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Research on the Training Paths for Interdisciplinary Innovative and Applied Talent in Water-Environment-Geology

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Abstract: The construction of ecological civilization is a major national strategy for the new era. The development philosophy of "lucid waters and lush mountains are invaluable assets" has taken deep root among the people. Water security guarantee, environmental pollution control, geological disaster prevention and control, as well as water and soil resources protection constitute the core tasks of ecological civilization construction. The advancement of these tasks relies on the in-depth integration and coordinated efforts of water, environment and geology disciplines. Against this background, an in-depth exploration into the training paths for interdisciplinary innovative and applied talents in the fields of water, environment, and geology can not only improve the talent training quality of universities, but also provide solid talent support for China's ecological civilization construction and resource and environment governance, which possesses important practical significance and application value. This paper first elaborates the core value of cultivating interdisciplinary innovative and applied talents majoring in water, environment, and geology, and then puts forward a set of effective training paths, aiming to offer references for relevant researchers.

Keywords: Water-Environment-Geology; Interdisciplinary discipline; Innovative and applied talents; Talent training

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1. Core value of cultivating interdisciplinary innovative and applied talents in water-environment-geology

1.1. Complying with national strategic needs and boosting ecological civilization construction

In the process of promoting China's ecological civilization and green development strategies, there is an urgent demand for a large number of interdisciplinary talents capable of solving complex resource and environmental problems [1]. National strategies including ecological protection and high-quality development of the Yellow River Basin, comprehensive protection of the Yangtze River, and coordinated development of the Beijing-Tianjin-Hebei region all cover key tasks such as water resource allocation, water

pollution treatment, geological environment restoration, and geological disaster prevention and control [2]. The implementation of these tasks requires the in-depth integration of water, environment and geology disciplines. The ecological protection of the Yellow River Basin needs to combine expertise and skills in hydraulic engineering, environmental engineering, geography and other fields to build a comprehensive and systematic ecological protection system. By cultivating interdisciplinary talents of water, environment and geology, universities can deliver strong talent support for the implementation of national strategies, break the bottlenecks restricting resources and the environment, and drive the high-quality development of ecological civilization construction. For example, relying on the national strategy for the Yellow River, relevant universities have established an interdisciplinary talent training system for water, environment and geology, and cultivated a large number of interdisciplinary talents for the ecological protection of the Yellow River Basin, setting a precedent for interdisciplinary talent training in river basins [3].

1.2. Promoting interdisciplinary integration and advancing high-quality discipline development

The integration of water, environment, and geology is an inevitable trend of disciplinary development, and also an important approach to tackle complex resource and environmental problems [4]. The traditional single-discipline training model has led to rigid disciplinary barriers and fragmented knowledge systems, hindering disciplinary innovation and development. In the training of interdisciplinary innovative and applied talents in water, environment and geology, disciplinary barriers are broken down to realize the integration of courses, teachers and scientific research among hydraulic engineering, environmental engineering, geography and other disciplines, so as to achieve collaborative innovation across fields. For instance, the integration of water resource circulation theories, pollution control technologies and geological environment evolution laws can drive theoretical innovation and technological breakthroughs in related disciplines, and effectively enhance core disciplinary competitiveness to facilitate high-quality disciplinary development [5]. Meanwhile, the cultivation of interdisciplinary applied talents can boost the optimization and upgrading of disciplinary construction in universities, help form characteristic and advantageous disciplinary groups, and elevate the overall strength and influence of institutions of higher learning.

1.3. Enhancing the cultivation of innovative competencies and fostering talents for the new era

Innovation is the primary driving force for development [6]. For the fields of water, environment and geology, solving complex resource and environmental problems and promoting technological upgrading all rely on innovative capabilities. The training of interdisciplinary innovative and applied talents in water, environment and geology takes the cultivation of innovative ability as the fundamental goal. Through interdisciplinary knowledge integration, strengthened practical teaching and innovation-driven projects, students are guided to break the shackles of traditional thinking and cultivate innovative thinking, awareness and capabilities. With interdisciplinary innovative design, scientific research projects and industrial practice as carriers, students are trained to solve practical problems by applying multidisciplinary knowledge. Encouraging students to participate in events such as the National College Students Hydraulic Innovation Design Competition and the College Students' Innovation and Entrepreneurship Competition can significantly improve their innovative abilities, cultivate more high-caliber interdisciplinary innovative talents, and accelerate the progress of building an innovation-oriented country.

2. Dilemmas in cultivating interdisciplinary innovative and applied talents in water-environment-geology

2.1. Prominent disciplinary barriers and imperfect interdisciplinary integration mechanisms

On the one hand, there is a lack of regular communication and collaboration mechanisms between different departments and universities [7]. Teaching and research resources cannot be shared, resulting in fragmented knowledge systems of water, environment, and geology. Students are unable to systematically master core knowledge of multiple disciplines. Universities generally set faculties and departments based on disciplinary categories. Such organizational structures fail to adapt to the research and talent training demands of earth system science. Different departments adopt inconsistent data quality standards, and differences in disciplinary cultures also undermine cooperation efficiency. On the other hand, the number of interdisciplinary courses is insufficient. The curriculum system is still dominated by single-discipline courses, lacking interdisciplinary and comprehensive courses that integrate knowledge of water, environment, and geology. Consequently, students possess relatively unitary knowledge structures and find it difficult to form interdisciplinary thinking. In addition, the interdisciplinary teaching team is inadequate. Most teachers only engage in teaching and research within their own majors, lacking interdisciplinary knowledge reserves and teaching competencies, and are unable to carry out interdisciplinary teaching and guidance [8]. Universities need to build teaching teams integrating hydraulic engineering, environmental engineering, and geography to alleviate this problem and comprehensively improve the quality of interdisciplinary talent training in water, environment, and geology.

2.2. Rigid training modes and inadequate cultivation of innovative abilities

First of all, theoretical teaching still mainly adopts classroom lecturing with monotonous teaching methods, which lack interactivity and inquiry-based learning [9]. Students passively receive knowledge, making it hard to cultivate their interdisciplinary thinking and innovative awareness. Some universities prioritize theoretical knowledge over practical training, and emphasize academic mastery rather than competency development, neglecting the cultivation of students' innovative abilities and comprehensive qualities. Secondly, the talent training system is incomplete. There is a shortage of targeted innovative courses, practical activities, and innovation platforms, which dampens students' enthusiasm for participating in innovation activities. Innovation education in most universities remains superficial, failing to integrate the cultivation of innovative abilities into the whole process of talent training. As a result, students lack the capability to apply multidisciplinary knowledge to solve practical problems in innovative ways. Furthermore, talent evaluation still focuses on theoretical scores and course examinations, with insufficient assessment of students' practical abilities, innovative competencies, and interdisciplinary literacy [10]. Such evaluation methods cannot guide students to focus on improving their innovative capabilities and also reduce the objectivity and comprehensiveness of evaluation results.

3. Optimization paths for cultivating interdisciplinary innovative and applied talents in water-environment-geology

3.1. Establishing interdisciplinary education concepts and breaking disciplinary barriers

Concepts serve as the forerunner of actions. To cultivate interdisciplinary innovative and applied talents in water, environment, and geology, universities must first establish interdisciplinary education concepts and

abandon the traditional single-discipline training mode to promote in-depth disciplinary integration.

First, universities shall update educational philosophies, set training objectives featuring interdisciplinary integration, innovation orientation and practical empowerment, and take interdisciplinary talent training as an important part of the overall development plan. Guided by national strategic demands, universities shall coordinate the integrated development of hydraulic engineering, environmental engineering, geography and other disciplines, clarify the orientation of interdisciplinary education, and form distinctive training characteristics for water-environment-geology interdisciplinary talents.

Second, break down barriers between faculties and departments, and build a collaborative interdisciplinary education mechanism. Set up a leading group for interdisciplinary education to coordinate teaching, research, and talent training across departments, and promote communication and resource sharing. Establish interdisciplinary teaching and research teams to carry out teaching discussions and research projects, and drive the integration and innovation of multidisciplinary knowledge.

Third, foster an interdisciplinary cultural atmosphere. Create an educational environment that values interdisciplinary learning, innovation and practice, and help teachers and students develop interdisciplinary thinking. Universities should encourage teachers to step out of their original research fields, explore interdisciplinary issues among hydraulic engineering, environmental engineering, and geography, and integrate interdisciplinary perspectives into teaching and research. In this way, students can break the constraints of single-discipline thinking, analyze and solve complex practical problems from multiple perspectives, and fundamentally eliminate the negative impact of inherent disciplinary thinking on interdisciplinary education.

3.2. Optimizing the curriculum system and building interdisciplinary course modules

The curriculum system is the core carrier of talent training. Optimizing the curriculum system is a key approach to cultivating applied talents with integrated knowledge of water, environment, and geology. In accordance with interdisciplinary education concepts and industrial demands, a four-tier curriculum system consisting of basic modules, core modules, interdisciplinary modules and innovation modules is constructed to realize the organic combination of multidisciplinary knowledge.

(1) Basic Module: Offer fundamental courses of hydraulic engineering, environmental engineering, geography, and other disciplines, such as Principles of Hydrology, Environmental Chemistry, and Fundamentals of Geology, enabling students to master basic theories and lay a solid foundation for interdisciplinary learning.

(2) Core Module: Set professional core courses based on the characteristics of each major, including Water Resources Planning and Management, Water Pollution Control Engineering, Geological Hazard Assessment and Treatment, so as to strengthen students' professional core competencies.

(3) Interdisciplinary Module: Develop interdisciplinary and comprehensive courses such as Collaborative Governance of Water, Environment and Geology, Water and Soil Resources & Ecological Restoration, Geological Environment, and Water Pollution Prevention and Control. Add cutting-edge interdisciplinary courses in response to industrial trends to enrich the curriculum system and cultivate students' interdisciplinary thinking and comprehensive problem-solving abilities.

(4) Innovation Module: Offer courses related to innovative thinking, research methods and academic paper writing, as well as interdisciplinary innovative design and entrepreneurship guidance courses to systematically cultivate students' innovative awareness and capabilities.

Meanwhile, universities shall update course content in a timely manner, incorporate the latest industrial

technologies, policies and practical cases into teaching, and keep the curriculum aligned with actual industrial demands.

3.3. Strengthening practical teaching and building a three-in-one practical training system

Practical teaching is a vital link for cultivating innovative and applied talents. Guided by industrial requirements, universities shall build a three-in-one practical training system combining on-campus training, off-campus practice and innovative projects to enhance students' practical and innovative capabilities.

First, increase investment in on-campus training bases. Build comprehensive training centers integrating water, environment and geology, and equip them with advanced training equipment and simulation platforms, including water resource simulation platforms, pollution control training platforms and geological hazard simulation platforms. Carry out comprehensive, verification, and innovative training activities to improve students' hands-on abilities. Virtual simulation training resources can be developed based on existing facilities to restore real working scenarios in a 1:1 ratio. Adopt the hybrid teaching mode of online preview, offline operation, and virtual expansion to make up for the shortage of training venues and equipment.

Second, expand off-campus practice bases. Establish long-term cooperative relations with environmental protection enterprises, research institutes, and relevant government departments to build joint practice bases. Organize on-the-job internships and project-based practice, allowing students to participate in real industrial projects and improve their practical abilities and post adaptability. Diversify practice platforms to fully meet students' practical training needs.

Third, intensify the cultivation of innovative projects. Launch interdisciplinary innovative projects and college students' innovation and entrepreneurship training programs to train students' team-building capabilities. Take practical problems such as water resource utilization, pollution control, and geological disaster prevention as research topics to mobilize students' enthusiasm for innovation. Supported by scientific and technological competitions such as the National College Students Hydraulic Innovation Design Competition, Environmental Engineering Design Competition and Geological Skills Competition, implement the strategy of promoting learning and innovation through competitions to improve students' comprehensive quality and innovative capabilities.

3.4. Improving the collaborative education mechanism and forming joint educational forces

The cultivation of interdisciplinary innovative and applied talents in water, environment and geology requires the joint efforts of universities, enterprises, research institutes and government departments. A collaborative education mechanism shall be established, featuring university leadership, enterprise participation, research institute support and government guidance to form joint educational forces.

(1) University-enterprise collaboration: Cooperate with leading enterprises in the industry to build industrial colleges and joint training bases. Co-formulate talent training schemes, develop courses, and carry out teaching and practical activities. Arrange enterprise technical experts to serve as part-time teachers, and organize university teachers to take temporary posts in enterprises, so as to realize the in-depth integration of teaching and industrial practice.

(2) Inter-university collaboration: Carry out cross-institutional cooperation with universities offering relevant majors in water, environment, and geology. Jointly develop interdisciplinary courses, share training resources, and implement joint training to improve talent quality and realize complementary

advantages and resource sharing.

(3) University-local government collaboration: Establish cooperative relations with local government departments. Organize students to participate in local resource and environment governance projects, so as to enhance their practical abilities and sense of responsibility while serving local development.

(4) Cooperation with research institutes: Build joint research platforms and carry out interdisciplinary research projects. Transform research achievements into teaching resources, and encourage students to participate in scientific research to improve their innovative capabilities and realize the coordinated development of scientific research and teaching.

3.5. Building a high-quality teaching team and improving interdisciplinary teaching competencies

Teachers are the fundamental guarantee for interdisciplinary talent training. It is essential to strengthen the construction of the teaching team and improve teachers' interdisciplinary literacy and teaching abilities.

First, organize regular interdisciplinary training, seminars, and exchange activities for teachers. Invite industrial experts and interdisciplinary scholars to deliver lectures, enrich teachers' knowledge reserves, and introduce high-level talents to build innovative teaching and research teams with creativity and practical capabilities.

Second, build interdisciplinary teaching and research platforms to promote the establishment of interdisciplinary teaching and research teams. Facilitate exchanges on teaching experience and research cooperation to enhance teachers' interdisciplinary teaching and research capabilities.

Third, optimize the teacher recruitment and incentive system. Introduce high-level talents and industrial technical experts with interdisciplinary backgrounds to enrich the teaching team. Improve incentive policies to mobilize teachers' initiative in interdisciplinary teaching, research, and talent training.

Fourth, implement two-way exchanges between university and enterprise teachers. Arrange university teachers to take temporary posts and participate in enterprise projects, and invite enterprise technical experts to give lectures and provide guidance. Select outstanding teachers for academic visits at renowned domestic and foreign universities and enterprises to broaden their interdisciplinary horizons.

4. Conclusion

The cultivation of interdisciplinary innovative and applied talents in water, environment and geology is an important initiative to meet the development demands of ecological civilization, hydraulic engineering and environmental governance, and promote interdisciplinary integration and high-quality disciplinary development. At present, this work still faces practical difficulties such as rigid disciplinary barriers, single training modes, and insufficient interdisciplinary competencies of teachers. Nevertheless, a series of systematic optimization measures, including establishing interdisciplinary education concepts, optimizing curriculum systems, improving practical teaching mechanisms, building collaborative education platforms, and strengthening the teaching team, can effectively address existing problems. This will steadily improve the quality of interdisciplinary talent training in water, environment and geology, cultivate more high-caliber interdisciplinary talents with innovative and practical capabilities for China's ecological civilization sector, and provide strong talent support for the implementation of national strategies in related fields.

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