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# Innovation and Practice of Collaborative Education Models for Water Engineering Majors under the Background of Digital Transformation

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**Abstract:** ***With the development of the digital economy and the increasing demand for informatization in the water engineering industry, the cultivation of water engineering professionals faces new challenges. This paper analyzes the current development trends in the water engineering industry and the impact of the digital economy on the talent competency structure, proposing a multidisciplinary talent training model centered on university-industry collaboration. By constructing a multidisciplinary curriculum system, strengthening practical teaching, promoting deep collaboration between universities and enterprises, and applying digital technologies, this study explores pathways to cultivate talent that meets the demands of the new era, providing a reference for the reform of higher education in water engineering.***

**Keywords:** Water Engineering, Talent Development, University-Industry Collaboration, Digital Economy.

## 1. Introduction

In recent years, China has implemented a series of policies and guidelines on the reform and development of vocational education, emphasizing the importance of deepening industry-education integration and university-enterprise collaboration to foster high-quality vocational education development. In this context, faculty members in the field of water conservancy and hydropower engineering in higher vocational colleges have been actively exploring talent cultivation pathways under the university-enterprise collaboration model, which is of crucial practical and strategic significance (Ke et al., 2024). Specifically, educators, through in-depth collaboration between schools and enterprises, establish a synergistic educational mechanism that promotes the alignment of curriculum content with industry standards and the integration of teaching processes with real-world production processes (Haikun & Jianmin). Building on university-enterprise cooperation, the optimization of talent development in vocational water conservancy and hydropower engineering programs is one of the pressing issues that educators must solve. This article aims to explore this topic in depth and hopes to offer theoretical guidance and practical experience for educators engaged in research within this field. The government has given high priority to this issue by issuing relevant policies to promote talent cultivation in the digital economy sector, emphasizing the importance of industry-education integration and establishing a “government-university-enterprise” collaborative mechanism to jointly formulate talent development programs, design curricula, and build training bases, enhancing the practical applicability of talent. Higher education institutions and vocational colleges have launched digital economy-related programs and courses, including big data and artificial intelligence, and have explored areas such as training methodologies, curriculum development, and teaching strategies. They have established a multi-layered, integrated curriculum system and actively engaged in interdisciplinary research and teaching activities to improve the digital teaching competencies of their faculty. By organizing students to participate in academic competitions, real-world projects, and similar activities, students acquire digital skills and knowledge through hands-on practice. Students are also encouraged to participate in innovation and entrepreneurship competitions to enhance their creativity. Furthermore, big data and other technologies are utilized to establish digital teaching information platforms, driving the digitization of teaching management and enabling personalized instruction.

At the same time, on a global scale, the digital economy is profoundly changing the traditional industrial landscape, and the water conservancy engineering industry is also accelerating its development toward digitalization and intelligence (Yubo & Yefeng, 2018). This poses higher demands on professionals in water conservancy engineering, who must master traditional engineering techniques while also possessing capabilities in information and digital management. The use of new-generation information technologies such as the Internet of Things, cloud computing, and artificial intelligence to digitally transform and upgrade the traditional water conservancy industry urgently requires the cultivation of high-quality technical talents with innovative spirit, craftsmanship, model worker spirit, and water conservancy spirit, who are equipped with expertise in water conservancy and hydropower engineering management and modern information technology. The integration of university-enterprise cooperation and the digital economy to explore new talent cultivation models is of great significance (Wei et al., 2025). Developed countries emphasize multi-pathways for talent cultivation: for example, developed nations such as the United States train digital talents through higher education, vocational education, online courses, and other methods. Transnational corporations and international organizations actively promote digital skills training and certification to enhance the international competitiveness of talents and adapt to the ever-changing labor demands (Huijuan, 2024). This paper systematically analyzes the key issues in the cultivation of water conservancy engineering talents through literature analysis, case studies, and practical exploration, and proposes innovative solutions.

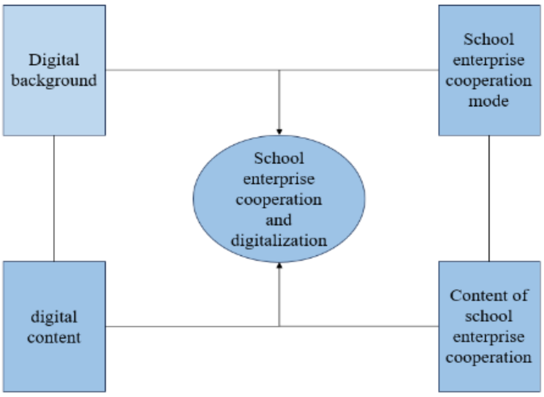


**Figure 1:** School enterprise cooperation under the digital background

## 2. Analysis of the Water Conservancy Engineering Industry and the Background of the Digital Economy

### 2.1 The Impact of the Digital Economy on the Water Conservancy Engineering Industry

With the development of the digital economy, China's water conservancy engineering industry has achieved significant results in the application of digital technologies, enhancing the competitiveness of Chinese water conservancy enterprises in the international market. For example, China's digital twin water conservancy technology can serve as an emerging flagship product for export and standard output, expanding market share internationally. The development of the digital economy has created new business areas for the water conservancy engineering industry, such as water conservancy big data analysis and water conservancy information system integration. This has provided new business growth points for enterprises, with some companies focusing on the research and promotion of digital solutions for water conservancy engineering, offering specialized information technology services for the sector.

### 2.2 Analysis of the Talent Capability Requirements in Water Conservancy Engineering

The use of digital technologies can establish a reasonable organizational model and business processes from the early stage of project demonstration to operation, enabling the effective integration and management of resources at each stage. For example, 3D modeling and simulated construction using BIM technology can identify problems in advance and optimize solutions. By leveraging information technology platforms, all parties involved in construction can form efficient collaborative workflows, improving communication efficiency and cooperation outcomes. This facilitates real-time sharing of engineering data and full-dimensional visualization of the construction process, enabling all parties to track project dynamics and make collaborative decisions. By using technologies such as the Internet of Things (IoT) and sensors, real-time data collection and transmission of water conservancy infrastructure and related environmental data are made possible, enabling real-time monitoring of engineering operational status. For example, monitoring reservoir water levels and dam deformations can provide early warnings in case of abnormalities. Based on big data and artificial intelligence (AI) technologies, large-scale data analysis and mining provide scientific support for scheduling decisions in water conservancy engineering. For example, hydrological data analysis can predict floods, allowing for early development of scheduling plans and the scientific allocation of water resources. The digital economy promotes the deep integration of the water conservancy engineering industry with technologies such as the Internet, big data, and artificial intelligence, giving rise to new technological application models like digital twin water conservancy. These innovations provide new ideas and methods for the planning, design, construction, and management of water conservancy projects. The development of the digital economy has stimulated innovation within the water conservancy engineering sector, prompting enterprises to increase investment in technological research and development, actively exploring new technological application scenarios and business models to improve computational efficiency and precision. Through digital methods, precise monitoring and analysis of the distribution, flow, and utilization of water resources are conducted, enabling refined management of water resources and improving efficiency. For example, smart meters and similar devices allow for real-time data collection and analysis of water usage, providing a basis for formulating water-saving measures. Digital technologies are used to monitor and assess the surrounding water environment of water conservancy engineering projects, promptly identifying issues such as water pollution and taking corrective actions. For instance, satellite remote sensing technology can monitor changes in water area and water quality, providing decision-making support for water environment protection.

### 2.3 Major Issues

The digital economy is developing rapidly, with new technologies, concepts, and business models continuously emerging, but the course content has not been updated in a timely manner. The textbook content is outdated and cannot reflect the latest industry trends and technological advancements, leading to a disconnect between the knowledge students acquire and its practical application. For example, cutting-edge technologies such as artificial intelligence, big data, and blockchain are not sufficiently reflected in the textbooks, resulting in students' inadequate understanding and application of these fields. The course design lacks systematization and forward-thinking, failing to adequately consider the demands of digital economy development. Some courses lack connection and integration, leading to repetition or gaps in content. At the same time, the course structure is unreasonable, with an imbalance between theory and practice, and weak practical teaching components. For example, some universities' digital economy programs focus too much on the transmission of theoretical knowledge and lack practical teaching components, making it difficult for students to apply what they have learned to real-world projects. Traditional teaching methods are teacher-centered, focusing on the transmission and memorization of knowledge, neglecting the students' role as the main agents of learning and the development of their innovative abilities. The teaching process lacks interactivity and inspiration, with students passively receiving knowledge, making it difficult to cultivate their ability for independent learning and problem-solving.

## 3. Talent Development Model Driven by Digital Economy Under School-Enterprise Cooperation

### 3.1 Course Design

The school offers basic courses in hydraulic engineering, such as Principles of Hydraulic Engineering, Hydraulics, and Engineering Mechanics, while also incorporating courses related to the digital economy, such as Big Data Analytics, Internet of Things (IoT) Technology, and Digital Management. For example, in hydraulic engineering courses, big data analytics are used to study the patterns of water flow and water quality changes, enabling students to master the application of digital technologies in hydraulic engineering. Breaking disciplinary boundaries, integrating knowledge from fields such as computer science, information technology, and geographic information science. For example, integrating Geographic Information Systems (GIS) with hydraulic engineering for planning, design, and management of water projects, thereby developing students' interdisciplinary application abilities. Numerous practical courses are provided, such as company internships and project-based learning activities. The school collaborates with enterprises to develop practical projects, such as digital simulations of hydraulic engineering and the application of smart monitoring systems, allowing students to enhance their problem-solving skills through practical experience.

### 3.2 Teaching Methods

Teachers use real-world projects as a medium to guide students in applying their knowledge to solve problems. For instance, in hydraulic engineering construction projects, students participate in project design, construction, and monitoring, thereby enhancing their practical skills and innovative thinking. Industry experts serve as mentors, providing students with professional guidance and sharing industry experiences. Mentors can hold regular lectures and workshops, introducing the latest trends and technological applications in the hydraulic engineering industry, helping students understand the operational processes of enterprises. Online teaching is conducted through platforms such as virtual learning environments and laboratories, in combination with offline activities, such as on-site corporate visits and hands-on operations. For instance, students acquire knowledge related to hydraulic engineering through online platforms, followed by practical operations at companies to enhance their comprehension and application of the material. Enterprises provide internship positions, allowing students to learn and practice in a real working environment. Internship bases are equipped with professional mentors who guide students in completing internship tasks, allowing students to understand the production operations and management models of enterprises. The school collaborates with enterprises to carry out industry-university-research projects, jointly conducting technology research and innovation. Students participate in project research, improving their innovative capabilities and research skills through practice. For example, enterprises and schools jointly conduct research on intelligent monitoring technologies for hydraulic engineering, with students participating in the project and providing technical support to enterprises. A diversified evaluation system is established, including students' academic performance, practical abilities, innovative capacity, and teamwork skills. The evaluators include school teachers, enterprise mentors, and company managers.

## 4. Case Study and Experience Summary

### 4.1 Collaboration Content

Enterprises and universities jointly develop the "Digital Hydraulic Technology" course, integrating digital technologies into the hydraulic engineering curriculum. The course content covers big data analysis, Internet of Things (IoT) technologies, and the application of artificial intelligence in hydraulic engineering. Industry experts participate in course design and teaching, sharing real-world cases and industry experience. Enterprises provide internship opportunities and establish internship bases. During the internship, students participate in the enterprise's hydraulic projects, such as the development and maintenance of digital monitoring systems for hydraulic engineering and the operation and management of intelligent water conservancy facilities. School teachers and enterprise mentors jointly guide students' practice, ensuring that students can integrate theoretical knowledge with practical application. Both parties collaborate on research projects, studying issues related to the application of digital technologies in the field of hydraulic engineering. The enterprise provides research equipment and financial support, while university faculty and students participate in the project research. For example, research on how to use big data technologies to improve the operational efficiency and management level of hydraulic engineering. The enterprise provides career development guidance for students, helping them understand industry trends and career paths. At the same time, the enterprise participates in guiding students' graduation projects and theses, enhancing their practical and innovative capabilities.

### 4.2 Implementation Process

The school selects hydraulic engineering students and determines the list of students participating in the collaboration through interviews and assessments. The enterprise screens students to ensure they have a certain level of digital technology foundation and learning ability. The course adopts a combination of theory and practice, with enterprise mentors responsible for practical teaching, and students performing practical operations at the company's internship base. School teachers conduct theoretical teaching and assist enterprise mentors in guiding students. Students participate in real enterprise projects, such as the development and application of digital monitoring systems for hydraulic engineering and the operation management of intelligent water conservancy facilities. During the project practice, students apply the knowledge they have learned to solve practical problems, improving their practical abilities. During their internships, students achieve a series of results, including project reports, academic papers, and technical solutions. The school organizes result exhibitions and exchange activities, showcasing students' practical achievements and innovative capabilities.

### 4.3 Results and Impact

By participating in the school-enterprise collaboration projects, students improved their ability to apply digital technologies and their practical skills. Some students participated in company projects during their internships and obtained relevant patents and awards. The enterprise highly evaluates the students' practical abilities and professional qualities, believing that the students can quickly adapt to the work environment and contribute to the company's development. The enterprise has established a long-term partnership with the school, providing students with more employment opportunities and development space. The talent cultivated through school-enterprise cooperation meets the local hydraulic industry's demand for digital technology professionals and enhances the school's social reputation. At the same time, this cooperation model provides a reference for other universities and promotes the development of talent cultivation in digital economy and hydraulic engineering disciplines.

## 5. Conclusion and Prospects

The digital economy era presents new requirements for water conservancy talent, with school-enterprise cooperation closely aligned with industry needs to cultivate talent capable of integrating digital technology and water conservancy expertise. Through cooperation, students can better master the application of digital technologies in hydraulic engineering, meeting the actual demands of enterprises for talent. Schools and enterprises form complementary advantages in the talent cultivation process. The school provides theoretical knowledge and basic research, while the enterprise offers practical platforms and real project experience. Both parties jointly participate in course design, teaching practices, and talent cultivation program development, improving the quality of talent cultivation. For example, enterprise engineers participate in teaching, bringing real-world cases and the latest industry technologies to help students understand the application of theoretical knowledge in practical work. School-enterprise cooperation allows students to accumulate rich experience in practice, enhancing their ability to solve real-world problems. By participating in enterprise projects, students can apply the knowledge they have learned to real-world work, thereby enhancing their employment competitiveness. For example, students participate in the development and maintenance of digital monitoring systems for hydraulic engineering, improving their ability to apply digital technologies. School-enterprise cooperation continuously explores innovative models, such as industry-university-research collaborations, joint laboratory construction, and enterprise internship bases. These models provide students with more practical opportunities and promote the conversion of knowledge and technology. Future research should further strengthen school-enterprise cooperation, expand the scope of collaboration, and extend the cooperation to more areas. Establish a more complete talent cultivation mechanism, focusing on cultivating students' innovative thinking and practical abilities. Encourage students to participate in enterprise projects and scientific research activities to enhance their independent innovation capabilities. For example, conduct interdisciplinary and cross-professional practical teaching activities to cultivate students' overall literacy. Through school-enterprise cooperation, promote the upgrading of the hydraulic industry and improve the competitiveness of enterprises. Strengthen research on the application of digital technologies in hydraulic engineering to promote technological innovation and result transformation. For example, promote the digitalization and intelligence construction of hydraulic engineering to improve the management level and operational efficiency of hydraulic projects.

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