The Research and Construction of Intelligent Construction Professional Curriculum System based on Multi-Discipline Deep Integration

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Abstract: At present, the intelligent construction specialty in domestic universities seeks new ways to develop in the connotation construction of multi-discipline cross-integration, and speeds up the pace of exploration. Based on the goal of education, universities focus on building a training system with professional characteristics in the training of intelligence building skills and ability. This paper probes into the connotation of talents training goal and graduation requirement of intelligent construction specialty in application-oriented universities, expounds the curriculum system of intelligent construction specialty, and starts with breaking through the simple "Civil Engineering+" curriculum system, to construct a new educational curriculum system of intelligent construction specialty, explore a new educational model of engineering and new measures of connotation construction.

Keywords: Intelligent Construction; Curriculum System; Applied Undergraduate

1. Introduction

With the transformation and upgrading of the construction industry in China, the concepts of industrialized construction, digital construction, and intelligent construction are being increasingly concretized. The rapid development of these technologies is expanding their application scenarios. As construction technology and management methods advance, the demand for intelligent construction talents will continue to grow. The industry's demand for intelligent construction talents and the standards for high-level talent cultivation in higher education institutions are also becoming clearer [1].

2. Key Issues in the Cultivation of Intelligent Construction Professionals

The intelligent construction major is based on civil engineering, oriented towards national strategic needs and the upgrading and transformation of the construction industry. It integrates computer and information technology, control machinery principles, the Internet of Things, big data, and engineering management, forming a new engineering discipline. For application-oriented undergraduates, the training requirements are to master the basic theories and methods of intelligent construction, possess practical and innovative abilities as intelligent builders, and be capable of engaging in engineering digital modeling and simulation, intelligent construction, prefabricated construction, and 5D project management. Therefore, enhancing practical ability is a key focus for cultivating a new force in intelligent construction [2].

Liaoning University of Science and Technology, as a higher education institution primarily targeting application-oriented undergraduate talent, focuses on twelve aspects for talent cultivation: engineering knowledge, problem analysis, design (development) solutions, research, use of modern tools, engineering and society, environment and sustainable development, professional norms, individual and team, communication, project management, and lifelong learning. Combining the university's metallurgical characteristics, the intelligent construction major builds its educational system and goals around these requirements, aiming to cultivate qualified builders in the construction field with good humanistic qualities, social responsibility, professional ethics, teamwork spirit, and a certain international vision. The curriculum system mainly includes the following four aspects:

Disciplinary System Construction: Intelligent

construction is an interdisciplinary field that requires students to master a broad knowledge system. Therefore, a sound disciplinary system needs to be established, including civil engineering, mechanical engineering, computer science, electronic engineering, and management science, to provide a solid foundation for intelligent construction talent cultivation.

Innovation Ability Cultivation: Intelligent construction requires continuous innovation and improvement, so it is necessary to cultivate students' awareness and ability to innovate. This can be achieved through scientific research projects, academic exchanges, practical activities, and other means.

Technical Skills Training: Intelligent construction requires students to master advanced engineering technical skills, including BIM technology, IoT technology, and artificial intelligence technology. Therefore, sufficient technical training and practice opportunities need to be provided so that students can proficiently master these skills.

Professional Quality Cultivation: Intelligent construction requires students to have high professional ethics and professional qualities, including teamwork, communication skills, sense of responsibility, and integrity. Therefore, professional ethics education and practical sessions need to be introduced into the training plan to improve students' professional qualities.

These four aspects are interwoven and together constitute the key issues in the cultivation of intelligent construction talents. Only by comprehensively considering and addressing these issues can outstanding intelligent construction professionals be cultivated.

3. Research on the Curriculum System of Intelligent Construction Major

Based on the knowledge structure, knowledge system, and professional abilities that intelligent construction professionals should possess, the curriculum should emphasize the "horizontal" (broad knowledge base) and "vertical" (deep professional knowledge in a specific area) T-shaped knowledge structure, solidifying the foundation in civil engineering and strengthening engineering practice abilities [3-6]. From the perspective of serving the national construction industry, the educational knowledge domain of the intelligent construction major should also cover professional knowledge in traditional construction industry areas such as real estate, surveying and design, construction, and supervision. It should also support new technology fields in the construction industry such as new real estate, BIM consulting, construction robotics development, and green building.

The courses in the intelligent construction major can be divided into two categories: basic professional courses and required professional courses, and module elective courses. The basic professional courses mainly include Python programming, the three mechanics (theoretical mechanics, material mechanics, and structural mechanics), construction machinery and control principles, fundamentals of BIM technology, and intelligent surveying. Required professional courses and module elective courses are more specifically targeted at the unique knowledge and skills of the intelligent construction major. Required professional courses include BIM engineering applications, principles of steel structure design, principles of concrete structure design, intelligent construction, intelligent sensing, and artificial intelligence data processing. Module elective courses consist of three modules: informationized construction, green building, and intelligent engineering management. Additionally, the curriculum includes content closely related to intelligent construction, such as descriptive geometry and civil engineering drawing, civil engineering materials, engineering mechanics, prefabricated structure design, BIM project management, building intelligent system engineering design, soil mechanics and foundation engineering, and smart site technology and applications.

4. Construction of the Curriculum System for Intelligent Construction Major

Intelligent construction mainly serves various stages of the construction engineering field, with the fundamental starting point being the cultivation of talents based on civil engineering [7]. According to the 2023 standards of the Civil Engineering Professional Teaching Guidance Committee of Higher Education Institutions, "Guidelines for Undergraduate Civil Engineering Major in Higher Education Institutions," combined with the talent cultivation positioning of this major, a multidisciplinary integrated curriculum framework has been constructed. This framework is based on basic courses in civil

engineering as theoretical support, with distinctive features in courses related to intelligent construction, intelligent management, intelligent detection, and operation and maintenance.

Emphasizing the importance of core courses in this major, the teaching hours of ten core courses, including theoretical mechanics, structural mechanics, material mechanics, civil engineering materials, basic principles of steel structures, basic principles of concrete structures, soil mechanics, foundation engineering, intelligent construction technology, and intelligent construction project management, have been increased. These courses are scheduled for intensive teaching in the first four semesters of the four-year study period to solidify the basic theoretical foundation of civil engineering. Practical sessions have been added to both required professional courses and elective professional courses to focus on cultivating and training students' practical and innovative abilities. The theoretical course teaching system is shown in Figure 1, and the practical course teaching system is shown in Figure 2.

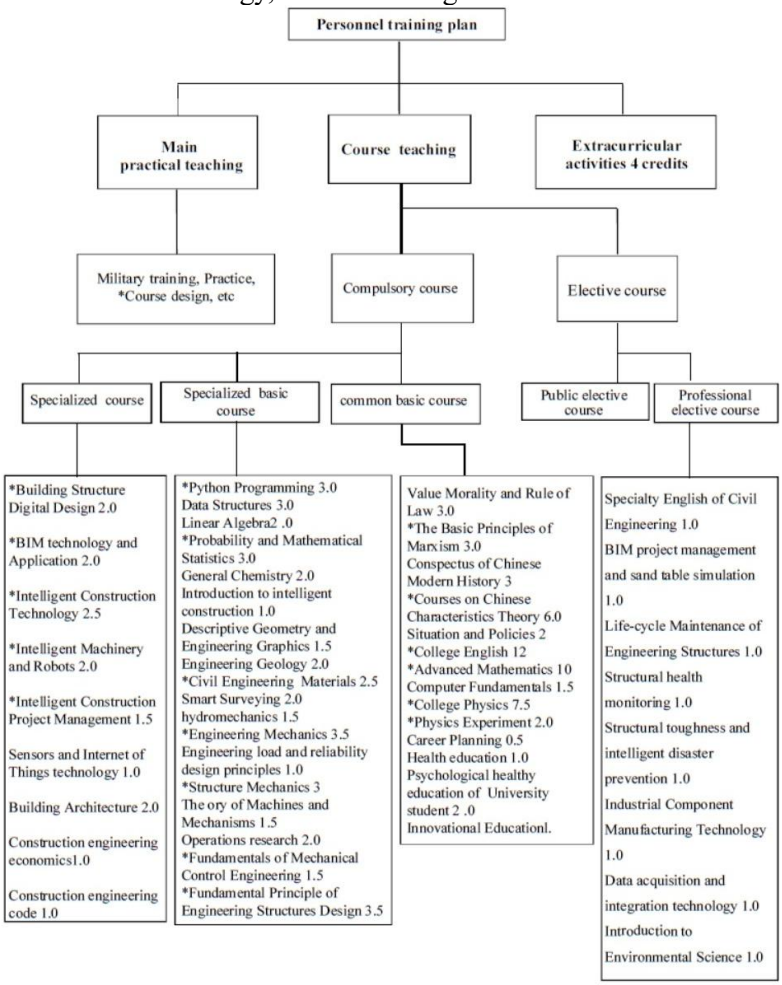

Figure 1. Theoretical Course Teaching System of the Intelligent Construction Major

For example, in the compilation of the basic course syllabus, refining the basic teaching knowledge of civil engineering, strengthening the assessment proportion of basic civil engineering teaching, and consolidating students' basic engineering abilities; in the compilation of the professional course syllabus, deepening the methods of integrating engineering knowledge with information technology, integrated technology, and digital technology knowledge points in the intelligent construction, intelligent operation and maintenance, and intelligent management module, broadening the knowledge base; from the perspective of strengthening engineering practice, increasing the proportion of experiments and practical training in courses, with methods such as setting up engineering case training and comprehensive experiments to highlight the cultivation of students' ability to solve engineering construction problems using intelligent technology.

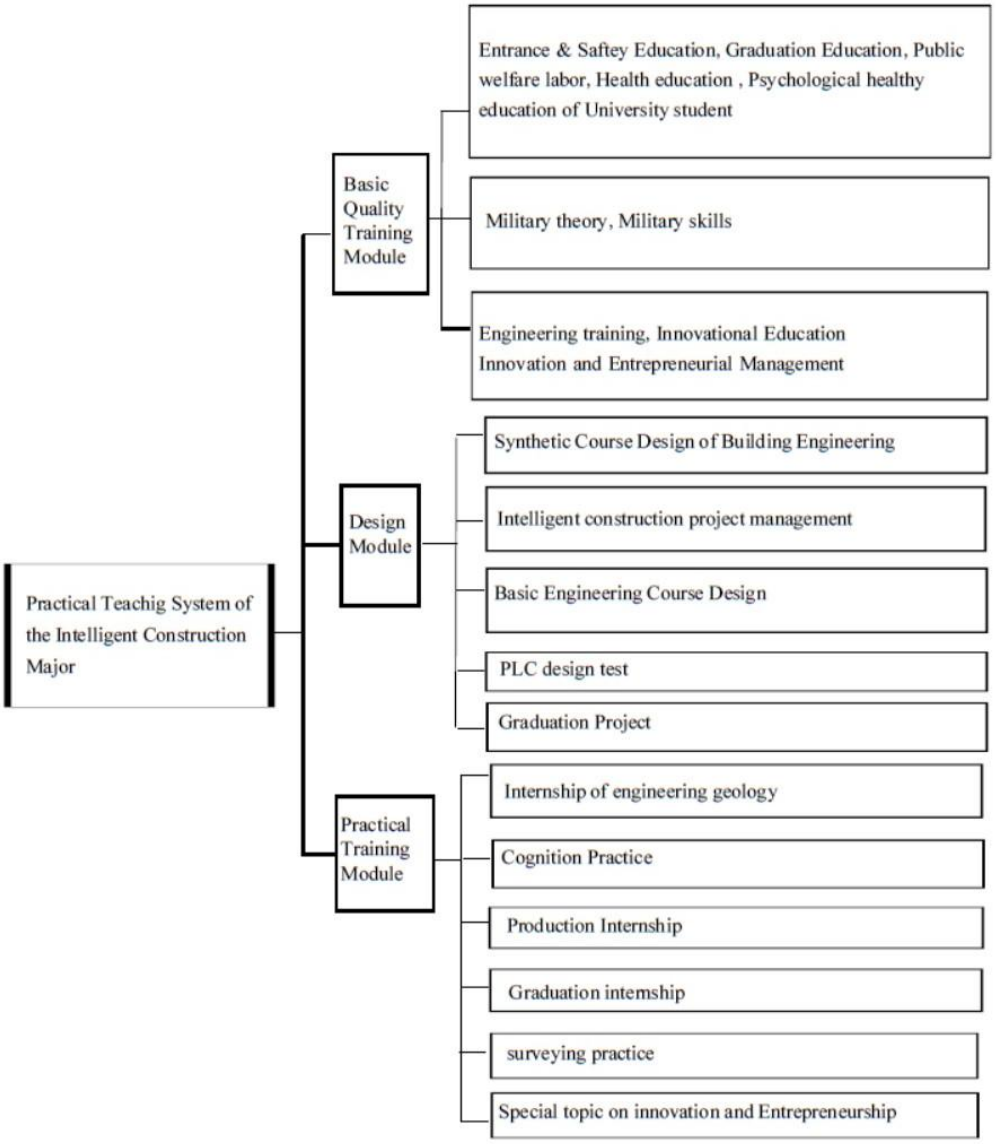

Figure 2. Practical Teaching System of the Intelligent Construction Major

5. Implementation of the Curriculum System for Intelligent Construction Major

Considering that the intelligent construction curriculum system integrates interdisciplinary knowledge from civil engineering, mechanical engineering, automation, information technology, and management, it has increased the difficulty of talent cultivation within the existing teaching system framework. Therefore, in the process of implementing the curriculum system, it is necessary to introduce a mentor-based training model [8] and comprehensive course practical training.

5.1 Mentor-Based Training for Elite Talent

Given the current small class enrollment situation in the intelligent construction major, it is clear that professional teachers are the primary responsible persons for student academic guidance. In the class, the mentor-student team is determined through a two-way selection process, and comprehensive assistance is provided throughout the four-year academic process for learning doubts, competition guidance, postgraduate exam counseling, and employment guidance.

5.2 Comprehensive Course Practical Training to Enhance Student Ability

Comprehensive course practical training is very important for the cultivation of application-oriented undergraduate talent [9,10]. This includes two major parts: prefabricated structure design and intelligent construction project management design. The practical course segment relies on the application-oriented undergraduate intelligent construction major talent cultivation orientation, focusing on

intelligent construction and management. Prefabricated building structure design is offered in the sixth semester of the undergraduate stage, set as a 3-week practical training. The design practice includes prefabricated concrete design and prefabricated steel structure design. The intelligent construction project management course design is offered in the seventh semester of the undergraduate stage, set as a 3-week practical training. It includes the entire lifecycle course design of prefabricated building construction, budget costing, and management and maintenance of each stage. Additionally, the setting of practical training segments such as PLC design experiments and foundation engineering course design has played a significant role in strengthening the professional knowledge cultivation of application-oriented undergraduate talent in the intelligent construction major.

5.3 Building a Multi-Form Integrated Training System to Expand Students' Professional Vision

In the process of continuously deepening and clarifying the connotation of the intelligent construction major, educators have found that to more effectively enhance the practical and timely effectiveness of each teaching link in the curriculum system, professional extension activities are indispensable [11,12]. To deepen the role of professional teaching practice of new technology topics, expand students' professional vision, and understand the cutting-edge intelligent construction professional knowledge, the intelligent construction major at Liaoning University of Science and Technology actively hosts domestic intelligent construction academic conferences, encourages students to attend and learn about the frontier technologies in the industry, creating good opportunities for improving the level of talent cultivation; by establishing an intelligent construction industry college, more than 80 students have been integrated into enterprises for practical training, exercising students' practical production creativity; through guiding students to participate in provincial and national professional competitions, professional course practical training is further extended to practical applications, and students' professional confidence is enhanced. In 2023, this major won two second prizes and more than ten third prizes in national A1-class competitions.

6. Conclusion

The positioning of talent cultivation for the intelligent construction major is closely related to the current state of national industry development and the positioning of talent cultivation in various universities. A more reasonable multidisciplinary integrated curriculum framework has been formulated for the cultivation of application-oriented undergraduate talents. The implementation of the mentor-based training model, comprehensive course practical training, and multi-form integrated training system in teaching execution has effectively reflected the training and execution effects of high-level application-oriented talents in the intelligent construction major. This provides reference suggestions for the construction and talent cultivation of the intelligent construction major in other universities.

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