

Teaching and Study of Artificial Intelligence-Driven Regional Architectural Design Courses

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Abstract: In the process of digitization and globalization, traditional regional architectural design education faces certain limitations. Although AI technology offers a new pathway for the innovation of architectural education, the integration of the two still encounters multiple challenges. To explore the compatibility between AI technology and the teaching of regional architectural design, this study proposes an approach for the teaching system that integrates technological empowerment, cultural restructuring, and capability development. Combining teaching cases, this work constructs a multi-level modular curriculum system that progresses from foundational empowerment to core practice and then to expansive innovation. Additionally, the study introduces a multi-dimensional evaluation mechanism that emphasizes both process and outcomes, along with a multi-type supporting resource development system.

Keywords: Artificial intelligence; Architecture; Style imitation; Text-to-image generation; Image-to-image generation

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1. Introduction

As globalization and digitalization are intertwined and evolving together, architectural education is confronting unprecedented challenges and opportunities. For a long time, traditional architectural design education has had certain limitations in terms of information exchange, divergent thinking, and the integration of theory with practice ^[1]. The introduction of artificial intelligence (AI) technology offers new ways to overcome these limitations. In particular, generative AI tools, such as Midjourney and Stable Diffusion, have dynamically entered the field of architecture, providing more possibilities for rapid image generation and inspiration for students ^[2]. In addition, these tools can not only be used for visual concept generation but also play a crucial role in design aspects such as architectural structural analysis, spatial planning, parametric modeling, and performance analysis ^[3].

However, as an important vehicle for inheriting and promoting local culture, regional architectural design education still faces challenges in its integration with AI. First, the complexity, diversity, and tacit

knowledge of regional architecture are difficult to fully quantify and encode, resulting in a potential lack of depth and accuracy when AI models handle regional specificity. Second, most deep learning models lack interpretability, with opaque decision-making processes and the so-called “black box” problem, which may lead students to overly rely on AI-generated results while neglecting critical thinking about design principles and regional context ^[3]. Without reliable human intervention, AI-generated results may sometimes lack originality and depth, and even exhibit a certain degree of mediocrity. Third, there is currently a lack of unified and effective standards for evaluating the teaching effectiveness of AI-assisted design, especially in measuring students’ creativity, regional adaptability, and the development of critical thinking. How to assess the correctness, creativity, and regional relevance of designs assisted or generated by AI remains a question worthy of discussion. Fourth, many practitioners in traditional architectural education lack professional knowledge and teaching experience in AI technology, making it difficult for them to effectively integrate AI tools into the curriculum or guide students in deeply understanding and utilizing AI tools ^[4]. Correspondingly, the rapid development of AI tools also places pressure on teachers for continuous learning ^[5]. Fifth, AI models are trained based on existing data. If the training data itself contains biases or lacks diversity, the designs generated by AI may further solidify these biases and even produce designs that are unethical or insensitive to regional culture ^[6].

Based on the above situation, this paper aims to explore the compatibility between AI technology and regional architectural design teaching and propose ideas for reconstructing a teaching system with an integrated framework of technology, culture, and competence. Through an analysis of the mechanisms of AI in terms of technological empowerment, cultural reconstruction, and competence cultivation, combined with specific teaching cases, this paper will construct a multi-level, modular curriculum system, providing a new paradigm for the living inheritance of regional architectural culture and the cultivation of innovative architectural talents in the digital age.

2. Compatibility between AI and regional architectural design education

At a time when the wave of digitalization is sweeping across the globe, the deep integration of AI technology with regional architectural design teaching has emerged as a pathway to drive innovation in architectural education. This adaptability is not only manifested in the optimization of traditional teaching processes by technological tools but also lies in its reconfiguration of the interactive relationship among humans, technology, and culture, providing a brand-new paradigm for the inheritance and innovation of regional architectural culture.

2.1. Technological empowerment: Breaking through traditional teaching bottlenecks

The teaching of traditional regional architectural design has long faced three major dilemmas. First, the refinement of cultural symbols relies heavily on extensive field research and manual drawing, requiring students to spend months combing through unstructured data such as local chronicles and oral histories from craftsmen. Second, design practice is constrained by geographical space, making it difficult for students to intuitively grasp the profound impacts of complex terrain, landforms, and climatic conditions on architectural forms. Third, knowledge transfer is unidirectional, with teachers acting as “authorities on knowledge”, struggling to accommodate the individualized needs of each student in understanding regional culture. The intervention of AI technology offers possibilities for resolving these challenges ^[7].

Taking the research on traditional Thai architectural teaching as an example, the temple complexes along the Chao Phraya River in Bangkok embody unique aquatic cultural genes. In traditional teaching, students are required to sort out the connections between spatial layouts and decorative symbols through on-site mapping and consulting ancient texts. With the introduction of AI, a multimodal database encompassing architectural floor plans, historical images, and videos of religious ceremonies can be constructed. This database enables students to rapidly generate three-dimensional models of temple main halls in virtual environments and utilize computer vision technology to identify the evolutionary patterns of eave decorations across different historical periods. The combination of data-driven approaches and scenario simulation can condense the data collection and form verification tasks that traditionally take weeks into just a few days, allowing students to devote more energy to cultural interpretation and conceptual deliberation.

2.2. Cultural reconstruction: Activating the modern translation of regional genes

The core of regional architectural design lies in the creative transformation of local knowledge; AI technology provides a unique cognitive framework for this endeavor. In traditional teaching, students often fall into the trap of superficial imitation of architectural forms, struggling to grasp the underlying cosmic and ethical structures of regional culture. The intervention of AI, through a bidirectional process of decoding and re-encoding, can facilitate the revitalization and regeneration of cultural symbols.

In a teaching case (**Figure 1**) that integrates architectural styles from Sichuan-Chongqing and Southeast Asia, there exists cultural resonance between the stilted building morphology of Chongqing's Hongya Cave and the wooden structures of traditional dwellings in Chiang Mai, Thailand ^[8]. However, achieving an organic fusion of these two styles had previously posed a significant challenge in teaching. By analyzing spatial scales, material properties, and climate adaptability data from buildings in both regions, the AI system generated a model library of new stilted buildings tailored to Chongqing's mountainous terrain and humid climate. Building upon this foundation, students utilized parametric design tools to adjust the depth of eave projections and the connection methods of wooden components, thereby creating hybrid-style solutions that not only retained the ecological wisdom of Sichuan-Chongqing architecture in adapting to mountainous terrain but also incorporated the transparent and light spatial qualities of Thai architecture. Evidently, the collaborative creative mode between humans and machines breaks the mental set of "region as a single culture", enabling students to understand that regionality does not equate to the solidification of a particular style but rather involves the dynamic recombination of different cultural genes through technological mediation.

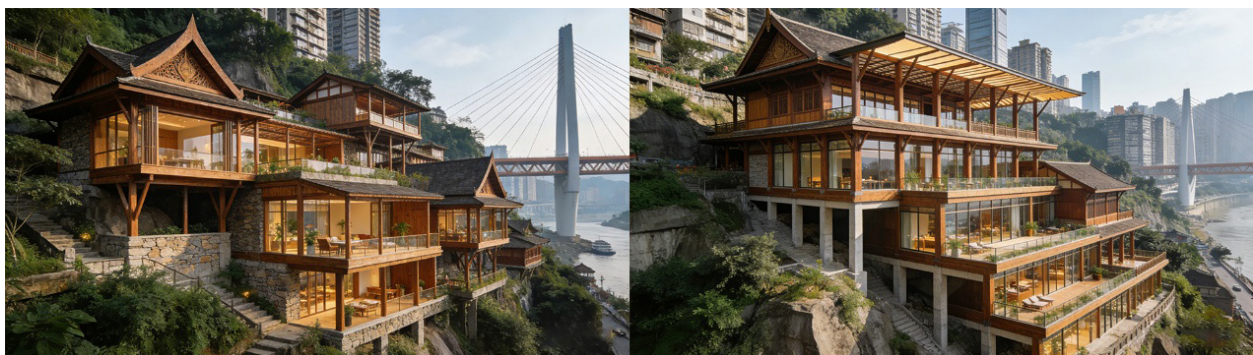


Figure 1. Architectural design case integrating styles from Sichuan-Chongqing and Southeast Asia.

2.3. Goal-driven approach: Cultivating composite competencies in future architects

The integration of AI into the teaching of regional architectural design, driven by the digital age, represents a paradigm shift in education. This transformation manifests itself on three levels. First, the role of teachers evolves from that of knowledge transmitters to learning facilitators, with their core responsibility being the design of thought-provoking question chains that stimulate deep thinking. Second, there is a fundamental change in students' skill sets. In addition to mastering traditional design skills, they must also possess digital literacy encompassing data governance, algorithm optimization, and critical filtering. Third, the evaluation system shifts from being outcome-oriented to process-oriented, capturing every parameter adjustment and conceptual iteration made by students on AI platforms to generate visual maps of their thought processes. For instance, in the teaching practice of industrial architectural design, students utilized AI tools for structural simulations to analyze the load-bearing characteristics of traditional brick arches and the connection methods with modern steel structures, thereby designing new industrial building solutions that not only meet the requirements of brewing processes for space humidity and temperature but also comply with modern seismic standards ^[9]. This teaching model, oriented towards real-world problems, mediated by technology, and rooted in culture, embodies the core value of regional architectural design education in the AI era.

3. Reconstruction approach for the teaching system

The reconstruction of the AI-driven teaching system for regional architectural design (**Figure 2**) centers on constructing an integrated framework that combines technology, culture, and capacity. Through systematic reorganization of the curriculum structure, dynamic optimization of teaching processes, in-depth innovation of evaluation mechanisms, and collaborative development of supporting resources, this system aims to break down disciplinary barriers and the one-way transmission model inherent in traditional architectural education. This model facilitates a paradigm shift from knowledge transfer to the cultivation of higher-order capabilities, ultimately achieving the dual objectives of preserving the vitality of regional architectural culture and nurturing innovative talents in the digital age.

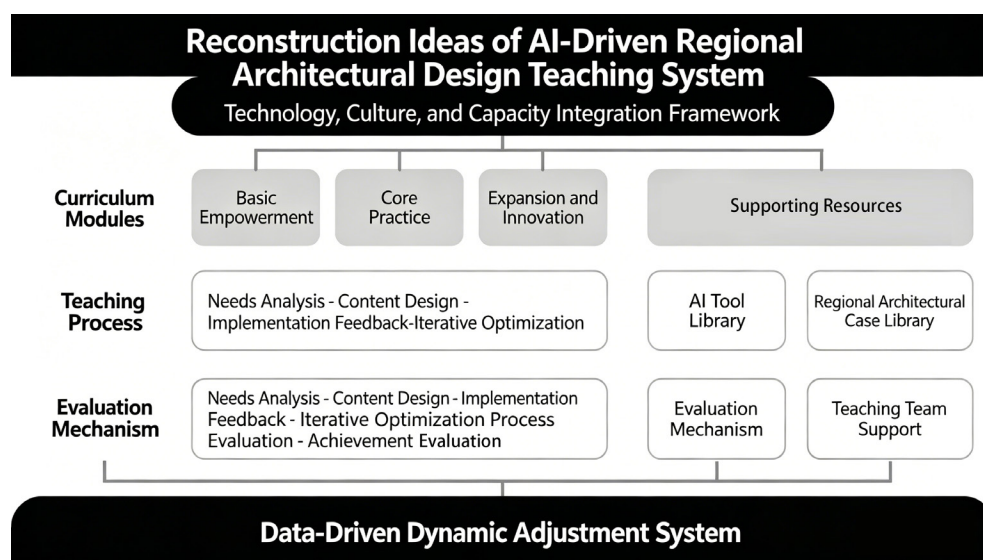


Figure 2. Conceptual framework for the reconstruction of the teaching system.

The reorganization of curriculum modules follows a logical sequence of basic empowerment—core practice—extension and innovation, forming a multi-tiered, modular knowledge and skill system. First, the basic empowerment module focuses on mastering technological tools and establishing cultural awareness. On one hand, through courses such as Introduction to Architectural AI Technologies and Data Collection and Processing, students are helped to grasp the operational logic of tools like text-to-image, image-to-image, and parametric design, as well as methods for collecting, cleaning, and visualizing architectural big data, thereby establishing a fundamental understanding of “technology serving design”. On the other hand, traditional courses on regional architecture are optimized by introducing AI-assisted teaching for cultural symbol extraction. By constructing a multimodal database of regional architectural cultures across multiple regions, students are guided to systematically extract core symbols, spatial prototypes, and ecological wisdom from regional architecture using AI image recognition and text analysis tools. Second, the core practice module, as a pivotal component of the teaching system, should be driven by real-world projects, deeply integrating AI technology throughout the entire design process. In the preliminary design phase, AI geographic information analysis tools are employed to rapidly complete site suitability analysis and concept generation. During the schematic design phase, generative AI tools are used to refine details, parametric design optimizes performance, and AI structural simulations validate feasibility. In the presentation phase, AI visualization techniques are fused with traditional presentation methods to enhance the cultural appeal of design proposals. Finally, the extension and innovation module emphasizes interdisciplinary collaboration and cutting-edge exploration. Interdisciplinary courses are offered to guide students from architecture, computer science, environmental studies, cultural heritage, and other disciplines to collaboratively complete complex design projects. Simultaneously, elective courses on cutting-edge topics are set up to cultivate students’ critical thinking and innovative exploration spirit. Throughout this process, a student-centered, AI-mediated, and teacher-guided closed loop of human-machine collaboration needs to be established.

For such a curriculum, evaluation dimensions should encompass multiple aspects, including technological application, cultural translation, design capability, collaboration, and reflection. The weighting of each dimension can be dynamically adjusted according to the curriculum module, considering not only students’ mastery and rational application of AI technologies but also the depth of understanding and innovative translation of regional culture in their design proposals, as well as their comprehensive design performance and communication contributions in interdisciplinary collaboration. Evaluation methods should emphasize the combination of formative and summative assessments, complementing quantitative scoring with qualitative evaluations. Utilizing an AI teaching management platform to record students’ learning trajectories and incorporating qualitative evaluations from teachers and opinions from industry experts ensures the scientific rigor and comprehensiveness of the evaluation results as much as possible.

Furthermore, the development of teaching resources is crucial for the efficient operation of this system. The application of multimodal databases on regional architectural cultures provides data support for teaching in terms of regional architectural resources, AI design cases, and tool algorithms. The development of teacher resources primarily focuses on training and enhancing the AI teaching capabilities of existing architecture faculty, supplemented by the recruitment of professional teachers from related fields or the hiring of industry experts to participate in curriculum design and practical guidance. This approach facilitates the construction of a composite faculty team, ensuring that teaching content closely aligns with industry demands and cultural heritage preservation requirements.

4. Conclusions

This study explores AI-driven teaching in regional architectural design, clarifying the compatibility between AI technology and regional architectural design education at the levels of technological empowerment, cultural reconstruction, and competency development. The work proposes a framework for restructuring the teaching system. Through the design of curriculum modules encompassing basic empowerment, core practice, and extension and innovation, combined with an evaluation mechanism that emphasizes both process and outcomes, as well as the construction of multi-type supporting resource development system, this study offers a pathway to address bottlenecks in traditional regional architectural design education. Additionally, this study establishes a human-machine collaborative teaching paradigm for the dynamic preservation of regional architectural culture and the cultivation of architectural innovation talents in the digital era.

However, while this study has constructed an overall teaching system framework, it still lacks more detailed practical validation in areas such as the adaptability of AI tools across diverse regional architectural cultural contexts and the tiered development of digital literacy for students at different academic levels. Moreover, a standardized approach for controlling the translation accuracy of regional cultural symbols in AI technology applications has yet to be established. Future research could further engage in localized teaching practices by incorporating the architectural cultural characteristics of different regions, refine application standards and operational procedures for AI tools across various teaching stages, and delve deeper into exploring long-term mechanisms for integrating AI with regional architectural design education. Through university-enterprise collaboration and interdisciplinary cooperation, continuous improvements can be made to teaching resources and faculty development. By balancing the application of technological tools with the expression of regional cultural essence, this research aims to propel AI-driven regional architectural design education toward greater precision, systematization, and innovation, ultimately cultivating a new generation of architectural talents equipped with cultural preservation awareness, digital technological proficiency, and innovative design thinking.

Author contributions

D.D. conceived the idea of the study. D.D. performed the experiments. D.D. and L.W. analyzed the data and wrote the paper.

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Disclosure statement

The authors declare no conflict of interest.

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