



# Research on the Construction of a Practical Teaching System Based on the Cultivation of “Data-Driven Design” Competence: Taking Micro-Professional Course Clusters as an Example

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**Abstract:** This paper, in response to the challenges faced by architecture education in the data-driven era, takes the “Urban Data Science and Digital Architecture” micro-major as the research object and systematically explores the construction of a practical teaching system for the cultivation of data-driven design ability. By analyzing the deficiencies of the traditional design practice teaching system in terms of competency objectives, curriculum structure and teaching methods, an innovative path for the micro-specialty teaching model is proposed, and a four-stage progressive practice teaching system of “concept enlightenment - tool mastery - analysis application - intelligent generation” is constructed, providing a practical solution for the digital reform of design education.

**Keywords:** data-driven design, micro-major, architectural education, practical teaching system

## 1. Introduction

At present, the convergence of smart cities, digital twins and generative AI is driving a profound paradigm shift in architecture and design: from the traditional “experience-driven” to the new “data-driven design”. This trend demands that designers in the architecture industry have the core ability to use data to gain insights into problems and algorithms to generate solutions. However, the traditional architecture education system has long focused on formal aesthetics and skills training, with significant shortcomings in the cultivation of key abilities such as data science and programming logic, resulting in a gap between the supply of talent and the digital demands of the industry.

In this context, micro-specialties, with their agility and interdisciplinarity, have become the ideal testing ground to break through this predicament. This paper takes the “Urban Data Science and Digital Architecture” micro-major in the Department of Architecture as the research object, focusing on its core course clusters: “Introduction to Artificial Intelligence”, “Fundamentals and Applications of Python Language”, “Python Language and Urban Data Analysis”, and “Confyui Architectural AI-Assisted Design”. These four courses form a progressive chain of practical ability development from “cognitive enlightenment” to “tool mastery”, “analysis application” to “intelligent generation”, providing a micro case for the study of the practical teaching system of “data-driven design”.

## 2. Problem Diagnosis of the Traditional Design Practice Teaching System

### 2.1 Misalignment of competency Objectives: Emphasizing “skill operations” over “data thinking”

The core objective of traditional practice teaching is to cultivate students’ ability to proficiently use professional software for drawing, modeling and presentation. This model views computers as “more efficient brushes”, with training focusing on software command operations and ignoring the logic and algorithms behind them. While students are able to produce fine drawings and models, their decision-making process still relies on subjective experience and aesthetic intuition, lacking the “data thinking” that uses data to define design problems, quantitatively analyze design conditions, and generate and optimize solutions through algorithms[1].

### 2.2 Single curriculum structure: The absence and fragmentation of interdisciplinary knowledge modules

In the traditional curriculum, programming, data analysis, and artificial intelligence are often classified as exclusive domains of computer science and are blank or marginal in the design curriculum system. Even if they are introduced, they are mostly isolated courses and have not been organically integrated with the core courses of design[2]. This fragmentation of knowledge modules makes it difficult for students to build a complete chain of knowledge from data to design and to translate emerging technologies into tangible design productivity.

### **2.3 Lagging teaching methods: Project practice disconnected from the real data loop**

The existing design studio teaching model has topics that are mostly virtual or simplified tasks, lacking real, dynamic data support[3]. Students' research and analysis often rely on static topographic maps, photographs and limited field investigations, and design schemes are difficult to respond to the flowing traffic, active communities and changing microclimates in the real urban environment. The practical teaching segment fails to establish a closed loop of "data collection - analysis - decision-making - validation", preventing students from experiencing how data continuously feeds back and optimizes the design.

## **3. Innovative Construction of the micro-specialty teaching system**

### **3.1 Connect the cultivation path of "data thinking"**

Micro-majors systematically reshape students' design thinking patterns by constructing a four-stage progressive curriculum chain of "cognitive building - tool mastery - analytical application - intelligent generation". Starting with "Introduction to Artificial Intelligence", this development path, through 16 hours of concentrated teaching, breaks students' technical myths about artificial intelligence and establishes a basic cognitive framework for data-driven design; Then, through 32 hours of systematic training in "Fundamentals and Applications of the Python Language", students will master the core concepts of programming and data processing methods, providing the necessary technical support for subsequent courses; On this basis, "Python Language and Urban Data Analysis" guides students to apply programming skills to professional fields and master the techniques of obtaining, cleaning, analyzing and visualizing urban data through practical cases; Ultimately, through Confyui Architectural AI-assisted Design, a direct transition from data analysis to design. [4] This complete capacity-building chain gradually shifts students from the traditional "experience-driven" design thinking to the "data-driven" design thinking based on data and algorithms, achieving a fundamental shift in the design paradigm.

### **3.2 Redesign of the teaching system**

Micro-majors have achieved substantial integration of art design and engineering technology by deeply reorganizing the curriculum structure. This reorganization is reflected in three aspects: First, at the curriculum level, courses traditionally belonging to engineering fields such as Python programming and data analysis are set as compulsory core courses for students majoring in design, breaking the disciplinary boundaries; Secondly, in terms of content connection, the courses "Python Language and Urban Data Analysis" and "Confyui Architectural AI-assisted Design" form a tight logical loop. The former focuses on extracting valuable information from urban complex systems, while the latter transforms that information into specific design solutions. Finally, in terms of teaching methods, the "project-through" teaching model is adopted, driven by real urban problems, allowing students to naturally combine technical tools with design creation in the process of solving practical problems, and enabling students to put the skills they have learned into practice in projects.

### **3.3 Reform and Improvement of Data-driven Teaching Models**

Micro-majors have created a new paradigm of design teaching based on real data through innovative teaching models. This reform is reflected in the adoption of a "practice-oriented" teaching organization, with experimental and computer hours in the last three courses reaching or exceeding theoretical hours, ensuring that students have sufficient time for practical operations; Build a "real data closed-loop" teaching environment, requiring students to use real urban datasets to complete the entire process from data collection, processing and analysis to scheme generation, so that the learning process is highly consistent with the actual workflow; Implement "problem-oriented" project design, with real problems in urban development as the subject of course projects, to deepen students' understanding of data-driven design methods in the process of solving practical problems. This series of teaching reform measures has effectively enhanced students' comprehensive ability to use data to solve design problems in real and complex situations.

## **4. Conclusions and Prospects**

### **4.1 Research Conclusions**

This study attempts to break through the limitations of the traditional design practice teaching system in response to the data-driven paradigm through the micro-specialty teaching model. The four-stage progressive practical teaching system of concept enlightenment - tool mastery - analysis application - intelligent generation, through the organic connection of four core courses, constructs a complete chain of ability development. With a teaching strategy of precise goals, integrated structure and closed-loop practice, it can effectively cultivate students' data insight, algorithmic thinking and application ability of intelligent tools.

## 4.2 Future Outlook

This micro-professional course makes a forward-looking exploration in the field of digital education in architecture, integrating computational thinking and data technology in computer science with the professional knowledge system of architecture to construct an interdisciplinary teaching paradigm.

First, establish a dynamic update mechanism for the course content. Keep a close eye on the latest developments in artificial intelligence technology and incorporate new technologies, methods and tools into the teaching content in a timely manner. Build a more complete digital design curriculum to ensure that the teaching content is always in sync with industry development.

Secondly, promote the multi-level application and promotion of teaching outcomes. At the vertical level, systematically integrate the course modules, teaching methods and practical projects that have been proven successful in the construction of micro-specialties into traditional specialties such as architecture core design courses to promote the digital upgrade of core specialties. At the horizontal level, strengthen in-depth cooperation with disciplines such as computer science and data science, and continuously deepen the cross-science training model.

Finally, deepen the integration of industry, academia, research and application. Establish partnerships with industry-leading architectural design institutes and technology innovation enterprises to jointly develop teaching cases based on real projects, build internship and practice bases, and form a virtuous cycle of “teaching - research - practice”. By continuously tracking the career development paths of graduates, collecting industry feedback, establishing a long-term assessment and improvement mechanism for the quality of talent cultivation, and constantly enhancing the forward-looking and adaptive nature of education and teaching.

This series of measures will drive digital education in architecture from curriculum reform to systematic innovation, providing strong support for the cultivation of high-quality, innovative talents who will lead the future development of the architecture industry.

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