Education Reform and Development, 2025, Volume 7, Issue 9
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

Research on the Transformation Path of Undergraduate Architecture Education in the Context of New-Era AI: A Case Study of Architecture Education in Universities in Western China

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Abstract: With the rapid development of artificial intelligence (AI) technology, architecture education is undergoing a profound transformation from traditional experience inheritance to innovation-driven development. Starting from undergraduate architecture education, this paper takes architecture education in universities in western China as an example to analyze the characteristics of its curriculum system and the practical model of the "apprenticeship system," and explores the impact of AI technology on architectural design teaching as well as corresponding response strategies. By integrating a three-in-one reform framework of "technology empowerment, cultural inheritance, and teaching reconstruction," the paper proposes curriculum optimization paths and practical training methods. The aim is to construct a new model of architecture education adapted to the intelligent era, and cultivate interdisciplinary talents with innovative capabilities, technical literacy, and a commitment to cultural inheritance.

Keywords: Architecture; Undergraduate education; Universities in western China; Educational model; Curriculum optimization

Online publication: October 17, 2025

1. Introduction

As artificial intelligence, digital technology, and other innovations exert an influence on the field of education, traditional education is gradually facing challenges. The channels for students to acquire knowledge have expanded; in the information age, various knowledge theories have been widely disseminated and permeated. How to impart more valuable knowledge and information to students, and how to update teaching models to meet the development requirements of the times, have gradually become issues for educators to ponder [1]. Driven by AI technologies such as generative design, intelligent construction, and virtual reality, the architecture industry is facing an ecological restructuring, and the limitations of the “apprenticeship system” model in traditional architecture education have become increasingly prominent [2]. Restricted by faculty strength and technical resources, universities in western China are in urgent need of exploring educational transformation paths to address the dual challenges of technological change and interdisciplinary integration [3]. By analyzing the current status of undergraduate architecture education and the new demands of the era, this study proposes strategies for integrating AI technology with traditional teaching models and provides teaching references for the transformation of modern architecture education.

2. Research background

The undergraduate education of Architecture in our university takes design courses as the core and has built a curriculum framework that covers architectural theory, architectural technology theory, and practical training. Architectural theory includes a series of courses such as Architectural History, Building Construction, and Principles of Architectural Design; architectural technology theory encompasses content related to Green Architecture, Building Energy Efficiency, and Computer-Aided Design (including technologies like BIM and Parametric Design); and practical training consists of elements such as design-oriented courses, curriculum design practice, cognitive internships, and surveying and mapping internships. The education of the Architecture major still mainly adopts traditional teaching methods for architecture disciplines, following the conventional “master-apprentice” model where teachers provide one-on-one guidance to students for foundational architectural training.

3. Curriculum characteristics and practical training requirements of undergraduate architectural teaching

3.1. Characteristics of the curriculum system

Undergraduate education in Architecture takes design courses as its core and forms a trinity training framework of “Theory-Technology-Practice.” The curriculum system comprises three modules: the theory module, which covers courses such as Architectural History, Principles of Building Construction, and Principles of Architectural Design, focuses on the cultivation of humanistic literacy and the accumulation of basic theories; the technology module, including courses like Computer-Aided Design, Parametric Design, and Green Building Design, emphasizes the ability to apply digital tools; and the practice module strengthens students’ ability to solve practical problems through practical courses such as art modeling course practice, design-related courses and their practical sessions, as well as historical building surveying and mapping internships. Starting from the lower grades, the curriculum system gradually develops students’ architectural design capabilities: it begins with fostering art skills and constructing spatial thinking, and progresses to conducting training on the creation of specific architectural schemes when students reach the upper grades.

3.2. Traditional master-apprentice practical training model

Design courses and architectural design practical training rely on the master-apprentice system, a “master guiding apprentice” mentoring model where teachers impart design experience and drawing skills through one-on-one tutoring. The teaching process involves design progress checks and feedback: teachers regularly review sketches, models, and schematic design drawings, and provide revision suggestions through hand-drawn annotations, verbal comments, and other methods. Drawing on their own project experience, teachers guide students in addressing practical issues such as spatial scale and material selection, transferring knowledge by translating their experience into teachable content. The advantages of this process lie in teachers' ability to offer personalized guidance on each student's design proposal, which embodies humanistic care in teaching and facilitates the effective inheritance of design thinking and methods. However, there are also shortcomings: for example, work efficiency is low, as teachers may need most of a day to help a student resolve design problems. Additionally, this model relies heavily on teachers' experience and is difficult to scale up. Different teachers have different ways of thinking, so the revision suggestions they put forward may vary, making it challenging to unify specific teaching requirements.

4. The impact of AI technology on architectural education

4.1. Technological empowerment of the design process

With the application of modern technological means, a variety of new methods have emerged that can quickly generate multiple design outcomes meeting the requirements of schematic design tasks. For instance, generative AI assists in conceptual design: tools like Midjourney and Stable Diffusion can rapidly produce diverse schematic sketches to inspire students' creativity [4]. In terms of parametric design and performance optimization, Grasshopper is combined with AI algorithms to realize the automation of form generation, structural analysis and energy consumption simulation, enhancing the scientific nature of students' schematic design; and through virtual construction and immersive experiences, such as dynamic spatial scenarios built with VR/AR technologies, it is possible to help students intuitively understand spatial logic [5].

4.2. Transformation of teaching modes

For teachers, new methods have also emerged to improve teaching efficiency. For instance, in terms of personalized teaching paths, AI analyzes students' assignment data to recommend customized learning resources—such as pushing specialized cases for weak areas in parametric design. Regarding intelligent drawing evaluation and real-time feedback, AI systems based on image recognition can automatically detect the standardization of drawings and generate revision suggestions through natural language processing, alleviating the pressure on teachers from grading [6]. Additionally, there are interdisciplinary collaboration platforms: tools like NotionAI integrate teams from architecture, computer science, and environmental science, supporting research on large-scale and complex comprehensive projects [7].

5. Adjustment strategies for teaching and learning methods in the AI era

The reconstruction of the master-apprentice system in the AI era is not about technological replacement, but about the evolutionary upgrading of the educational ecosystem. By establishing a human-machine symbiotic teaching system, we not only retain the essence of individualized instruction in the traditional master-apprentice system but also expand the cognitive dimensions of the digital age. Ultimately, this cultivates a new generation of architectural talents who possess both humanistic warmth and technological sharpness.

5.1. Reconstructing the master-apprentice system: From "Human-to-Human Transmission" to "Human-Machine Collaboration"

An intelligent hierarchical evaluation system is established, and a student competence assessment model based on BIM parameter analysis, design thinking evaluation, and machine learning algorithms is constructed. Through the collection of design work data, cognitive behavior analysis, and knowledge graph construction, an accurate portrayal of students' three-dimensional competence profiles is realized. This system can dynamically track students' growth curves in dimensions such as spatial imagination, structural understanding, and aesthetic perception.

For instance, a digital twin curriculum module can be developed, building a three-in-one curriculum framework of "architectural scheme + digital modeling + virtual simulation." This framework deeply integrates traditional construction techniques with technologies such as generative design, AI-assisted rendering, and XR spatial interaction [8]. In the course of "Protection of Historical Buildings", for example, laser scanning data reconstruction and machine learning style transfer technology are integrated. In response to the development of modern intelligent technology, an intelligent enhanced knowledge graph is utilized, and natural language processing technology is applied to build a dynamic knowledge base for architecture [9]. This enables functions such as intelligent retrieval of specification clauses, semantic association of design cases, and version tracing of technical standards. Through the visual presentation of the knowledge graph, students are helped to establish a cross-scale systematic cognition [10].

5.2. Innovation in practical training

5.2.1. Intelligent construction workshop

A practical platform equipped with intelligent devices such as robotic arms, 3D printers, and UAV surveying and mapping tools is built, and a curriculum module on architectural robot programming is developed. In the process of human-machine collaboration, students master the complete workflow from digital modeling to physical construction. For example, by combining 3D printing and UAV technology, virtual schemes can be transformed into physical models to verify the feasibility of designs.

5.2.2. Augmented reality (AR) guidance system

An AR-assisted design guidance tool is developed, enabling real-time annotation of 3D spaces through spatial projection and gesture interaction. Mentors can remotely add virtual annotations, and the AI system automatically identifies design flaws and provides improvement suggestions.

AI design seminars are set up to guide students to think dialectically about the relationship between machine aesthetics and humanistic values through creative design training. For example, in the construction of a traditional architecture database, a "Xinjiang Earthen Architecture Intelligent Database" is established through 3D scanning and machine learning, which can automatically identify cultural elements such as arches and wood carvings. AI algorithm tools are developed to translate the ventilation logic of the Uyghur "Ayiwang" courtyard into design parameters for modern residential buildings, facilitating innovative practice.

6. Practical approaches to cultivating interdisciplinary architectural talents

6.1. Curriculum reconstruction for cross-domain knowledge integration

6.1.1. Intelligent-enhanced curriculum modules

Develop a "triple-linked" curriculum integrating Architectural Structural Design, Architectural Physics Performance Simulation, and Environmental Data Visualization. This curriculum is connected through the Grasshopper-Dynamo-UE5 toolchain to foster students' dual competencies in parametric design and technical verification [11]. Launch an interdisciplinary course "Architectural Anthropology × Spatial Machine Learning," which uses eye trackers and behavioral sensors to collect spatial usage data, and trains AI models to predict human spatial perception patterns.

6.1.2. Development of dynamic knowledge graphs

Build an AI-based interpretation system for architectural codes, converting provisions in fields such as fire protection, energy efficiency, and accessibility into 3D spatial constraints to real-time verify the compliance of design schemes. Develop a genetic database of historical buildings, deconstruct and reorganize regional architectural features using StyleGAN [12], helping students master digital translation methods for cultural symbols.

6.2. Industry-university-research collaborative talent cultivation

(1) University-Enterprise Joint Laboratories: Collaborate with enterprises to establish "Intelligent Construction Joint Laboratories," providing practical training platforms for BIM modeling, robotic construction, and other technologies.

(2) Rural Revitalization Practice Bases: Students carry out the "AI-Assisted Renovation of Traditional Dwellings" project in southern Xinjiang villages, realizing rapid renovation through UAV mapping and 3D printing technologies.

The cultivation of interdisciplinary architectural talents needs to break through the boundaries of traditional majors and build a new educational ecosystem characterized by "digital technology as the backbone and humanistic spirit as the soul." Through a human-machine collaborative knowledge production model and a practice field that integrates the virtual and the real, we aim to nurture architectural leaders who can not only master intelligent tools while upholding humanistic values, but also excel in professional fields while perceiving systematic connections. This transformation requires educators to redefine the relationship between "teaching" and "learning," and cultivate students' interdisciplinary capabilities in the "melting pot" of real-world problems.

7. Countermeasures

7.1. Strategic positioning for differentiated development

Focus on the special needs of ecologically fragile areas and multi-ethnic settlements in Western China, and launch distinctive course modules such as "AI-Assisted Ecological Restoration Design" and "Digital Protection of Traditional Architecture." Establish a lightweight technology application model: adopt technologies with low configuration requirements, such as edge computing and lightweight BIM, and develop teaching toolkits adapted to the hardware conditions in Western China. For example, based on UAV aerial survey and open-source GIS platforms, build a low-cost digital surveying and mapping teaching system for rural settlements.

7.2. Reconstruction of localized curriculum system

"Digital Craftsman" Training Program: Offer compulsory courses such as "Python Application in Architecture" and "Fundamentals of Geographic Information System (GIS)," and integrate general education on AI technology; carry out regional design topics like "Microclimate Simulation in Arid Areas"; set up "Western Smart Construction Workshops" to conduct practical training in combination with real projects such as photovoltaic agricultural greenhouses and ecological migration resettlement [9]. Develop courses on digital inheritance of living heritage: establish a "Digital Twin Library of Traditional Architectural Techniques," record craftsmen's construction processes through motion capture technology [13], and convert them into AR-guided teaching resources.

7.3. Construction of a diversified and collaborative ecosystem

Establish a cross-regional "Digital Education Alliance", co-build virtual course teaching and research sections with universities in Eastern China, and share intelligent design teaching resources; join hands with scientific research institutions in Western China to set up the "Silk Road Architectural Digital Archive" and build an inter-provincial cultural heritage database. In terms of the government-industry-university-research-application linkage mechanism, align with the policy needs of "new-type urbanization in Western China" and undertake government projects such as smart villages and activation of historical blocks [14].

7.4. Adaptive upgrading of the teaching staff

Implement the "double qualification and double competence" training for teachers, introduce a teacher AI competence certification system, and require professional teachers to master intelligent design tools (e.g., Rhino + Grasshopper, CLO3D) [15]. Build a digital teaching and research community, establish interdisciplinary virtual teaching and research sections, and regularly carry out thematic teaching and research activities such as BIM forward design.

8. Conclusion

The adaptation of architectural education in Western China's universities to the era of AI should not be a simple technology transplantation. Instead, it is necessary to build a new educational paradigm featuring "technology adapting to regional needs, digitalization activating traditional wisdom, and intelligence serving the development of Western China". By exploring the potential of digital expression of regional cultural genes, establishing a low-cost and high-efficiency technology application model, we can cultivate new-type architectural talents who can not only master intelligent tools but also have a deep understanding of the construction wisdom in Western China. This transformation is not only an inevitable choice to respond to the technological revolution but also a historical opportunity for Western architectural education to achieve "corner overtaking." It needs to be based on cultural confidence and blaze a path of educational development with distinctive Western regional characteristics.

Disclosure statement

The author declares no conflict of interest.

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