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Research on the Development Path of "Dual-Qualified" Intelligent Construction Teaching Teams

Quan Shen[1]，Wenliang Wu[1]，Yuan Yan[2]，Zhifeng Zhong[2]，Heping Ouyang[2]
[1]*Civil Engineering， Hunan University of Technology, Zhuzou,Hunan China*
[2]*Civil Engineering, Hunan Vocational and Technical College of Water Resources and Hydropower, Zhuzou,Hunan China*
Corresponding Author:Quan Shen

----------*ABSTRACT*----------
With the rapid development of intelligent construction technology, it has become a crucial task for higher education to cultivate professional talents who can meet the needs of the industry. The construction of a "dual-qualified" intelligent construction teaching team plays a key role in improving the quality of talent training. This article analyzes the characteristics of the intelligent construction specialty and the necessity of building a "dual-qualified" teaching team, discusses the current problems, including the single source of teachers, insufficient practical ability, and imperfect team collaboration mechanism, and proposes construction paths from optimizing the teacher recruitment and training system, strengthening school-enterprise cooperation, and improving team management and incentive mechanisms, aiming to provide theoretical reference and practical guidance for building a high-quality "dual-qualified" intelligent construction teaching team.
KEYWORDS; *Intelligent Construction; "Dual-Qualified" Teaching Team; Talent Training; Construction Path*

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I. INTRODUCTION

In the midst of the digital wave, traditional industries have embarked on a path of deep integration with emerging information technologies. The construction industry has also actively participated in this trend, giving rise to intelligent construction and its rapid development. This has reshaped the landscape of the construction industry, pushing it towards a new phase of intelligence and digitization.

The in-depth penetration of cutting-edge technologies such as big data, artificial intelligence, the Internet of Things (IoT), and Building Information Modeling (BIM) into the field of architecture has brought about comprehensive changes in design, construction, and operation and maintenance. During the design phase, intelligent algorithms help generate better solutions; during construction, automated equipment and real-time monitoring systems ensure quality and efficiency are both enhanced; during the operation and maintenance phase, IoT sensors collect and analyze data throughout the entire lifecycle for precise maintenance management. These transformations not only improve economic and environmental benefits but also raise higher demands for professional talents in the construction industry. Investigating issues related to intelligent construction is crucially important, as it pertains to the continuous progress of the construction industry and meeting the needs of modernization. Intelligent construction specializes in cultivating versatile talents who must possess interdisciplinary knowledge and practical skills. They need to solidify their foundation in architecture while mastering information technology and extensively explore knowledge in fields such as mechanical automation and materials science. Practical skills are particularly critical, enabling them to flexibly apply theoretical knowledge to actual projects. In intelligent design, they use smart software to create schemes that combine technological appeal with functionality; during construction management, they rely on intelligent methods to plan schedules, allocate resources, and control quality efficiently; in operational services, they utilize intelligent monitoring systems to ensure building stability, thus fully meeting industry talent requirements.

Within the talent training system for intelligent construction, teacher teams are considered core pillars, similar to conductors of an orchestra whose quality and ability directly influence teaching quality and training outcomes. Outstanding teachers should not only possess profound professional knowledge but also be able to convey complex theories to students in a clear and understandable manner. Moreover, they should have extensive practical experience to activate dull theory through real cases, allowing students to truly appreciate the application value of knowledge in engineering.

Therefore, establishing a “dual-qualified” intelligent construction teacher team is imperative and far-reaching in significance. “Dual-qualified” teachers must have solid theoretical teaching skills like seasoned

scholars who thoroughly analyze textbook knowledge points and extensive practical experience from project sites where they coordinate resources, solve problems, or witness innovations at the frontier of intelligent construction technology. Such teachers can integrate advanced intelligent construction techniques with real engineering cases into their teaching effectively. They introduce the latest research results to students, keeping them up-to-date with industry trends. Through case analysis, they guide students to apply their knowledge to solve practical problems, fostering innovative thinking and practical abilities.

In conclusion, a "dual-qualified" intelligent construction teacher team serves as a solid bridge for talent training, assisting students in transitioning smoothly from theoretical learning to practical work. It continuously supplies high-quality talents into the intelligent construction industry, propelling its vigorous development. This contributes significantly to China's architectural and urbanization efforts by providing strong momentum towards reaching higher levels of development.

II. CHARACTERISTICS OF THE INTELLIGENT CONSTRUCTION DISCIPLINE AND THE NECESSITY OF BUILDING "DUAL-QUALIFIED" TEACHING TEAMS

Characteristics of theIntelligent Construction Discipline

Intelligent construction involves the integration of multiple disciplines, such as architectural engineering, civil engineering, mechanical engineering, electrical engineering, computer science, and information technology. For example, Building Information Modeling (BIM) technology integrates knowledge of 3D modeling, database management, and collaborative design, while the application of robotics in intelligent construction combines mechanical automation, artificial intelligence, and construction techniques. This requires teaching team members to possess interdisciplinary knowledge structures and the ability to conduct teaching and research from a multidisciplinary perspective.

The intelligent construction field experiences rapid technological advancements, with new technologies, processes, and methods emerging continuously. Examples include the application of big data in building energy consumption analysis, the use of Internet of Things (IoT) technology for real-time monitoring on construction sites, and the application of Virtual Reality (VR)/Augmented Reality (AR) in architectural design and construction handover. Teachers must stay at the forefront of technological developments, updating teaching content promptly to convey the latest intelligent construction technologies to students, ensuring that their knowledge aligns with industry demands.

The intelligent construction discipline is highly practice-oriented. Students not only need to grasp theoretical knowledge but also must be capable of applying intelligent construction technologies to real engineering projects. From the design and commissioning of intelligent building systems to the organization and management of intelligent construction sites, students must accumulate practical experience. Therefore, teaching teams require extensive engineering practice backgrounds to guide students in practical teaching activities, such as course design, internships, training programs, and graduation projects. This ensures the cultivation of students' hands-on skills and their ability to solve real-world problems.

The Necessity of Building "Dual-Qualified" Teaching Teams

"Dual-qualified" teaching teams play a crucial role in the education of intelligent construction disciplines. With the rapid development of intelligent construction technologies, the demand for professionals in the industry continues to rise, particularly for interdisciplinary talents who possess both solid theoretical knowledge and extensive engineering practice experience. The following outlines the primary reasons for building such teams:

(1) "Dual-qualified" teachers can seamlessly integrate theoretical knowledge with practical experience, introducing real engineering cases into classroom teaching. This approach makes abstract theoretical concepts more vivid and easier for students to understand and master. Additionally, during practical teaching sessions, teachers can utilize their hands-on expertise to guide students more effectively, enhancing their practical skills and innovative thinking, thereby comprehensively improving teaching quality.

(2) The development of the intelligent construction industry relies on collaboration between universities and enterprises in production, education, and research. "Dual-qualified" teaching teams can act as bridges between academia and industry. They bring real-world needs and cutting-edge technologies from enterprises into university teaching and research while translating academic research outcomes into practical productivity, thus driving technological innovation and development in the intelligent construction sector.

(3) The intelligent construction industry places high demands on the comprehensive quality of its workforce, requiring a solid theoretical foundation, advanced intelligent construction technologies, and substantial practical experience. Students trained by "dual-qualified" teaching teams are better equipped to meet these demands, enhancing their employability and providing strong talent support for the sustainable development of the intelligent construction industry.

III. SURVEY ON "DUAL-QUALIFIED" INTELLIGENT CONSTRUCTION TEACHING TEAMS AND ANALYSIS OF RESULTS

This survey aimed to deeply understand the current status and challenges of building "dual-qualified" teaching teams in the field of intelligent construction at vocational colleges. With the rapid development of intelligent construction technologies, the construction industry is undergoing profound changes, imposing new requirements on the training of high-level technical talents. By collecting feedback from professionals, educators, and students in the construction education sector, we sought to identify key factors affecting the development of "dual-qualified" teachers and explore effective ways to enhance their core skills.The survey results indicate that participants generally agree that intelligent construction is driving industry transformation, yet challenges remain in talent development, such as insufficient teaching staff, incomplete curriculum design, and limited industry collaboration. Respondents emphasized that enhancing "dual-qualified" teachers' practical experience and technical skills is critical, recommending measures like joint training programs between academia and industry and the establishment of standardized skill certification systems to promote teachers' professional development. These insights will provide valuable references for future policy-making and practical exploration, supporting educational reform and development in the intelligent construction field.

Regarding current university students and educators in related fields, the survey results show that most respondents have limited knowledge of "intelligent construction." Specifically, 63.27% of respondents indicated "slightly familiar," while 8.16% stated they were "completely unfamiliar." Only a small percentage (2.04%) reported being "very familiar." This highlights a significant opportunity for improvement in the dissemination and education of intelligent construction concepts. However, regarding whether respondents agree that the construction industry is undergoing profound changes due to the development of intelligent construction, an overwhelming majority expressed a positive stance. Specifically, 51.02% of respondents indicated "somewhat agree," 34.69% chose "strongly agree," and only 14.29% selected "neutral." Not a single respondent chose "disagree." This demonstrates the broad recognition of intelligent construction's impact on the construction industry.

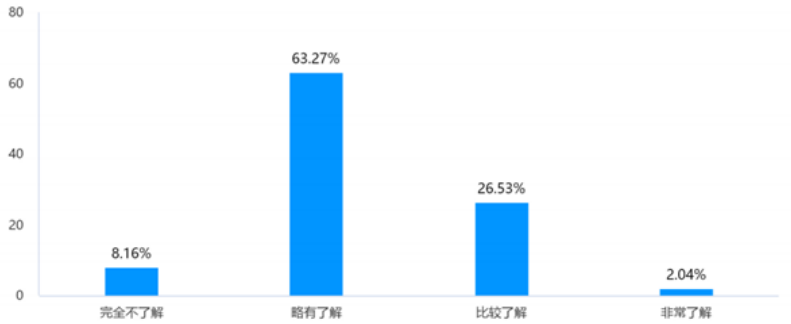

Figure 1. Survey Results on the Level of Understanding of "Intelligent Construction"

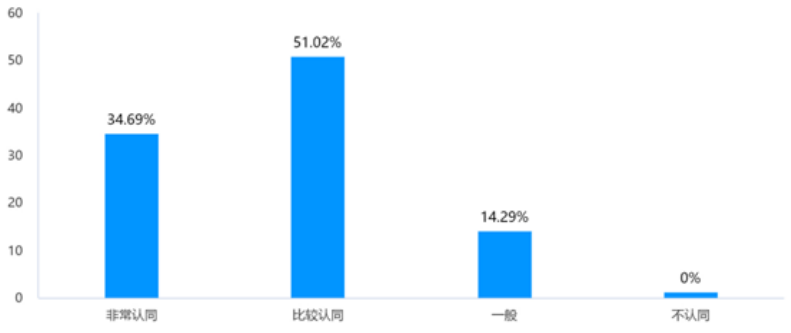

Figure 2. Survey Results on Whether the Construction Industry Is Undergoing Profound Transformation Due to the Development of Intelligent Construction

Therefore, in the context of the current digital age, civil engineering urgently needs to transform to adapt to rapidly evolving technological advancements and market demands. The promotion of intelligent construction has become a key measure to ensure continuous progress and competitiveness in the industry. This transformative development enhances design accuracy, optimizes resource allocation, reduces waste, and improves construction efficiency and project quality. Simultaneously, it is an essential approach to responding to global environmental protection requirements and mitigating ecological impacts. In summary, intelligent

construction is the optimal choice for achieving the goals of innovation, efficiency, sustainability, and safety in the field of civil engineering.

Regarding the skills required for "dual-qualified" intelligent construction professionals, survey results indicate that the ability to apply relevant skills is the most recognized, with a rate of 97.96%, reflecting respondents' emphasis on intelligent construction technologies such as BIM, robotic construction, and 3D printing. Construction information management skills ranked second, at 87.76%, showing broad recognition of this skill in intelligent construction. The rates for construction process data analysis skills and intelligent equipment operation and maintenance skills were 77.55% and 73.47%, respectively, indicating attention to data analysis and equipment maintenance, though slightly lower than the top two skills. The rates for comprehensive project management skills and teaching and curriculum design skills were 69.39% and 71.43%, respectively, suggesting that while these skills are important, they are of relatively lower priority in respondents' minds.

Based on the current situation, colleges and universities need to strengthen training in intelligent construction technologies to ensure that "dual-qualified" professionals can proficiently master technologies such as BIM, robotic construction, and 3D printing. The curriculum on construction information management should be improved to help these professionals better understand and apply management tools. Training content on data analysis and equipment maintenance should be increased to enhance their overall competence. Additionally, emphasis should be placed on improving project management and teaching design skills to ensure these professionals can effectively integrate various skills in practical applications.

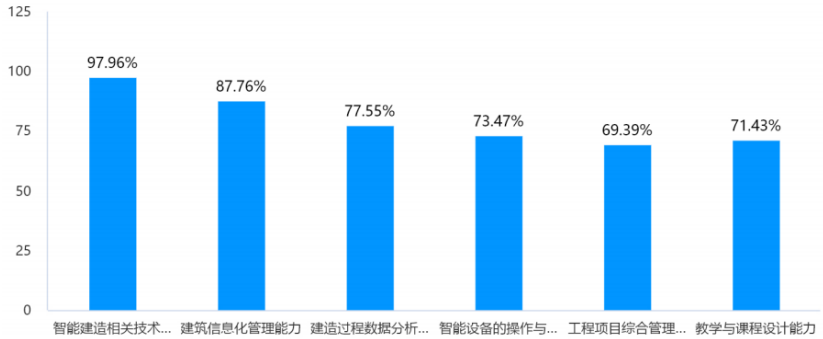

Figure 3. Survey Results on the Relevant Skills of "Dual-Qualified" Intelligent Construction Professionals

Regarding how to effectively promote the training of "dual-qualified" intelligent construction teachers, data analysis shows that participants generally believe that "establishing clear 'dual-qualified' competency standards" is the most important step in promoting the training of such teachers, with a composite score of 3, and 60.87% of respondents selecting it as their top choice. This result indicates that clear competency standards provide direction and a basis for teacher training. Next, "providing special funding support" ranked second with a score of 2.59, particularly with 59.52% of respondents selecting it as their second choice. This shows the importance of financial support for teacher training. Although the overall score is lower than that for competency standards, participants still recognize the necessity of economic investment. "Promoting school-enterprise collaboration to build practical platforms" scored 2.2, highlighting the value of school-enterprise cooperation in teacher training. Notably, 52.27% of respondents selected it as their third choice, indicating a high demand for practical platforms. Finally, "regularly organizing teachers to participate in industry frontier technology training" scored the lowest, with a score of only 1.33 and just 5.26% of respondents selecting it as their top choice. This may reflect participants' lower emphasis on technology training or their perception that it is less important than the other options. Based on the above analysis, it is recommended that in promoting the training of "dual-qualified" intelligent construction teachers, efforts should first be focused on establishing clear competency standards, with other supporting measures implemented based on these standards. Additionally, investment in special funding should be increased to meet the actual needs of teacher training. Furthermore, promoting school-enterprise collaboration and the construction of practical platforms is an essential component. Technology training can be integrated with industry development trends to enhance its attractiveness and effectiveness.

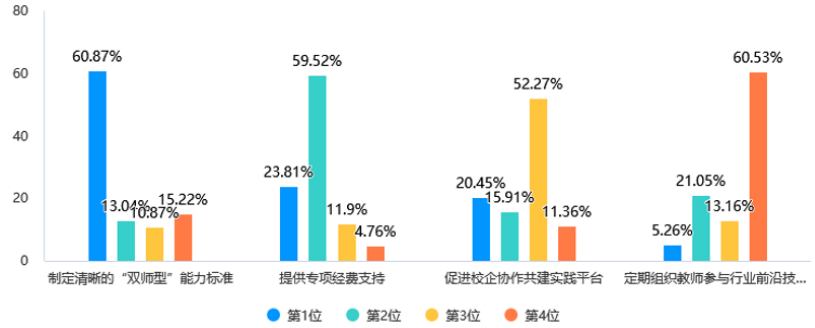

Figure 4. Survey Results on Effectively Promoting the Training of "Dual-Qualified" Intelligent Construction Teachers Based on Data Analysis

IV. "DUAL-QUALIFIED" INTELLIGENT CONSTRUCTION TEACHER TEAM DEVELOPMENT PATH

Optimizing Teacher Recruitment and Training Systems

(1) Expanding Teacher Recruitment Channels

When recruiting teachers, in addition to focusing on the academic background and teaching ability of university graduates, efforts should be made to introduce high-level technical and management talents from intelligent construction enterprises. Favorable policies should be formulated to attract industry experts with rich engineering practice experience and knowledge of intelligent construction technologies to join the teaching staff. For example, special support can be provided in aspects such as title evaluation, salary, and research start-up funding for talents introduced from enterprises, encouraging them to bring their industry experience and cutting-edge technologies into university teaching.

(2) Establishing a Long-term Teacher Training Mechanism

On-campus Training: Regularly organize on-campus teacher training activities, inviting experts and scholars from the intelligent construction field to give special lectures covering new technologies, standards, and policies in intelligent construction. At the same time, on-campus teaching seminars should be held to encourage teachers to share teaching experiences and methods, promoting mutual learning and improvement among teachers. Industry Practice Training: Establish a system for teachers to regularly work in intelligent construction enterprises, requiring them to participate in design, construction, and management of actual engineering projects, gaining a deeper understanding of industry development trends and enterprise needs while accumulating practical experience. The university and enterprise should jointly develop a teacher practice training plan, specifying practice tasks and evaluation criteria to ensure effective practice training for teachers. Degree Advancement and Academic Exchange: Encourage teachers to pursue doctoral degrees in intelligent construction-related disciplines to enhance their academic and research capabilities. At the same time, actively support teachers in participating in academic conferences and seminars both domestically and internationally in the field of intelligent construction, broadening their academic perspectives, understanding international cutting-edge research trends, and promoting communication and cooperation with peers and experts.

Strengthening University-Enterprise Cooperation

(1) Co-building Teacher Practice Bases

The university should cooperate with intelligent construction enterprises to co-build teacher practice bases, providing teachers with a stable practice platform. The practice bases should be equipped with advanced intelligent construction technology and a comprehensive engineering project management system, allowing teachers to participate in real intelligent construction projects. The university and enterprise should jointly develop operational management mechanisms for the practice bases, clarifying the rights and responsibilities of both parties to ensure their effective operation.

(2) Mutual Appointment and Utilization of Personnel Between the University and Enterprise

Establish a mechanism for mutual appointment and utilization of personnel between the university and the enterprise. The university should hire technical experts and managers from enterprises as part-time teachers, responsible for teaching certain professional courses, providing practical teaching guidance, and advising on graduation projects. Part-time teachers can bring real enterprise cases and practical experience into the classroom, enriching the teaching content and enhancing its relevance and practicality. At the same time, the university should send teachers to enterprises for practical training, participating in technical research, project management, and other tasks, enhancing their practical abilities and engineering competence. This mutual personnel exchange achieves the sharing and complementing of talent resources between the university and enterprise.

Improving Team Management and Incentive Mechanisms

Forming an Interdisciplinary Teaching Team: Based on the curriculum system and teaching tasks of the intelligent construction program, an interdisciplinary teaching team should be established. The team members should include teachers with backgrounds in various disciplines, such as civil engineering, computer science, mechanical engineering, and electrical engineering. The interdisciplinary teaching team should regularly conduct teaching seminars and jointly develop course syllabi, teaching plans, and teaching methods, to achieve the sharing and optimal allocation of teaching resources.

Establishing a Project Cooperation Mechanism: During the process of applying for and implementing research projects, interdisciplinary collaboration among team members should be encouraged. The institution should develop relevant policies to prioritize support for interdisciplinary research projects, with preferential allocation of project funding and research resources. Through project collaboration, communication and cooperation among teachers can be promoted, enhancing the team's research innovation capacity and ability to solve practical problems.

Improving the Teacher Evaluation System

(1) Establishing Diversified Evaluation Indicators: For "dual-qualified" intelligent construction teachers, a diversified evaluation system should be established, covering indicators such as teaching ability, research level, practical ability, and social service. Teaching ability evaluation should focus on classroom effectiveness, student evaluations, and teaching achievements; research level evaluation should focus on research project initiation, published research results, and research awards; practical ability evaluation should assess teachers' industry experience, practical teaching guidance effectiveness, and involvement in industry-university-research cooperation projects; social service evaluation should assess teachers' contributions in providing technical consulting and training services to enterprises.

(2) Strengthening the Weight of Practical Ability in Evaluation: In the teacher evaluation system, the weight of practical ability should be appropriately increased to encourage teachers to focus on improving their practical skills. Teachers with outstanding practical abilities and exceptional performance in industry practice should be given priority in promotion, position advancement, and performance evaluation, motivating them to actively participate in practical teaching and industry practice activities.

Improving Teacher Incentive Mechanisms

(1) Material Incentives: Establishing a special allowance for "dual-qualified" teachers, offering material rewards to those recognized as "dual-qualified" teachers. Teachers and teams who achieve outstanding results in teaching, research, and practice should be rewarded with corresponding bonuses, research funding, and other material incentives, enhancing their work enthusiasm and initiative.

(2) Spiritual Incentives: Teachers who perform excellently in the construction of "dual-qualified" teacher teams should be recognized and publicized, with honors such as "Outstanding Dual-Qualified Teacher" or "Advanced Individual in Dual-Qualified Teacher Team Building" being awarded, thus enhancing their sense of honor and belonging. More career development opportunities and promotion space should be provided for teachers, such as recommending excellent teachers to participate in domestic and international high-level academic exchanges or to hold academic organization positions, stimulating their internal motivation and promoting their self-development.

V. CONCLUSION

The development of "dual-qualified" intelligent construction teacher teams is a key measure to meet the development needs of the intelligent construction industry and improve the quality of talent training in the field of intelligent construction. By optimizing teacher recruitment and training systems, strengthening university-enterprise cooperation, and improving team management and incentive mechanisms, we can effectively address the current issues in teacher team development and create a high-quality, high-level "dual-qualified" intelligent construction teacher team. Such teacher teams can better impart theoretical knowledge and practical skills of intelligent construction to students, cultivating innovative and versatile talents who meet the development needs of the intelligent construction industry, providing a solid talent foundation for the sustainable development of the industry, while also laying a strong foundation for the establishment and development of intelligent construction programs at universities. In future development, continuous exploration and innovation of teacher team building models should be undertaken, with a focus on enhancing the overall quality and capabilities of teacher teams to adapt to the ever-evolving intelligent construction technologies and the changing demands of the industry.

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