2024 Volume 2, Issue 2
Education Innovation Research
ISSN(Online): 3029-1852 ISSN(Print): 3029-1844

# Construction of Practical Courses Based on Industry-Education Integration: A Case Study of the School-Enterprise Collaboration Major in Environmental Science (Smart Water Management)

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**Abstract:**

Environmental science is an interdisciplinary and comprehensive field that emphasizes the cultivation of applied talents. Based on the cooperation project between our university's Environmental Science (Smart Water Management) and enterprises, this study focuses on the collaborative education practice platform of industry-education integration and the construction mode of practical courses. By innovating the content of practical courses, this study aims to explore a set of practical course systems that adapt to social development and conducts an in-depth analysis and discussion of the issues encountered in the course construction process.

**Keywords:**

Industry-education integration
Practical courses
Environmental science

***Online publication:*** December 16, 2024

## 1. Overview of the industry-education integration talent cultivation model

The industry-education integration talent cultivation model has become an important direction actively explored in the field of education. This model is dedicated to improving the quality of talent cultivation through deep integration of industry and education, in order to meet the needs of socioeconomic development. In recent years, the state has successively issued relevant policies and documents to promote the deepening of industry-education integration. The matching degree of school-enterprise cooperation resources, the collaboration capabilities of cooperative entities, and the mechanisms that facilitate the orderly flow and aggregation of core elements constitute the connotative characteristics of industry-education integration. These characteristics

not only reflect the closeness and quality of school-enterprise cooperation but also serve as the intrinsic motivation for the smooth development of industry-education integration [1].

Combining the characteristics of the major and the needs of industry development, our university's Environmental Science (Smart Water Management) major is committed to cultivating applied talents, which is the main goal of collaborative education in industry-education integration. The core of industry-education integration lies in closely integrating the actual needs of the industry with the education system, jointly designing talent cultivation programs, optimizing curriculum structures, and improving practical teaching systems to achieve deep integration between education and industry. This model helps cultivate high-quality talents who possess both a solid theoretical foundation and rich practical experience, providing strong talent support for industrial development.

In 2017 and 2019, the State Council and the Ministry of Education issued important documents such as "Several Opinions on Deepening Industry-Education Integration" and the "Implementation Measures for Building Industry-Education Integration Enterprises (Trial)," respectively [1]. These documents emphasized the importance of closely integrating professional education with the industrial chain, advocating for the innovation of talent cultivation models through school-enterprise cooperation to meet the talent needs and employment standards of enterprises, and achieving true collaborative progress between industries and educational institutions. The documents also required higher educational institutions to further promote the education model of "industry-education integration and school-enterprise cooperation" [2,3]. The 20th National Congress of the Communist Party of China elevated "modernization featuring harmonious coexistence between humans and nature" as one of the core contents of "Chinese-style modernization," reiterating the strategic goals of China's ecological civilization construction in the new era. With the aim of serving local economic development and considering the needs of ecological civilization construction and regional ecological development, it has become crucial to construct a high-quality and innovative talent cultivation model that integrates industry and education for environmental majors [4].

## 2. Constructing an industry-education integrated "teaching-research-practice-innovation (four-tier framework)" practical curriculum cultivation system

Schools and enterprises work hand-in-hand to build a practical curriculum system. Dedicated to continuously improving the existing talent cultivation framework and enhancing the configuration of practical courses, we aim to create a practical and innovative talent curriculum system that integrates theory and practice teaching. This curriculum system adopts the "four-tier structure" model of industry-academia-research integration, which includes "basic platform, professional skill modules, practical teaching platform, and research platform." The curriculum system consists of modules such as basic course experiments, core course experiments, comprehensive practical courses, and innovative practical courses, emphasizing the core of practical teaching in basic cultivation, innovative practice, and extended training; the school focuses on the teaching of basic practical courses, while the enterprise specializes in the construction of practical bases and the development and application of innovation and entrepreneurship practical courses. By establishing a platform that emphasizes the integration of practice and innovation, schools and enterprises jointly build a "dual-mentor system" faculty, research platform, practical teaching platform, and teaching quality evaluation system, aiming to solve practical problems, improve students' practical innovation abilities and scientific research literacy, and cultivate students' professional skills and scientific research innovation abilities [5].

Within the framework of industry-education integration, we actively seek innovative methods for constructing practical courses [6]. Taking our university's Environmental Science major as an example, we collaborate with leading industry enterprises to jointly cultivate talents and have established Environmental Science (Smart Water Management) as a school-enterprise cooperation major. Through establishing close cooperative relationships, we have implemented a series of industry-education integration strategies. These strategies

specifically include: implementing a 3+1 joint cultivation model, establishing off-campus internships and practical bases in enterprises to enhance students' practical skills; inviting enterprise experts with rich practical experience to teach industry technology development and internship practical knowledge; students further enhance their practical operation and skills through on-the-job internships in their fourth year; meanwhile, we have also established a talent supply-demand matching mechanism to promote graduates' employment and entrepreneurship [7]. Additionally, we have constructed a curriculum system centered on applied skills and adopted a "four-in-one" innovative practical curriculum system structure, which combines technology service platforms, innovation and entrepreneurship education platforms, skill competition platforms, and internship and practical training platforms.

## 3. Construction content of industry-education integrated practical courses

Under the background of "industry-academia-research" integration, undergraduate institutions have conducted specific research on the "four-in-one" (teaching-research-practice-innovation) applied research-oriented environmental talent cultivation system from aspects such as cultivation mode, practical teaching, technological innovation, and quality evaluation [8].

### 3.1. Research on talent cultivation mode for environmental majors

Through extensive research, analysis, and demonstration, combined with the realistic demand for innovative research-oriented environmental talents from society and the industry, as well as the school's positioning and disciplinary characteristics, we have further clarified the cultivation goals for innovative research talents. At the same time, we have conducted an in-depth and detailed analysis of the skill structure required by these talents, and used this as a guide to adjust and improve the current talent cultivation mode, establishing an innovative research-oriented cultivation mode that is more suited to the current professional needs [9].

Based on this, we have established and constructed a practical curriculum system that matches the talent cultivation goals, targets various skills, and coordinates with the cultivation mode. For outstanding and innovative students in environmental majors, we have optimized the practical course settings to enhance basic and professional courses, optimize practical training, and reform the cultivation plan with innovative scientific research ability as the core, such as adding practical content for environmental toxicology, carbon neutrality-related courses, and innovative entrepreneurship practical credit courses, increasing the total practical credit proportion from 26.5% to 30.5% [10].

### 3.2. Construction of practical teaching content for environmental majors

A comprehensive curriculum system that includes basic theory, professional skills, and experimental practical training has been constructed, forming a multi-layered experimental practical teaching framework. Through diversified cooperation between colleges, industries, and enterprises, we have continuously improved the practical teaching system. As the core of modern universities, laboratories have adopted a three-pronged experimental practical teaching strategy of "utilizing research to promote experimental teaching, implementing small-class experimental teaching, and jointly cultivating talents with scientific academies and enterprises," establishing an experimental teaching system aimed at "consolidating basic knowledge, strengthening professional experimental teaching, enhancing applied practical ability, and stimulating innovative potential," thereby creating a new practical teaching mode. Relying on the industry-academia-research cooperation platform between colleges and enterprises, we have opened professional skill training, field practice, and production internship courses, such as practical content related to the smart operation of sewage treatment plants, enabling students to conduct on-site practice in frontline operational environments, thereby exercising their practical skills and cultivating their innovative abilities and capabilities to serve society [11].

### 3.3. Improving the chain-like platform support system for innovative cultivation

Research platforms are known as "the source of knowledge innovation and the cradle of talent cultivation," and their high-level construction plays

a crucial role in cultivating innovative talents. By constructing a technological innovation system that runs through "applied basic research, technology research and development, and industrialization," we have created a comprehensive chain-like support network for innovative talents, forming a complementary practical training system composed of laboratories, enterprises, training bases, and research institutes. Currently, the college has two provincial key laboratory platforms and the scientific research platform of the Ecology Institute of the Academy of Sciences, which significantly enhance the abilities of disciplinary research and information assurance. The college also has a virtual simulation experimental teaching center, forming a distinctive practical teaching platform that combines virtual and reality and complements each other. Relying on these strong teaching and research platforms, we have changed the traditional model of experimental teaching that relies on theoretical teaching, constructing a practical teaching system that includes four levels: "basic experiments, comprehensive experiments, innovative experiments, and entrepreneurial outputs"; adhering to the small-class experimental teaching mode, practical operation training enables the cultivation of students' abilities to solve practical problems.

### 3.4. Constructing a rich and diversified cultivation system for innovation and entrepreneurship

The innovative talent cultivation mode requires close collaboration between the first classroom and the second classroom. Fully aligning with the talent cultivation plan, with academic technological innovation activities as the core and the goal of promoting graduates' in-depth learning and innovation and entrepreneurship, we have actively constructed a platform that reflects students' independent practical skills and self-development, creating a distinctive research innovation and practical application cultivation system dedicated to promoting the effectiveness of innovation and entrepreneurship. As a multidisciplinary and intersecting field, the environmental major meets the national major strategic needs and provides an ideal environment for students' innovation and entrepreneurship. In order to break through the bottlenecks of innovation and entrepreneurship, schools and enterprises have jointly established an academic technological innovation incubation fund, eliminated barriers between national innovation experiment plans, social practice projects, and teacher projects, established a resource library for innovation and entrepreneurship projects, and participated in the Industry-Education Integration Summit Forum led by Beijing Enterprises Water Group and the "Internet+" Ecological Environment Innovation and Entrepreneurship Competition hosted by Beijing Enterprises Water Group Cup, providing excellent platforms and development opportunities for talent innovation and output.

### 3.5. Dual-mentor system cultivation model through school-enterprise collaboration

Actively promoting the construction of a "dual-mentor system" (combining mentors from both the school and enterprises) faculty team is crucial for enhancing the practical skills and teaching level of professional teachers, which is key to cultivating students' practical skills. An excellent "dual-mentor system" faculty team has been established, currently comprising 18 senior professional technicians with rich practical experience, who, along with professional teachers, serve as academic mentors for students in Environmental Science (Smart Water Management), providing comprehensive guidance on their academics and innovation and entrepreneurship. This has strengthened practical teaching and innovation education by directly arranging experiments, internships, graduation projects, and other links to internal and external practical teaching bases in enterprises and research institutes, achieving joint guidance and cultivation of students' practical and innovation and entrepreneurship abilities, while also enhancing their practical capabilities and qualities in innovation and entrepreneurship.

### 3.6. Exploring "industry-academia-research" as the foundation to improve multi-level quality evaluation mechanisms for cultivating innovative talents

Evaluation forms an integral part of the teaching process, particularly when exploring the content of practical courses jointly built by school-enterprise collaboration, reforms in teaching methods, as well as new evaluation objectives, standards, methods, and subjects. Through industry-education integration, the core purpose of

innovating practical curriculum design is to enhance students' abilities in innovation, entrepreneurship, and applying innovation in practice. To this end, a quality evaluation system centered on students' innovative output capabilities has been established to strengthen their practical skills and increase their weight in professional courses. Professional application skills will become a necessary component of professional assessments, with minimum requirements set for practical skills and innovative abilities. Therefore, the quality evaluation of innovative practical courses will be jointly developed in terms of standards and content by both school and enterprise parties, who will also jointly participate in the implementation of practical courses. A comprehensive indicator system for evaluating students' practical skills has been formulated.

Primarily, an "industry-academia-research" collaborative quality evaluation system for innovative practical skills has been constructed to promote the complementarity of teaching and practice, jointly enhancing the quality of talent cultivation, and making related research more systematic, scientific, and comprehensive. Strengthening the cultivation of innovative practical skills at the undergraduate education stage can enhance students' research capabilities and awareness.

## 4. Conclusion

This paper took the school-enterprise collaboration major of Environmental Science (Smart Water Management) as a case study, delving into the construction of practical courses based on industry-education integration. As a key exploration in the field of education, industry-education integration aims to improve the quality of talent cultivation through the deep integration of industry and education, meeting the needs of socioeconomic development. Specifically, it involves combining the actual needs of the industry with the education system, jointly designing talent cultivation programs, adjusting curriculum structures, improving practical teaching systems, and achieving a close connection between education and industry. This includes jointly building a curriculum system through school-enterprise collaboration, emphasizing the construction of platforms for the integration of practice and innovation, and improving the chain-like platform support system for innovative cultivation. This research aims to guide and promote universities in making progress in innovative research, talent cultivation, and mechanism construction within the "industry-academia-research collaborative education" system, thereby enhancing the level of talent cultivation, increasing educational efficiency and social influence, and more effectively meeting societal needs.

**Funding**

2023 Qilu University of Technology Key Teaching and Research Project at the School Level: Research and Practice on the Industry-University-Research Collaborative Education Mechanism under the Background of First-Class Environmental Science Program Construction (2023zd13); 2023 Shandong Provincial Department of Education General Teaching and Research Project: Practical Path of Labor Education in Environmental Science and Engineering Majors under the Background of Science-Education Integration (M2023232)

**Disclosure statement**

The authors declare no conflict of interest.

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