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Architecture-AI Curriculum Integration: Theoretical Frameworks and Pedagogical Innovations

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Abstract: Facing the urgent need for digital transformation and deep integration of intelligent technologies in the construction industry, the traditional architectural education system faces severe challenges in interdisciplinary coll aboration, depth of technological application, and cultivation of innovation capabilities. Based on the staged learni ng rules of disciplines, this study focuses on the interdisciplinary curriculum integration mechanism between archi tecture and artificial intelligence, proposing the “Three-stage Five-chain” teaching system aimed at breaking down disciplinary barriers, constructing a modular connection framework, and promoting the transformation of architect ural education toward intelligence and systematization.

Keywords: architecture, Artificial Intelligence, interdisciplinary mapping, modularization, curriculum integration

Introduction

Since the concept of”artificial intelligence” was introduced at the Dartmouth Conference in 1956, AI technology has undergone several stages of paradigm evolution, including machine reasoning, expert systems, neural networks, and deep learning, gradually permeating all areas of human society. In recent years, breakthroughs in generative AI technologies represented by ChatGPT, Midjourney, and Deepseek have marked the entry of AI into a new phase of “strong generalization capability” — from image generation to video creation, from natural language understanding to multimodal interaction — demonstrating the disruptive potential of AI to reshape industrial logic.

In the field of architectural design, exploration into AI can be traced back to the 1970s with the development of shape grammars, where computers generated basic geometric forms through rule-based systems to assist architects in form exploration. After 2010, breakthroughs in deep learning technologies accelerated the transformation of architectural design paradigms toward intelligence, with artificial intelligence providing momentum for the further development of architecture and urban construction.

Based on the above research background, this study is initiated. It intends to rely on architectural professional courses, integrating artificial intelligence technologies by establishing course modules such as “AI + Architectural Design,” “AI + Building Technology,” and “AI + Employment and Entrepreneurship.” These modules will guide students to use AI for design assistance and decision analysis, cultivating their comprehensive application abilities in cutting-edge fields such as urban data analysis and green building simulation. Ultimately, it aims to construct an architectural talent training system adapted to the intelligent transformation of the industry and provide theoretical support and practical examples for the deep integration of architectural education and industry development.

2 Literature Review

2.1Theoretical Foundation and Development of Interdisciplinary Mapping Mechanism

The research mainly explores the interdisciplinary mapping mechanism between architecture and artificial intelligence from two aspects: technology-driven mapping logic and interdisciplinary theoretical frameworks. On the technological side, studies have preliminarily established a framework for the correspondence between artificial intelligence technologies (such as generative AI and computer vision) and core knowledge nodes in architecture[1]. The logical structure of architectural form generation maps onto the algorithmic logic of Generative Adversarial Networks (GAN), enabling intelligent iteration of spatial forms through parametric design. On the other hand, neuroarchitecture and computational design theories provide cognitive frameworks for interdisciplinary mapping. The former establishes connections between architectural environments and neural network models via brain spatial perception devices, while the latter emphasizes the interactive feedback between algorithmic generation and design intentions, promoting a shift in architecture from experience-driven to data-driven paradigms.

2.2 Theoretical Discussion and Practical Path of Curriculum Integration

Regarding curriculum integration, current research and practice focus mainly on two aspects: curriculum integration and teaching tools. In curriculum integration, one approach is to embed AI tools into design courses to assist in scheme generation and performance optimization[2]. For example, Xi'an University of Architecture and Technology has introduced performance simulation technologies into third-year teaching to achieve seamless integration between technology and design. Another approach adopts parallel curriculum clusters, such as the MIT Media Lab, which independently establishes AI algorithm modules to complement design courses and achieves knowledge chain integration through cross-curricular projects.

2.3Key Issues and Strategies for the Modular Connection System

Significant differences exist between architectural design teaching systems and artificial intelligence teaching in both content and methodology[3].To address the modular connection issues, Xi'an University of Architecture and Technology formed teaching groups comprising experienced design instructors and specialists in architectural technology research to explore teaching reforms at different academic levels.Meanwhile, the Smart Architecture Pilot Class at Wuhan University constructed a three-tier ability system of "Tool Application - Algorithm Understanding - System Development."Students in lower grades master parametric tools such as Grasshopper, senior students learn CNN image recognition algorithms and develop customized models, and finally, comprehensive capabilities are integrated through intelligent city design projects.

3 Existing Problems

Although interdisciplinary research between architecture and artificial intelligence has achieved significant progress, particularly in areas such as generative design and digital construction, systemic theoretical construction and educational system integration are still at an exploratory stage[4].First, most existing studies focus on technological breakthroughs, lacking in-depth exploration of the underlying mapping mechanisms between the ontology knowledge of architecture and the fundamental algorithms of artificial intelligence.Second, the curriculum system exhibits a "fragmentation" tendency; many reforms adopt a "technology module embedding" model without establishing dynamic connection logic between modules.Third, the cultivation of competencies that integrate technological ethics and humanistic values remains at an exploratory stage.

4 Overall Construction of the Curriculum Integration and Teaching Reform System

The traditional architectural education system, which satisfied the needs for specialization and refinement during the industrial era, facilitated the vertical deepening of students' knowledge and skills. However, the disciplinary barriers formed under excessively refined teaching approaches have restricted possibilities for interdisciplinary collaborative innovation.Therefore, this project, oriented toward the cultivation of intelligent architecture talents, constructs a "Three-stage, Five-dimension" AI-empowered architectural teaching system.Through interdisciplinary knowledge design and modular curriculum system teaching, the integration and reorganization of architectural education and artificial intelligence technologies are achieved.

Based on the knowledge structure of architecture, a five-dimensional competency model is constructed:**“Design Thinking – Digital Technology – Green Building – Innovation Cultivation – Design Competition.”**Correspondingly, five dynamically intertwined curriculum chains are formed:①**.Architectural Design Main Chain**:Focused on core design courses, integrating AI modules such as generative design and spatial cognition algorithms to assist in teaching.②**.Intelligent Technology Support Chain**:Introducing interdisciplinary courses on computer machine learning and urban data mining, cultivating computational thinking and interdisciplinary application skills.③**.Green Building Technology Chain**:Embedding content on ecological analysis of green buildings and teaching intelligent performance simulation tools[5].④**.Innovation Ability Cultivation Chain**:Guiding students to apply knowledge such as intelligent architecture and urban data processing to innovation and entrepreneurship practices, progressively refining their project proposals and cultivating innovative thinking.⑤**. Design Competition Practice Chain**:In senior years, design competition courses are implemented, applying students’ knowledge and skills to academic competitions, thereby testing learning outcomes through practical projects.

On the other hand, to ensure the stage-wise progression and flexibility of the curriculum system, a “Foundation – Core – Expansion” three-level modular curriculum group is established for progressive cultivation:**Foundation Modules**: Courses such as Basic Architectural Design, Python Programming, Introduction to Artificial Intelligence, and Urban Cognition, fostering students’ fundamental understanding.**Core Modules**: Covering content such as parametric intelligent design, neural network applications in architecture, and urban big data analysis, cultivating interdisciplinary architectural design capabilities[6]. **Expansion Modules**: Including courses on innovation and entrepreneurship theory and practice, architectural design competitions, etc., serving as the practical application and verification phase of the curriculum system.

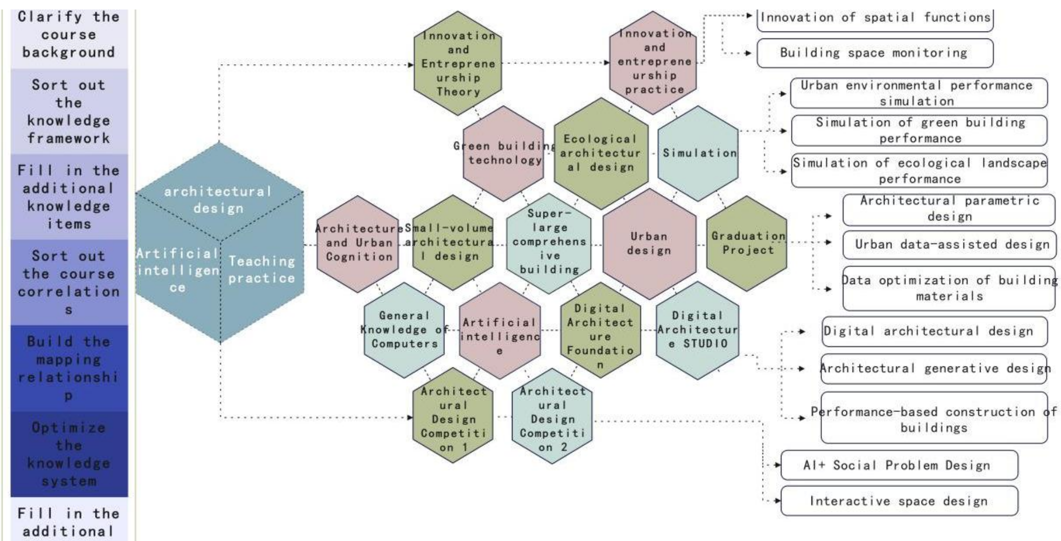

Figure 1：The Mapping Relationship of the Five-Chain Integrated Curriculum System

5 Conclusion

This research project breaks through traditional architectural design methodology by introducing cutting-edge technologies such as artificial intelligence (AI) and urban big data. It integrates multidisciplinary knowledge into the design process, employs intelligent algorithms and data analysis to realize a systematic workflow from data-driven identification of social issues to AI-powered alternative evaluation, thereby establishing a social demand-oriented and intelligent data-driven architectural design methodology. At the practical level, it forms an innovative design practice framework spanning from urban issue diagnosis to design scheme generation and post-occupancy evaluation (POE). Through engagement in real-world projects, students are empowered to bridge theoretical knowledge with practical implementation, effectively cultivating application-oriented talents capable of addressing complex urban challenges.

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