking abilities and learning initiative, and effectively motivate them to carry out independent innovation and stimulate their creativity.

The course refrigeration technology for freezing and cold storage is an important theoretical course for the major of building environment and energy application engineering, aiming to cultivate students' ability to use refrigeration theory and knowledge to solve practical engineering problems. However, traditional curriculum teaching focuses on the sequential explanation of textbook content, with scattered knowledge points and incoherent logic among chapters. It does not emphasize the "approaches and methods" of curriculum explanation and ignores the individual learning differences and interest needs of students, leading to students' lack of interest in curriculum content, insufficient learning motivation, and thus negative emotions. Therefore, based on the innovative talent training model from the perspective of industry-education integration and the (OBE) philosophy, this paper focuses on interdisciplinary development trends

and the demand for interdisciplinary talents in the industry. It carries out curriculum teaching reform from the aspects of curriculum positioning, teaching philosophy and teaching methods, focuses on scientific research project and engineering case-driven approaches, creates a project-driven “problem chain” scenario simulation platform, and implements targeted “teaching according to needs and effective guidance” to improve students’ ability to comprehensively apply theoretical knowledge in practical applications.

Ideas for Teaching Curriculum Reform

Based on the curriculum positioning of refrigeration technology for freezing and cold storage, graduation requirements, achievement degree of curriculum objectives, and the collection of academic tracking information such as “questionnaire follow-up and discussion” with practical units during students’ internship and “effect experience exchange” when students return to school, this study timely observes and evaluates students’ learning status (classroom performance, phased assessment, student self-assessment, psychological interview, etc.), formulates personalized learning guidance plans in a timely manner, and launches curriculum academic early warning and assistance measures. Finally, it achieves the win-win effect of “promoting learning through teaching and practicing through learning,” helping students achieve curriculum objectives and meet graduation requirements.

In the implementation process of theoretical teaching, in addition to focusing on the logic of knowledge points between chapters and constructing mind maps with clear logic and regular layout, it is also necessary to create an “innovation-driven motivation” problem orientation, carefully design teaching cases of “chain questions,” create targeted “problem chain” scenarios, focus on interdisciplinary project-based learning case task-driven approaches, guide students to explore solutions and strategies for problem-solving in the practical process, enhance the cultivation of their innovative thinking abilities, and promote teaching and learning to complement

each other. The overall scheme of the curriculum teaching reform idea is shown in Figure 1.

RECONSTRUCTION AND REFORM STRATEGIES OF TEACHING CONTENT

Overview of the Integration of Industry and Education

A large number of universities at home and abroad have launched university-enterprise cooperation models. Practice has proved that the university-enterprise collaborative education and joint training model has achieved remarkable results, effectively improving the quality of talent training and practical innovation capabilities.

At this stage, under the dual-carbon goals, the cold chain industry is being promoted to develop in the direction of low carbonization, high efficiency, and sustainability. Based on the current distribution of the cold chain logistics industry in the East China region of China and the collation and analysis of the survey data collected by the research group during July–August 2024, the overview of industry-education integration in the cold chain sector within the region shows a multi-field coverage pattern. As of August 2024, the overview of industry-education integration related to the cold chain industry among universities in East China (type data proportion) is shown in Figure 2, and the overview of cooperation between typical enterprises and universities (type data proportion) is shown in Figure 3.

Project-Driven “Problem Chain” Stage Model

Looking at curriculum teaching, the “traditional lecture method” mainly focuses on the breadth and depth of knowledge content, while “modern education” emphasizes the “approaches and methods” of curriculum explanation. It also pays attention to the individual learning differences and interest needs of students, inspires and guides students’ inquiry thinking, enhances their innovative abilities, stimulates their creativity, cultivates their ability to comprehensively apply knowledge to solve problems in real scenarios, and improves

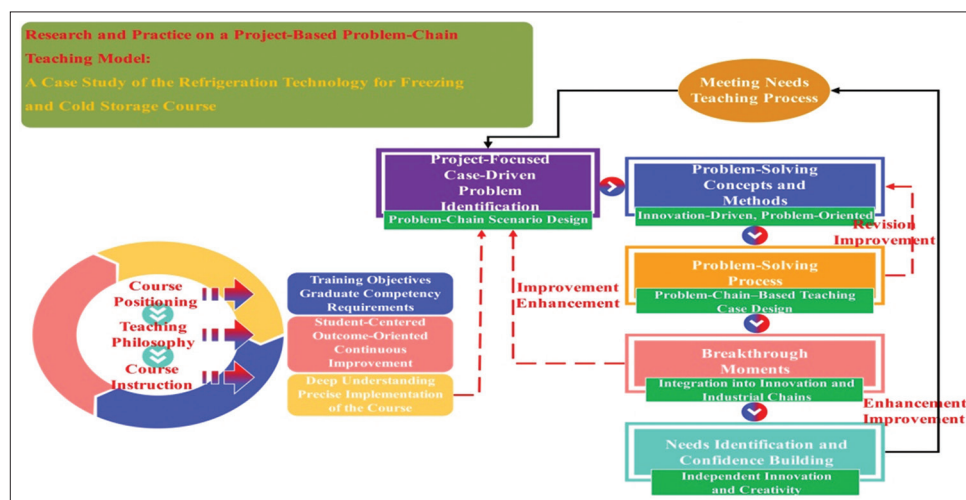


Figure 1: Overall plan for ideas on teaching curriculum reform

the efficiency of students' understanding and acquisition of curriculum content.

University-enterprise collaborative innovation and industry-education integration are promoted in parallel. The course refrigeration technology for freezing and cold storage is student-centered and competency-oriented. It strengthens university-enterprise cooperation and promotes industry-education integration. Universities and enterprises jointly develop typical innovative practice cases and continuously transform them into teaching resources, so as to realize the reconstruction of teaching content and feed back to improve classroom teaching effectiveness. The curriculum reform and teaching strategies include (1) resource integration and in-depth thinking to create an “innovation-driven motivation” problem orientation; (2) designing “chain-question” teaching cases, organizing group discussions to promote the advancement of students' thinking; (3) revision and improvement stage: Creating “problem chain” scenarios, optimizing strategies,

conducting comparative analysis, and carrying out laboratory and platform online tests; (4) enhancement and improvement stage: Enabling students to experience success and moments of insight, and take the initiative to integrate into the “innovation chain and industrial chain;” and (5) further improvement stage: Encouraging independent innovation, stimulating creativity, and fostering the formation of demand awareness and self-confidence. The stage model of scenario creation and project-focused “problem chain” is shown in Figure 4.

Innovation in Teaching Process and Methods

Scenario creation and problem posing

By collecting innovative practice project cases of previous students who participated in training bases, we construct engineering practice teaching resources for “thinking advancement” in curriculum teaching, and improve students' practical innovation capabilities through project-driven approaches.

Typical case module 1: The cold chain sector is facing bottlenecks due to prominent problems such as high energy consumption, single function, backward comprehensive resource utilization technology, low equipment integration, and imperfect industrialization promotion and application systems.

It fails to meet the demand for high-value and high-efficiency resource recycling of general-purpose high-performance cold chain systems.

Typical case module 2: There is a deviation and low matching degree in the timely regulation between the “diversified cooling demand” of stored products and the “cooling capacity adaptability.”

It is impossible to achieve flexible cooling locking and real-time regulation in the “wide temperature range” of the cold chain.

Typical case module 3: The intelligent traceability technology for the “dynamic identification of circulation quality” of fruits and vegetables is not synchronized with the “real-time tracking and precise regulation” of the refrigeration system.

A technical system for integrated real-time monitoring, data analysis, and intelligent decision-making of multi-source data for “product freshness and full-domain perception” has not yet been established.

Task-driven and inquiry-based teaching

Centering on the above typical case modules, guided by typical engineering case tasks, we adopt methods such as heuristic

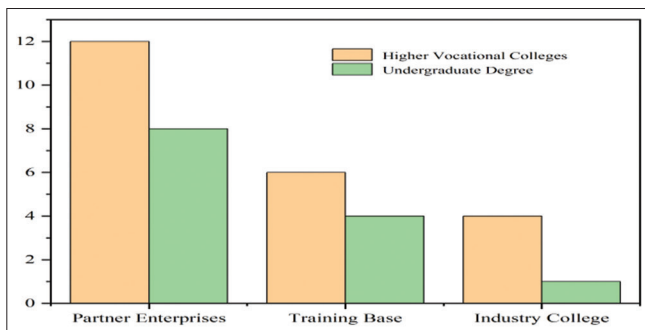


Figure 2: Overview of the integration of industry and education between universities and the cold chain industry

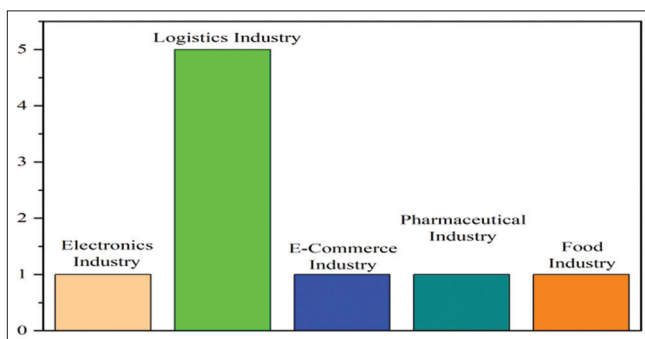


Figure 3: Statistical overview of the number of collaborations between typical enterprises and universities

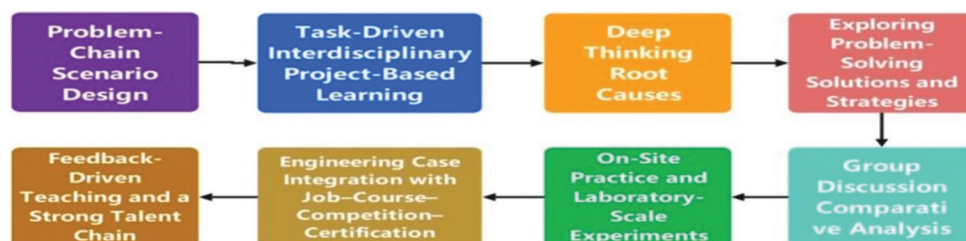


Figure 4: Stage model of scenario creation and project-focused “Problem Chain”

guidance, extensive quotation, and task-driven approaches to conduct preliminary case exploration and optimize the curriculum teaching model. We create an “innovation-driven motivation” problem orientation, organize “problem chains” of curriculum teaching case materials, use problems as the link to drive the advancement of students’ thinking, and guide them to conduct in-depth learning of the content of curriculum chapters. Through knowledge internalization and group discussions, we aim to build efficient classrooms and improve the effectiveness and efficiency of classroom teaching.

1. Scenario problem 1: Centering on the engineering practice case of “ineffective separation and regeneration of dynamically accumulated ammonia and oil in the cold chain system,” drive the advancement of students’ thinking and guide them to conduct in-depth learning of the content of curriculum chapters.

Question transition: Use the problem (technology for efficient separation, recovery, purification, and reuse of “ammonia and oil”) to lead the advancement of students’ thinking and guide them to conduct in-depth learning of the content of curriculum chapters.

2. Scenario problem 2: In the cold chain sector, there are many types and varieties of fruits and vegetables stored in different temperature zones, with a wide range of temperature and humidity regulation areas. There is a deviation and low matching degree in the timely regulation between the “diversified cooling demand” of products and the “cooling capacity adaptability.”

Question transition: Use the problem (“diversified cooling demand” and “cooling capacity adaptability”) to lead the advancement of students’ thinking and guide them to conduct in-depth learning of the content of curriculum chapters.

3. Scenario problem 3: The intelligent traceability technology for the “dynamic identification of circulation quality” of fruits and vegetables is not synchronized with the “real-time tracking and precise regulation” of the refrigeration system, and a technical system for integrated real-time monitoring, data analysis, and intelligent decision-making of multi-source data for “product freshness and full-domain perception” has not yet been established.

Question transition: Use the problem (key technical bottlenecks such as perishability, difficult temperature control, and instability across climate zones during the logistics and transportation of fruits and vegetables) to lead the advancement of students’ thinking and guide them to conduct in-depth learning of the content of curriculum chapters.

Problem-oriented and path exploration

Based on the curriculum positioning, this study puts forward problems targeting the above typical case modules and explores the approaches and methods of curriculum teaching, aiming to stimulate students’ higher-order thinking and promote the improvement of their practical abilities.

Problem 1: How to achieve effective separation of dynamically accumulated ammonia and oil in the cold chain system? According to the competition rules of the “Challenge Cup” China College Students’ Entrepreneurship Competition, which advocates the “energy-saving concept” and improves “resource and environmental awareness,” how to carry out innovative treatment of “waste fruits and vegetables” during the cold processing and storage process from a professional perspective to realize efficient resource utilization and environmentally sustainable development?

Problem 2: According to the requirements of “diversified cooling demand” and “cooling capacity adaptability” of products, how to achieve flexible cooling locking and real-time regulation in the “wide temperature range” of the cold chain?

Problem 3: How to construct an integrated monitoring Internet of Things cloud platform technical system for “product freshness and full-domain perception” to solve key technical bottlenecks such as perishability, difficult temperature control, and instability across climate zones of fruits and vegetables?

Progressive thinking and creative stimulation (entrepreneurship competitions, case-based practical training themes)

Based on the curriculum objective achievement evaluation rules and the student-centered education and teaching philosophy, and in accordance with the individual learning differences and interests of students, universities and enterprises conduct collaborative discussions to sort out the crux of problems. We actively carry out teaching reforms such as case-based, seminar-based, and inquiry-based teaching, and adopt multiple measures to improve the effectiveness of collaborative education. Centering on problem orientation, we take the initiative to integrate into and adapt to the industry’s demand for interdisciplinary talents, inspire and guide students’ inquiry thinking, enhance their innovative abilities, stimulate their creativity, cultivate their ability to comprehensively apply knowledge to solve problems in real scenarios, and improve the efficiency of students’ understanding and acquisition of curriculum content.

Solution to problem 1: Technology for efficient separation, recovery, purification, and reuse of “ammonia and oil” – The ammonia-oil mixture is introduced into the ammonia-oil thermal separation unit. The separated ammonia gas can be used for the circulation of the refrigeration system, or it can enter the reaction kettle to participate in reactions as a raw material for the production of nitrogen fertilizer.

Innovative treatment methods for “identification of slight wilting and wrinkling of fruits and vegetables” and “waste fruits and vegetables” – Based on the Bluetooth remote monitoring APP, through the identification device of infrared light in different wavebands (including moisture content monitoring and positioning modules), the “identification of slight wilting and wrinkling” of fruit and vegetable deterioration is accurately realized. Spoiled fruits and

vegetables are composted and fermented to produce biogas, which can be used for cooking or connected to the natural gas grid. The biogas residue produced from waste fruits and vegetables can be dried and incinerated to be used as fertilizer for farmland.

Solution to problem 2: “Wide temperature range” flexible cooling locking and real-time regulation – Establish a series of collaborative calling modules of “key technologies for wide temperature range high-efficiency and energy-saving cold chain equipment” integrating three functions of “cold chain processing, fresh-keeping and cold storage, and warehousing and logistics.” Build a “perception-decision-execution” closed-loop feedback system to realize real-time online regulation of the unit.

Solution to problem 3: Asynchronization between the intelligent traceability technology for “dynamic identification of circulation quality” of fruits and vegetables and “real-time tracking and precise regulation” of the refrigeration system – Establish an integrated monitoring Internet of Things cloud platform technical system for “product freshness and full-domain perception” of multi-source data. Realize reverse regulation, data monitoring, real-time online inspection, and dynamic presentation of cold chain transportation. Focus on remote diagnosis and full-domain intelligent regulation of equipment perception to solve key technical bottlenecks such as perishability, difficult temperature control, and instability across climate zones during the logistics and transportation of fruits and vegetables.

Building on the cultivation of systematic thinking, this course consciously guides students through problem-chain scenarios toward a holistic understanding of sustainable engineering. The progressive advancement of the problem-chain scenarios is underpinned by a deeper pedagogical intention: To construct a targeted cognitive loop that propels students into industrial realities driven by genuine confusions, and then guides them back to the classroom with practical insights to achieve cognitive elevation. During the classroom-based problem-chain teaching phase, students engage with typical case modules not to obtain immediate solutions, but to cultivate doubts; subsequently, they enter the industry-education integration practice bases and joint training units established through university-enterprise cooperation for immersive learning in real production and operation scenarios. Upon completion of the enterprise joint-training period, students return to the classroom with accumulated measured data, on-site observation records, and new queries, entering a stage of “return and rumination.” This rumination is not a mere repetition of classroom content, but a reorganization, deepening, and systematization of the existing knowledge system under the illumination of practical experiences.

ACHIEVEMENTS IN TEACHING REFORM

By adopting the integrated approach of case-based teaching and project practice, students are guided to explore solutions and

strategies for problem-solving in the practical process, which enhances the cultivation of their innovative thinking abilities, realizes the reconstruction of teaching content, and achieves the effect of feeding back and improving classroom teaching. After 3 years of curriculum teaching exploration and reform, the project-based problem chain curriculum case teaching model has achieved initial results, which are summarized as follows:

1. Based on curriculum positioning, graduation requirements, and course objective achievement evaluation, regular training sessions and lectures on personalized learning interest cultivation, scientific and technological innovation and discipline competitions, academic planning and course guidance are carried out to guide students to clarify course teaching objectives, master effective learning methods, and improve the efficiency and effectiveness of course learning.

1. The average course scores, the proportion of students scoring above 90, and the participation rate in practical innovation (training and competitions) have increased year by year.

After curriculum teaching exploration and reform, in 2023, the average score was 81.03, the proportion of students scoring above 90 was 9.34%, the participation rate in practical innovation was 5.51%, and the course objective achievement rate was 84.01%; in 2024, the average score was 84.71, the proportion of students scoring above 90 was 11.73%, the participation rate in practical innovation was 7.94%, and the course objective achievement rate was 85.73%; in 2025, the average score was 88.57, the proportion of students scoring above 90 was 14.18%, the participation rate in practical innovation was 11.27%, and the course objective achievement rate was 87.49%. The trend of students' scores and various proportions from 2023 to 2025 is shown in Figure 5.

2. Build a curriculum theoretical teaching platform integrating “specialty and innovation” and “industry and education,” so as to realize the reconstruction of teaching content and promote mutual improvement of teaching and learning.

Based on the teaching platform, the course teaching process integrates industry-education integration and practical guidance, centers on “knowledge + ability + quality,” carries out group discussions and comparative analysis, and encourages in-depth thinking on the root causes of problems and exploration of solutions and strategies. In June 2024, won the Best Health Value Award in the project-based teaching road show of “Innovation and Entrepreneurship Theory and Practice.”

2. In the course teaching process, guided by problems and integrating industry-education integration, we create “problem chain” scenarios, cultivate “innovation motivation,” design “chain-question” teaching cases, and realize the deep integration and organic connection between teaching content and industry needs.

1. Through scenario perception and enhanced reflection, students' ability to transform classroom knowledge into practical problem-solving skills has been gradually improved.

In April 2023, students were organized to participate in the 34th International Exhibition on Refrigeration, air conditioning, heating, ventilation and food freezing processing with the theme of “Focus on Global Cooling and Heating, Commit to System Innovation” in Shanghai. Through scenario perception, students were promoted to deeply understand the technical needs, industrial chain resources, and new research trends in the cold chain field at home and abroad.

2. Case-based teaching cultivates students' in-depth thinking and explores teaching paths to promote the cultivation of students' scientific thinking.

In April 2023, the China Circular Economy Association organized experts in the form of a meeting to conduct scientific and technological achievement appraisal on the project supported by the course – “Research on Key Technologies of Cold Chain in Full-temperature Range Wide Storage Center of Modern Agricultural Industrial Park.” The project achievements have significant innovation, which helps realize the industrialization and large-scale promotion of the cold chain industry, and won the third prize of science and technology of China General Chamber of Commerce in December.

In December 2024, the Cold Chain Logistics industry Association conducted a comprehensive evaluation on the cloud platform technology system of “Product Freshness and Full-domain Perception” supported by the course: It expands the efficiency and temperature adaptability of fruit and vegetable storage and transportation preservation technologies, realizes real-time online inspection and dynamic presentation of cold chain transportation, and focuses on full-domain intelligent control of temperature and humidity in terms of remote diagnosis and equipment perception.

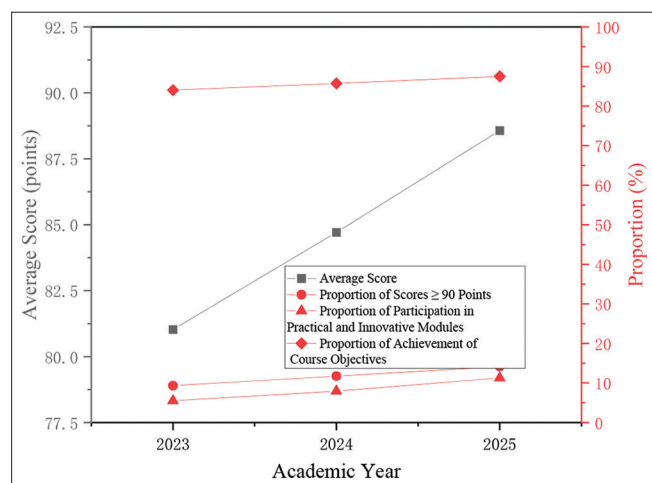


Figure 5: Trend chart of annual performance and proportion of various items (2023–2025)

3. Through the teaching of knowledge system and training of logical thinking methods, adhering to the educational philosophy of “student-centered, outcome-oriented and continuous improvement,” taking “problem orientation + practice orientation” as the starting point, we adopt the integrated method of “theoretical explanation + case analysis + project practice,” which is progressive, interlocking, combining education and training, and integrating knowledge and practice.

In April 2023, the project supported by the course – “Employment Education through Supply and Demand Connection” of the Ministry of Education was approved, aiming to deepen the reform of higher education, promote the organic linkage between employment and talent training, and realize the effective connection between talent supply and demand.

In June 2025, the Jiangsu Higher Education Teaching Reform Research Project supported by the course – “Research and practice of project-based problem chain curriculum case teaching model – taking the course refrigeration technology for freezing and cold storage as an example” was approved.

4. The employment rate of three batches of students from 2023 to 2025 in the industry has shown a steady upward trend as a whole, with good results and high professional matching degree, and employers' satisfaction with graduates has been continuously rising. According to the feedback from online questionnaires and offline visits to alumni and employers, combined with the collection of information such as exchanges and interactions between practical units and students' experience feedback, the annual employment rate of the recent three batches of students in the industry has increased by about 2.01%. Moreover, students can update their knowledge through modern learning channels, continuously improve their

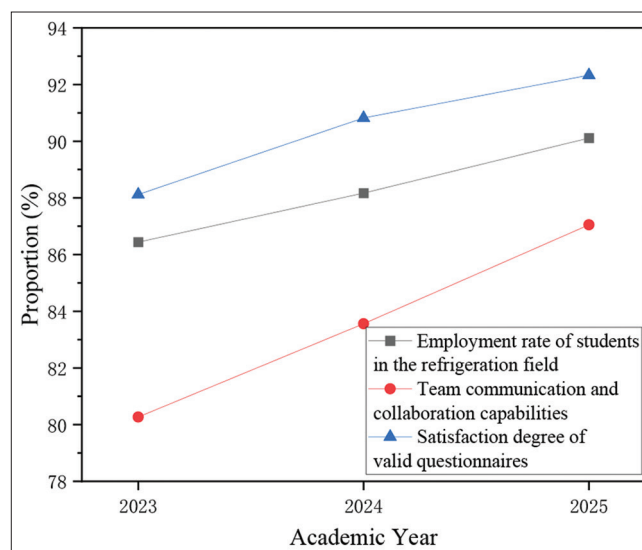


Figure 6: Trend chart of core indicators for student development (2023–2025)

abilities and levels, and adapt to the development needs of professional positions.

The trend of core indicators for student development from 2023 to 2025 is shown in Figure 6. In 2023, the employment rate of students in the refrigeration field was 86.44%, the team communication and collaboration ability score was 80.27%, and the satisfaction rate of valid questionnaires was 88.12%; in 2024, the employment rate of students in the refrigeration field was 88.17%, the team communication and collaboration ability score was 83.56%, and the satisfaction rate of valid questionnaires was 90.82%; in 2025, the employment rate of students in the refrigeration field was 90.11%, the team communication and collaboration ability score was 87.05%, and the satisfaction rate of valid questionnaires was 92.33%.

CONCLUSION

After 3 years of curriculum teaching exploration and reform, the project-based problem chain industry-education integration curriculum case teaching model, guided by the OBE educational philosophy, has constructed the implementation path of “promotion through teaching, guidance through tutors, and assistance through peers” and personalized learning guidance plans. It attaches importance to the cultivation of students’ abilities of “scenario perception, problem-solving, and enhanced reflection,” stimulates their learning interest and enthusiasm through industry-education integration, inspires and guides students’ inquiry thinking, deepens their understanding of course theoretical knowledge in practice, and explores solutions and strategies to problems. This model can effectively expand the knowledge scope of interdisciplinary (professional) integration and innovation, strengthen team collaborative learning, and improve the cultivation effect of innovative thinking and engineering practice abilities.

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