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Systematic Reform of Architectural Construction Technology Teaching Under the Background of Artificial Intelligence

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Abstract: The rapid development of artificial intelligence has driven the comprehensive transformation and upgrading of the construction industry, and put forward brand-new requirements for the training of architectural construction technology talents. At present, prominent problems exist in professional teaching of colleges and universities, including outdated curriculum content lagging behind industrial development, teachers' weak interdisciplinary capabilities and rigid teaching modes. Against the background of industrial transformation, professional teaching should not be limited to simple implantation of intelligent software; a comprehensive paradigm reconstruction is urgently required. Centered on composite post competencies, this paper reconstructs the curriculum system by integrating digital literacy and engineering practice, innovates teaching modes relying on AI, and builds a government-school-enterprise collaborative education mechanism, so as to provide theoretical basis and practical reference for the training of intelligent construction talents.

Keywords: Artificial intelligence; Architectural construction technology; Professional teaching reform; Intelligent construction; Compound talent training

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1. Introduction

The wave of artificial intelligence has brought comprehensive changes to production modes across all industries, and the intelligent development process of the construction industry has been accelerating. Technologies such as BIM collaborative design, smart construction site management, UAV inspection and construction robot construction have been widely applied nowadays. Cutting-edge methods including digital twin, large model optimization and machine vision recognition have gradually become essential skills for construction practitioners, completely reshaping the industrial development landscape covering design, construction and project management.

Compared with the rapid upgrading of the industrial side, the talent training of architectural construction technology majors still adheres to traditional school-running ideas, and curriculum design and teaching modes fail to keep pace with the intelligent development of the industry. The existing training system cannot match enterprise post standards, and the supply of compound talents equipped with both traditional construction capabilities and intelligent technology literacy is severely insufficient. Intelligent monitoring and robot operations are commonly adopted on construction sites, while college teaching still focuses on lecturing traditional techniques and manual experience, forming an obvious gap between students' competency structure and actual industrial demands.

Simply adding new courses and updating equipment cannot fundamentally resolve the contradiction. It is necessary to promote comprehensive and in-depth reform of professional teaching. Teaching reform should break away from the superficial mode of simply superimposing intelligent tools, and systematically reconstruct the talent training system from the aspects of talent positioning, curriculum framework, classroom forms and practical training, so as to deliver high-quality technical and skilled talents adapted to the development demands of the intelligent construction industry.

2. Difficulties and challenges of architectural construction technology teaching in the AI era

2.1. Intergenerational gap between curriculum content and industrial technologies

At present, the curricula of architectural construction technology majors in many colleges are obviously disconnected from the frontiers of intelligent construction. Courses are still dominated by traditional civil engineering techniques and manual management, while content related to intelligent construction is scattered in lectures and elective courses without a systematic core curriculum layout. Even courses concerning BIM and smart construction only stay at the level of software operation, without in-depth explanation of the integration principles of AI and construction technologies. In addition, intelligent construction is an emerging direction of Emerging Engineering Education, with immature interdisciplinary boundaries, curriculum standards and teaching systems, leading to delayed curriculum updates and failure to meet the training requirements of compound talents.

2.2. Single-disciplinary limitation of teachers' knowledge structure

The core bottleneck restricting the implementation effect of professional teaching reform lies in the comprehensive literacy of teaching staff. Most full-time teachers of architectural construction technology majors possess a solid civil engineering professional foundation and rich traditional teaching experience, yet they have not received systematic training in emerging interdisciplinary fields such as artificial intelligence, big data analysis, Internet of Things sensing, and digital twin. Their single civil engineering knowledge structure makes them only able to explain superficial operation procedures when carrying out integrated teaching of intelligent technologies and construction techniques, failing to interpret technical principles and application logic, and falling into the teaching dilemma of only knowing phenomena without understanding underlying mechanisms.

Meanwhile, the iteration speed of artificial intelligence technologies in the construction industry is extremely fast. It has evolved from early basic BIM modeling applications to advanced applications such as AI-aided construction scheme optimization, large-model intelligent drawing review and automatic robot construction control. The pace of technical upgrading far exceeds the speed of teachers' knowledge renewal. Teachers' deficiencies in digital literacy and intelligent technology application have become key obstacles restricting the in-depth and connotative advancement of professional teaching reform [1].

2.3. Traditional technical inertia restricting teaching modes

For a long time, architectural construction technology majors have rigidly adopted the traditional teaching paradigm of "teacher classroom lecture – students' passive memorization – repeated practical operation". The biggest drawback of this mode is the separation between professional theoretical knowledge and real engineering application, as well as the isolation between single-skill training and comprehensive competency cultivation, which cannot adapt to the educational requirements of intelligent teaching. Artificial intelligence technologies feature strong scenario dependence and dynamic changes; relying solely on classroom theoretical lectures cannot enable students to grasp the discrimination logic, decision-making basis and applicable boundaries of AI tools in real construction scenarios.

With the deep integration of AI and BIM technologies, the industry has spawned new business forms such as intelligent architectural design, unmanned intelligent construction and full-process intelligent project management, putting forward higher standards for practitioners' knowledge reserve, professional capabilities and comprehensive literacy. Colleges must strengthen the top-level design of professional teaching and break the shackles of traditional teaching modes to synchronize curriculum contents, teaching methods with the development of industrial intelligent technologies and meet the talent training demands of the new era [2].

3. Logic of teaching transformation from tool embedding to system reconstruction

Faced with multiple dilemmas existing in current professional teaching, the teaching reform of architectural construction technology majors cannot simply aim at adding new courses and replacing training equipment; it is essential to clarify the in-depth transformation logic and realize the shift from simple tool embedding to overall paradigm reconstruction. Tool embedding refers to implanting artificial intelligence software and intelligent equipment into traditional courses while retaining the original teaching system framework. This approach features low implementation difficulty and low input cost, yet it can only achieve superficial teaching optimization, failing to fundamentally reshape students' knowledge structure or cultivate their ability to analyze and solve practical construction problems with artificial intelligence thinking.

Paradigm reconstruction, based on the core competency demands of posts in the intelligent construction industry, recalibrates talent training positioning and integrates & reconstructs interdisciplinary curriculum systems to innovate integrated teaching modes. Such reform does not rigidly implant intelligent technical contents into traditional teaching systems; instead, it takes the technical logic of artificial intelligence and intelligent construction as the core to comprehensively reshape the whole process of professional talent training [3].

3.1. Training objectives: Shift from single skill orientation to comprehensive compound literacy

The transformation of the intelligent construction industry forces architectural construction technology majors to redefine talent training positioning. Relying on school-enterprise cooperation to conduct post surveys, sort out core work contents of intelligent construction posts, and establish a four-dimensional competency training system covering professional literacy, engineering literacy, professional skills and innovative practice. The new framework breaks the competency limitations of traditional civil engineering construction and on-site management, expands training of emerging skills including digital design, intelligent construction and green construction, and strengthens students' systematic thinking, project control and collaborative capabilities. New-era professionals are required to possess both on-site practical experience and application logic of intelligent technologies, as well as human-machine collaborative decision-making capabilities, and be able to convert construction experience into standardized data to support the upgrading of intelligent systems, forming a comprehensive competency structure integrating technical thinking, engineering judgment and digital literacy.

3.2. Curriculum system: Interdisciplinary integration and modular hierarchical design

The training of compound talents for architectural construction technology majors requires synchronous reconstruction of the existing curriculum system. The traditional curriculum framework with separated single disciplines and solidified barriers can hardly adapt to the development demands of the intelligent construction industry. The new system shall follow two major principles: interdisciplinary integration and modular design. By breaking disciplinary boundaries of civil engineering, machinery, big data and computer science, multi-disciplinary knowledge is integrated guided by practical engineering problems, and cutting-edge technologies such as AI, BIM and Internet of Things are incorporated to cultivate students' digital literacy and cross-disciplinary application capabilities. Meanwhile, modular curricula are built relying on the full life cycle scenarios of real engineering, with joint teaching by school and enterprise dual teachers. This can guarantee the integrity of the professional training system, dynamically update teaching contents with industrial technical iterations, and adapt to actual employment demands of posts [4].

3.3. Teaching modes: From passive knowledge delivery to autonomous cognitive construction

The in-depth changes brought by artificial intelligence to architectural construction teaching are concentrated on the reconstruction and upgrading of teaching modes. AI tools can rapidly complete basic work such as information retrieval, data operation and preliminary scheme generation, so the core of teaching is no longer simple indoctrination of theoretical knowledge, but the cultivation of students' comprehensive abilities, guiding them to establish cognition independently, proficiently apply technologies and form collaborative innovative artificial intelligence thinking.

The brand-new teaching mode has three core characteristics: first, taking real engineering project problems as teaching entry points to guide students to independently integrate professional knowledge and flexibly utilize intelligent tools when solving complex engineering tasks; second, adopting artificial intelligence tool chains as teaching carriers to lead students to master the full-process application logic of AI in construction rather than isolated operation of single software; third, taking reflective practice as the path for competency improvement to guide students to objectively recognize technical advantages and application limitations during the use of intelligent tools and form critical application thinking. A three-dimensional teaching mode combining systematic theoretical teaching, real project practice and comprehensive application of AI tools is constructed, with micro-project teaching of intelligent construction implanted guided by practical engineering demands, providing a feasible path for the reform of professional teaching modes [5].

4. Implementation paths of AI empowering architectural construction technology teaching

4.1. Systematic embedding of intelligent construction curriculum contents

Optimization and reconstruction of curriculum contents are the fundamental premise of professional teaching reform. Curriculum updating should not merely scatter artificial intelligence knowledge points into original courses, but systematically reconstruct the overall curriculum contents following the full-process technical logic of intelligent construction.

At the basic teaching level, basic digital literacy courses such as Introduction to Intelligent Construction, Python Engineering Programming and Construction Engineering Data Analysis are added to consolidate students' theoretical foundation of artificial intelligence technologies. At the professional core level, contents including full-professional BIM modeling, smart construction platform management, construction robot practical operation, and AI-aided construction scheme decision-making are deeply integrated into traditional core courses such as Architectural Construction Technology, Construction Organization Management, and Engineering Quality & Safety Control, realizing organic integration of traditional construction techniques and intelligent technologies. At the practical teaching level, relying on on-campus virtual simulation training bases and off-campus enterprise smart construction platforms, a modern training teaching system integrating virtual and real scenarios and combining theory with practice is built. Through immersive simulation of smart construction sites and on-site practical training of construction robots, deep integration of teaching resources and industrial resources and integrated development of production, teaching, research and application are realized [6].

4.2. School-enterprise co-education and two-way empowerment of teaching staff

The construction of teaching staff is the key starting point for the implementation of professional teaching reform. To improve teachers' comprehensive teaching capabilities in intelligent construction, a school-enterprise collaborative training path featuring two-way empowerment must be adopted. On the one hand, a regular enterprise practice mechanism for teachers is established; professional teachers are assigned to demonstration intelligent construction projects on a regular basis to deeply participate in the practical application of AI technologies in construction process control, engineering quality inspection and on-site safety monitoring, updating their knowledge systems and accumulating practical experience in intelligent construction in real engineering scenarios. On the other hand, senior technical personnel and project leaders from enterprises are introduced as part-time teachers and industrial tutors of colleges, bringing cutting-edge industrial technical application cases and on-site management experience directly into classrooms, and forming a dual-teaching team consisting of full-time college teachers and enterprise industrial tutors. Meanwhile, teachers are encouraged to deeply participate in enterprise technology research and project tackling, deepen their understanding of artificial intelligence technologies while solving practical engineering problems, and realize two-way improvement of teaching and research capabilities [7].

4.3. Co-construction of school-enterprise platforms to promote sharing of teaching resources

Industry-education integration is not short-term loose cooperation between schools and enterprises, but requires the construction of institutionalized, in-depth and long-term collaborative education mechanisms. The *Technical Guidelines for Intelligent Construction (Trial)* issued by the Ministry of Housing and Urban-Rural

Development clearly proposes to accelerate the application of intelligent construction technologies in the full life cycle of engineering construction, providing policy guidance and institutional guarantee for collaborative education between colleges and enterprises.

In terms of platform construction, colleges cooperate with leading industrial enterprises to build physical education platforms such as industrial colleges and intelligent construction collaborative innovation centers, fully embed real enterprise projects, intelligent technical platforms and vocational skill certification systems into the whole talent training process. The school-enterprise co-construction mode can effectively support the teaching reform of core modules such as intelligent construction and smart operation & maintenance, and build a complete growth path for students from campus learning to enterprise practical operation. In terms of resource sharing, schools and enterprises jointly develop new-form textbooks and loose-leaf training handbooks, build high-standard training bases, share industrial technical data and teaching resources, and promote synchronization between college teaching and industrial development [8].

4.4. Innovation of evaluation system: Shift from result assessment to process empowerment

Innovation of teaching evaluation mechanisms is an important lever to guarantee the effective implementation of teaching reform. The traditional single evaluation mode centered on final written examinations and focusing on memorization of theoretical knowledge cannot adapt to the training objectives of compound talents in the artificial intelligence era. The brand-new evaluation system needs to realize three transformations: from summative result assessment to whole-process competency empowerment, from single knowledge evaluation to multi-dimensional comprehensive measurement, and from static paper examination to dynamic competency tracking [9].

A three-dimensional comprehensive evaluation framework covering knowledge mastery, professional skill application and innovative practice performance is constructed: the knowledge dimension assesses students' mastery of basic intelligent construction theories, technical principles and industrial specifications; the skill dimension measures students' ability to utilize AI tools and intelligent equipment to solve practical construction problems in simulated projects and real engineering; the innovation dimension focuses on examining students' scheme optimization thinking and technical reflection capabilities in human-machine collaboration. Meanwhile, performances in industrial college projects, vocational skill competitions and enterprise internships are incorporated into comprehensive evaluation, forming a diversified evaluation network linking in-class and after-class, on-campus and off-campus learning.

5. Conclusion and prospect

Artificial intelligence has been deeply integrated into the whole industrial chain of the construction industry, forcing systematic teaching innovation for architectural construction technology majors. Professional reform cannot only carry out simple additions of intelligent equipment and software; it is necessary to complete overall paradigm upgrading covering training objectives, curriculum design, teaching methods and assessment evaluation, transforming talent training from traditional skilled craftsmen to compound engineering talents who understand technical logic, can conduct human-machine collaboration and possess digital literacy [10].

With the continuous implementation of cutting-edge technologies such as digital twins and large models in the whole construction life cycle, professional teaching will face higher transformation requirements.

Educators should keep up with industrial trends, adhere to the education-oriented principle, rationally apply intelligent technologies to empower teaching, and simultaneously strengthen students' engineering ethics, critical thinking and lifelong learning awareness, so that students can not only meet current post demands but also contribute to the digital high-quality development of the construction industry.

Disclosure statement

The author declares no conflict of interest.

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