Research on the Innovation Path of Architectural Education Oriented to Artificial Intelligence: Based on the Construction of a "Three-Stage" Artificial Intelligence Teaching System

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Abstract: With the rapid development of artificial intelligence technology, its deep integration with architectural education has become an important topic at the forefront of the discipline. This paper aims to respond to this demand by introducing artificial intelligence technology and constructing a three-stage educational system that progresses step by step. It covers a complete knowledge chain from the basics of computer programming, to understanding the core algorithms of artificial intelligence, and then to the cutting-edge applications such as architectural generation, performance optimization, and intelligent construction. This research provides a framework and path for reference in building a systematic artificial intelligence architecture teaching plan, and has positive reference significance for promoting the intelligent transformation and interdisciplinary innovation of architectural education.
***Keywords*:** artificial intelligence, architectural education, computer programming, core algorithms, architectural generation, performance optimization

1. Progress in the Integration of Artificial Intelligence and Architecture

In recent years, the integration of artificial intelligence and architecture has progressed from early computer-aided design (CAD) to a new stage centered on intelligent, data-driven generation. Breakthroughs in generative AI, such as generative adversarial networks (GANs) and diffusion models, have expanded research from form generation to comprehensive generative design. In building performance optimization, machine learning enables real-time prediction and iteration of energy consumption, lighting, and wind environments, improving design efficiency and scientific rigor. [1] At the construction and operational levels, computer vision, robotics, and IoT-based intelligent management systems are promoting automated construction and dynamic control of building operations. Current challenges include data standardization, interdisciplinary collaboration, and algorithm reliability, while future trends will focus on deeper AI integration with BIM/CIM, embodied intelligent buildings, and enhanced human-machine collaboration in design.

2. Bottlenecks and Existing Issues in Architectural Development

Currently, architecture faces severe challenges as its traditional development model reveals multiple bottlenecks against increasingly complex social, environmental, and technological demands. [2] These issues highlight methodological and knowledge-system lags in the industry, while also pointing to the need for integration of artificial intelligence.

In terms of design methodology, overreliance on experience and insufficient quantification have become pronounced. The conventional design process depends heavily on personal intuition, with building performance assessments often lagging behind conceptual design, leading to prolonged optimization cycles and inadequate decision-making basis. Given today's sustainability standards and complex built environments, human experience alone can hardly identify optimal balances among numerous multi-objective variables.

At the technical level, the industry suffers from severe data silos and fragmented workflows. Although BIM aims to integrate the building lifecycle, data from planning, design, construction, and operation still cannot flow seamlessly or be analyzed intelligently. This disrupts the knowledge feedback loop, causing loss of design intent during construction and preventing operational data from informing future designs.

Moreover, the industry is constrained by efficiency bottlenecks and lack of innovation. Under tight schedules and budgets, designers have limited time to explore alternatives, often resorting to safe, repetitive solutions, which stifles architectural creativity. [3]

The root issue lies in the misalignment between traditional architectural education and future industry needs. While current education solidifies spatial perception, aesthetics, and construction skills, it falls short in cultivating computational thinking, data literacy, and the ability to collaborate with AI. Most practitioners and students are either unfamiliar with AI or use it fragmentarily, unable to incorporate it systematically into design practice.

Therefore, establishing a structured AI-in-architecture education system is no longer a frontier exploration but an urgent necessity to tackle core industry challenges and drive disciplinary transformation.

3. Construction of the Teaching System

To address the methodological and educational lag issues that architecture faces in its intelligent transformation, this study has constructed a three-stage teaching system from the basic to the advanced level. This system follows the progressive logic of "cognitive establishment - skill acquisition - innovative application", aiming to comprehensively cultivate students' digital literacy and human-machine collaborative design capabilities, and provide a feasible path for the innovation of architectural education in the era of artificial intelligence.

3.1 General Education: Building Cognitive Frameworks and Critical Thinking

General education, as the foundational component of the system, focuses on guiding students to establish a systematic understanding of artificial intelligence technology. The teaching content covers core AI concepts, application scenarios throughout the entire building life cycle, and their social and ethical implications. Through case studies and dialectical analysis, it helps students break through technical barriers and develop a correct view of human-machine collaboration, laying the necessary thinking foundation for subsequent technical learning.

3.2 Programming Basics and Urban Data Analysis: Strengthening Technical Skills and Methodological Transformation

After acquiring basic knowledge, the teaching focus shifts to the practical application of programming tools and data analysis methods. This stage centers on the Python language and combines urban open data (such as traffic flow, land use functions, and spatial forms) to train students to complete the entire process from data acquisition, processing to visualization analysis. Through project-based workshops, students will gradually develop research capabilities that drive design decisions with data, achieving a transformation from experience-based thinking to data-supported thinking.

3.3 AIGC and Architectural Design Applications: Exploring an Innovative Paradigm of Human-Machine Collaboration

As the advanced stage of the teaching system, this module focuses on the deep integration and application innovation of AIGC technology in architectural design. It centers on prompt engineering, generation tools such as Stable Diffusion and Midjourney, and the process integration of design platforms like ComfyUI, organizing students to conduct comprehensive research projects from concept generation to performance optimization. The ultimate goal is to cultivate students' ability to master intelligent tools and expand creative boundaries, forming a collaborative design loop of "human guidance, machine generation, and professional evaluation".

4. Conclusion

This research has developed and implemented a "three-stage progressive" teaching system to address the transformational needs of architectural education in the AI era. Through two years of teaching practice and iterative refinement, the system has proven effective and innovative.

Theoretically, it establishes a progressive cultivation path of "cognitive establishment – skill acquisition – innovative application," overcoming the conventional separation between technical and design courses. In the general education stage, students build a sound understanding of human–AI collaboration through conceptual and ethical discussions. The programming and data analysis phase uses urban space as a context for mastering Python and data skills by solving real problems. The AIGC design application stage achieves deep integration of intelligent technology and creative innovation. This structured approach effectively reduces students' cognitive barriers and learning anxiety.

In practice, project-based learning, workshops, and specialized labs significantly enhanced students' digital literacy and innovation capabilities. Participants demonstrated outstanding performance in graduation projects and competitions, showing improved ability to employ data analysis in design decisions and expand creativity with generative tools. Especially in complex topics like urban renewal and sustainable design, students exhibited comprehensive problem-solving skills based on data insight and AI generation.

The innovative value of this research lies in three aspects: it establishes the first complete architectural AI teaching system spanning from basic cognition to advanced application; it integrates technical learning with design thinking cultivation; and it offers an operational model for proactively adapting to technological change. The system not only tackles current issues such as lack of computational thinking and fragmented technology use but, more importantly, equips students with future core competitiveness — the ability to skillfully use intelligent tools while retaining professional judgment.

Looking ahead, the teaching framework offers an important reference for the intelligent transformation of architectural education. It will remain open and developmental, continuously incorporating new technologies and methods to further contribute to educational innovation and the cultivation of future industry leaders.

References

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