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Interdisciplinary Talent Training for Water Conservancy Engineering Masters under New Engineering

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Abstract: To satisfy the demands of major national strategic projects including digital twin river basins and national water networks, and address the prominent dilemmas in traditional postgraduate education of water conservancy engineering, such as ambiguous training objectives, fragmented curriculum systems, single practical platforms, limited evaluation mechanisms, and inflexible faculty structures, this paper proposes a five-in-one interdisciplinary integrated training model covering training objectives, curriculum system, practice platform, assessment mechanism, and teaching staff. By orienting to industrial needs to refine interdisciplinary training goals, rebuilding modular cross-curriculum systems, constructing diversified practical platforms, establishing multi-dimensional evaluation systems, and forming cross-field collaborative supervisor teams, the model aims to transform talent cultivation from single-discipline technical professionals to "water conservancy + X" interdisciplinary compound talents. It provides a feasible path for the educational reform of master students majoring in water conservancy engineering under the new engineering background, and supports the digital transformation of the water conservancy sector and the guarantee of national water security.

Keywords: Water Conservancy Engineering; New Engineering; Interdisciplinary Integration; Talent Training Model

1. Introduction

With the growing shortage of global water resources and increasing ecological pressure, China has launched a series of major strategic projects including digital twin river basins and national water networks, which serve as key pillars for safeguarding national water security, advancing ecological civilization, and achieving high-quality development of the water conservancy industry [1]. Driven by national policies, the water conservancy field is accelerating digital and intelligent transformation, raising unprecedented requirements for professionals capable of integrating water conservancy engineering with information technology, economic management, ecological protection, and other disciplines.

The Ministry of Education has issued policies including Opinions on Deeply Promoting the Classified Development of Academic and Professional Degree Postgraduate Education and the Special Program for Engineering Talent Training Reform, which clearly require new engineering construction to break disciplinary boundaries, strengthen interdisciplinary integration, and focus on cultivating interdisciplinary and innovative engineering talents. Relevant national degree authorities have added interdisciplinary research directions under the first-level discipline of water conservancy engineering, further indicating that interdisciplinary talent training has become an inevitable trend in the reform and development of postgraduate education for water conservancy engineering [2].

As the core force supporting the construction and technological innovation of major water conservancy projects, postgraduate students majoring in water conservancy engineering are expected to master not only traditional professional theories and technologies but also interdisciplinary knowledge and comprehensive capabilities to solve complex engineering problems. Nevertheless, the traditional training mode for water conservancy engineering postgraduates is plagued by problems such as single disciplinary orientation, rigid curriculum arrangement, insufficient practical training, and backward evaluation methods, leading to an increasingly acute contradiction between “specialized but not integrated” talent supply and the industry’s demand for compound talents. Graduates generally lack the ability to apply new-generation information technologies such as big data, artificial intelligence, and cloud computing to deal with practical engineering tasks including multi-source data fusion, digital twin modeling, and intelligent scheduling decision-making, making it difficult for them to adapt to the development of smart water conservancy and digital transformation [3].

At present, many universities and research institutions in China have begun to explore interdisciplinary talent training for engineering postgraduates. However, most existing studies only focus on single links such as curriculum adjustment or practical platform construction, and lack a systematic and integrated training model that runs through training objectives, curriculum systems, practice platforms, evaluation mechanisms, and teaching staff [4]. Therefore, guided by the demands of the water conservancy industry under the background of new engineering, this paper constructs a five-in-one interdisciplinary integration talent training model for professional master students of water conservancy engineering in view of the pain points of the traditional training mode. This study is expected to provide a feasible reference for the reform of postgraduate talent training in water conservancy engineering, help cultivate high-quality compound talents with interdisciplinary literacy and engineering innovation capabilities, and provide strong talent support for the construction of digital twin river basins, national water networks, and the high-quality development of the water conservancy industry.

2. Pain Points of Traditional Cultivation

2.1 The Training Objectives are Ambiguous and Disconnected from Industry Demands

At present, most colleges and universities still follow the logic of academic postgraduate training when setting training objectives for master students of water conservancy engineering. They emphasize the profound mastery of traditional disciplinary theories such as hydraulics, hydraulic structures, and water resources, but lack systematic research and dynamic response to the real demands of the industry for compound capabilities under the background of new engineering. Major projects such as national water networks, digital twin river basins, and smart water conservancy require technicians to be familiar with water conservancy business, proficient in new-generation information technologies including big data, artificial intelligence, and cloud computing for system modeling, risk decision-making, and resource optimization, as well as capable of project management, water economic analysis, and cross-departmental collaboration. However, existing training programs attach insufficient importance to the cultivation of interdisciplinary abilities, resulting in graduates being incompetent in tasks such as multi-source heterogeneous data integration, digital twin scene construction, and water rights trading mechanism design due to their single knowledge structure and competency map. In the era of digital water conservancy, such a single knowledge structure can no longer support the efficient solution of complex engineering problems involving multi-field collaboration. The traditional expression of training objectives is mostly at a macro level, lacking measurable and achievable detailed indicators, and is difficult to effectively connect with industrial vocational qualification standards and major engineering technical specifications, eventually leading to a structural mismatch between talent training and industrial demands. This mismatch has become a key bottleneck restricting the high-quality development of water conservancy postgraduate education.

2.2 The Curriculum System is Fragmented and the Intersections are Merely Formalistic

The curriculum system of traditional water conservancy engineering postgraduate education has long adopted a three-stage structure: public basic courses, professional compulsory courses, and professional elective courses, lacking horizontal correlation and vertical integration among modules, with problems of repeated content, poor connection, and low integration. Interdisciplinary courses are mostly offered as additional electives, completely separated from core professional courses such as hydraulic mechanics, hydraulic structures, river dynamics, and hydrological forecasting in teaching content, schedule, and practical links. Students can only learn fragmented knowledge of water conservancy, computer science, economics, and management in different semesters, and cannot experience the complete process of multi-disciplinary knowledge collaboration to solve complex engineering problems in a unified teaching scenario.

Meanwhile, the syllabus of each course is formulated independently without the guidance of a unified knowledge graph and competency framework. Interdisciplinary courses are often simplified into general lectures with insufficient theoretical depth and scarce engineering cases, which can hardly support high-level application scenarios such as water conservancy monitoring data cleaning, flood forecasting model coupling, water ecological restoration scheme optimization, and water rights trading algorithm design [5]. Interdisciplinary integration remains superficial. Even if students complete the required credits, it is difficult for them to form a systematic competency system oriented to new business forms such as digital twin river basins, smart water networks, and intelligent scheduling, resulting in an obvious fault between knowledge and capabilities.

2.3 The Practical Platform is Single and there is a Lack of Real Scenarios

The practical teaching of traditional water conservancy engineering postgraduates has long relied on scaled-down water tanks, centrifugal pumps, and pipeline circulation devices in the on-campus hydraulics laboratory. Experimental tasks are limited to confirmatory measurement and data fitting, lacking training in the complete chain of data perception–model driving–decision feedback required by new business forms such as digital twin river basins and intelligent scheduling platforms [6]. Off-campus practice is mostly limited to observational visits to dams, pump stations, or water quality monitoring stations, preventing students from deeply participating in real-time data collection, online model calibration, and multi-departmental collaborative consultations. As a result, practical links are disconnected from industrial pain points, and students are rarely exposed to real scenarios of major projects such as national water networks and the four-prevention flood control system. Consequently, graduates often feel helpless when facing tasks such as air-space-ground integrated data fusion, multi-source heterogeneous model coupling, and dynamic risk decision-making due to the lack of experience in high-complexity scenarios.

2.4 The Evaluation Dimensions are Single and the Innovation Orientation is Insufficient

The current evaluation system for water conservancy engineering postgraduates still centers on academic achievements, with weight highly concentrated on indicators such as the number of published papers, journal impact factors, and patent applications. It lacks operable and quantifiable evaluation tools for key qualities including interdisciplinary knowledge integration ability, complex engineering system thinking, teamwork capability, innovative design ability, engineering ethics, and professional literacy. Process assessment mostly adopts traditional forms such as closed-book examinations, experimental reports, and course papers, focusing on knowledge memorization and standard answer reproduction, which hardly stimulates students' creativity in putting forward new ideas, constructing new models, and designing new schemes for real water conservancy problems. Under such an evaluation system, students are often encouraged to pursue short-term academic outputs rather than improve practical engineering capabilities.

The weak correlation between assessment results and job competency drives students to choose theoretical research directions with short cycles and easy outputs, rather than devoting energy to high-difficulty topics requiring long-term iteration, cross-border collaboration, and engineering verification, such as digital twin river basin construction, water rights trading mechanism design, and intelligent scheduling platform development. This phenomenon further widens the gap between campus training and actual engineering needs. The innovation-driven and competency-oriented training concept fails to take root, and the evaluation system cannot effectively guide students in knowledge integration and engineering innovation, making it difficult to support the cultivation of compound innovative talents.

3. Cross-Integration Mode Design

3.1 Anchor Industry Demands and Clarify the Goals of Cross-Disciplinary Training

Guided by the demands of major projects such as digital twin river basins and national water networks, an interdisciplinary training objective system is established to ensure that objectives are measurable, achievable, and implementable. In the knowledge dimension, students are required to solidify the core theories of water conservancy engineering and systematically master interdisciplinary knowledge including big data processing, artificial intelligence modeling, water economic analysis, and ecological protection, forming a “water conservancy + X” compound knowledge structure [7]. In the capability dimension, the model focuses on core competencies such as digital twin scene construction, multi-source heterogeneous data fusion, cross-departmental collaborative decision-making, and innovative solutions to complex engineering problems, with quantitative indicators including participation in one interdisciplinary research project and mastery of more than two cross-field professional software tools. In the literacy dimension, it strengthens engineering patriotism, data ethics awareness, and interdisciplinary collaboration quality, aligning with vocational qualification standards and major engineering technical specifications in the water conservancy industry to achieve an accurate match between talent training and job competency [8].

3.2 Break down Disciplinary Barriers and Build a Modular and Interdisciplinary Curriculum System

Core integrated compulsory courses including Introduction to Interdisciplinary Studies of Water Conservancy Engineering and Fundamentals of Digital Twin River Basins are offered to build a general knowledge bridge between water conservancy and information technology, economic management, and ecological environment, helping students establish an interdisciplinary thinking framework. Four modular elective course groups are set up: “water conservancy + information technology”, “water conservancy + economic management”, “water conservancy + ecological environment”, and “water conservancy + surveying, mapping and remote sensing”, covering characteristic courses such as Water Conservancy Big Data Mining, Water Rights Trading Mechanism, River Basin Ecological Restoration Engineering, and Air-Space-Ground Integrated Water Conservancy Monitoring, which students can select independently according to their research directions. Project-driven courses such as Interdisciplinary Practice of Complex Water Conservancy Projects and Comprehensive Design of Digital Twin River Basins are added. Taking real engineering problems as the carrier, students are required to form interdisciplinary teams to complete the whole-process training from data collection and model construction to decision-making scheme output, realizing the seamless connection between knowledge learning and engineering practice.

3.3 Integrate Internal and External Resources and Build a Diversified Practice Platform

On campus, a digital twin river basin simulation laboratory and a water conservancy big data analysis center are constructed, equipped with hydrological and water quality monitoring simulation systems, intelligent decision-making platforms for river basin scheduling, and other equipment to carry out virtual simulation experiments for complex scenario training such as air-space-ground integrated data fusion and flood forecasting and early warning. Off-campus joint training bases are built together with river basin management agencies, water conservancy engineering enterprises, and research institutes, and "on-site workstations for major projects" are set up to enable students to deeply participate in real projects including digital twin river basin construction, water rights trading pilots, and cross-regional water resource scheduling, and engage in core links such as data collection, model calibration, and collaborative consultations [9]. Interdisciplinary research teams are formed in cooperation with information technology enterprises and ecological and environmental protection institutions, and “special projects for water conservancy interdisciplinary innovation” are established to encourage students to participate in industry-university-research cooperation projects, transforming real enterprise data, engineering constraints, and industrial pain points into research topics to enhance innovative practical abilities [10].

3.4 Innovate the Evaluation Mechanism and

Establish a Multi-Dimensional Assessment System

The "paper-oriented" evaluation orientation is abandoned, and a multi-dimensional dynamic evaluation system covering knowledge, capabilities, and literacy is constructed to strengthen process assessment and interdisciplinary competency evaluation. In terms of assessment content, in addition to academic achievements, interdisciplinary course scores, practical project performance, teamwork contribution, and professional software proficiency are included, with interdisciplinary practice and innovation achievements accounting for no less than 40%. The assessment adopts a combined method of "closed-book examination + project defense + achievement presentation + enterprise evaluation". Process assessment runs through the entire training process, focusing on evaluating students' knowledge integration ability and innovative thinking through course case analysis, interdisciplinary project reports, on-site practical assessment, and other forms. A joint evaluation team composed of "on-campus supervisors + industry experts + enterprise mentors" is formed to conduct comprehensive evaluation from multiple perspectives such as academic level, practical ability, and job adaptability, ensuring objective and comprehensive evaluation results.This multi-agent evaluation mechanism can better reflect the actual ability level of students and their adaptability to future jobs.

4. Conclusion

Against the background of new engineering, the advancement of major projects such as digital twin river basins and national water networks and the digital transformation of the water conservancy industry have put forward higher requirements for the interdisciplinary integration ability and complex problem-solving ability of master students majoring in water conservancy engineering. The dilemmas existing in the traditional training mode, including ambiguous training objectives, fragmented curriculum systems, single practical platforms, limited evaluation dimensions, and inflexible faculty structures, have led to a structural mismatch between talent training and industrial demands, which can hardly meet the industry's urgent need for compound innovative talents. These problems not only restrict the improvement of postgraduate training quality in water conservancy engineering, but also affect the supporting role of higher education in national water security strategy and industrial intelligent upgrading.

To solve these problems, this paper constructs a five-in-one interdisciplinary integration training model of objectives–curriculum–platform–evaluation–teaching staff. By orienting to industrial demands to clarify interdisciplinary training objectives, breaking disciplinary barriers to rebuild modular curriculum systems, integrating internal and external resources to build diversified practical platforms, innovating evaluation mechanisms to establish multi-dimensional assessment systems, and optimizing faculty structure to form cross-border collaborative supervisor teams, the model effectively breaks through the dilemmas of traditional training and realizes the transformation from single-discipline technical professionals to "water conservancy + X" compound talents. The model highlights the orientation of industry demand, emphasizes the integration of production and education, and highlights the training of practical innovation ability, which is highly compatible with the development law of professional degree postgraduate education under the background of new engineering.

This exploration can provide a feasible and replicable path for water conservancy engineering postgraduate education to adapt to industrial development and serve national strategies. It helps universities further optimize the training system of water conservancy professionals, improve the matching degree between graduates and job requirements, and enhance the core competitiveness of students in digital and intelligent transformation of the water conservancy industry. In the long run, the promotion of this model will continuously deliver more high-quality compound talents with interdisciplinary thinking, engineering practice ability and innovation consciousness for the construction of digital twin river basins, the construction of national water networks and the high-quality development of water conservancy, so as to provide solid talent support and intellectual guarantee for national water security.

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