Region - Educational Research and Reviews, 2025, Volume 7, Issue 9
DOI: 10.32629/rerr.v7i9.4426
ISSN Online: 2661-4634
ISSN Print: 2661-4626

Teaching and innovative practice of territorial spatial planning based on digital technology

Yongzhi JIANG[1], Xiaochuan JIA[2], Yanquan CUI[3]

1. School of Urban Construction, Hainan Vocational University of Science and Technology, Haikou 570100, China
2. China Construction Design and Research Institute Co., Ltd., Beijing 100000, China
3. China Academy of Building Research, Beijing 100013, China

Abstract: The iteration of digital technology has forced a paradigm shift in the educational system for territorial spatial planning. This study constructs a digital technology integration framework featuring "one core, three pillars, and multiple interfaces"; designs a four-stage progressive teaching process covering cognitive construction, simulation deduction, collaborative decision-making, and implementation evaluation; and develops a three-level practical system through a collaborative mechanism of virtual and real scenarios. A four-stage teaching model of "theoretical modeling - simulation deduction - decision optimization - implementation evaluation" is implemented. The research reveals the threefold mechanism of digital technology empowering planning education, namely "tool enhancement - cognitive reconstruction - capability leap", providing theoretical and practical support for the cultivation of innovative digital territorial planning talents.

Keywords: digital twin; territorial spatial planning; educational model; technology integration

1 Introduction

1.1 Dual drivers of policy and technology

Against the backdrop of restructuring the territorial spatial planning system, strengthening the informatization construction of planning has become a new goal orientation for urban development in the new era. In July 2025, the construction of China's first batch of city information modeling (CIM) platforms was completed. Driven by both policy and technology, there is a large gap in the digital skills of planning practitioners, which puts forward new requirements for the cultivation of talents in the field of territorial spatial planning in colleges and universities. Currently, education in this field faces three major contradictions: the disconnection between the traditional 2D teaching model and the demand for 3D intelligent planning; the imbalance between single technical training and the cultivation of comprehensive capabilities; and the separation between closed classroom training and real planning scenarios.

1.2 Progress in academic research

Tang Sibiao suggested using big data and spatial analysis to support planning decisions, simplify project processes, and improve public participation [1]. Li Xiaolei and Hu Zhenyu proposed optimizing the teaching system and enriching teaching content based on courses of digital technology and artificial intelligence [2]. Zhao Ke et al. introduced the DIKW model to clarify the principles of two core technologies—knowledge representation and knowledge calculation—in generating intelligent planning schemes and guiding decision-making [3]. Wang Yafei et al. used 5G communication technology to build a virtual simulation experimental teaching system for narrowband Internet of Things (NB-IoT) planning and design, and carried out NB-IoT network planning and design practice [4]. Gui Xinggang took the smart city planning practice in the core area of Fuzhou Binhai New City as an example to analyze the experience in smart spatial layout, integrated planning of smart infrastructure, and the construction of a holographic management platform [5].

1.3 Research framework and value

This study proposes a digital technology integration framework of "one core, three pillars, and multiple interfaces"; designs a four-stage progressive teaching process including cognitive construction, simulation deduction, collaborative decision-making, and implementation evaluation; and develops a three-level practical system through a collaborative mechanism of virtual and real scenarios. The research results transform planning education from "application of technical tools" to "cultivation of digital thinking", contributing to the goal of cultivating intelligent planners proposed in the *New Urbanization Plan (2021-2035)*.

2 Reconstruction of the teaching system driven by digital technology

2.1 Technology integration framework

The reconstruction of the territorial spatial planning teaching system driven by digital technology adopts the framework of "1 core, 3 pillars, and multiple interfaces", forming a multi-dimensional collaborative innovation structure. Among them, the intelligent core platform built based on City Information Modeling (CIM) integrates multi-source heterogeneous spatial data and dynamic analysis models, creating a digital foundation for the integration of virtual and real environments for teaching and research. The three technical pillars of the support system form a collaborative matrix with complementary functions: The GIS technology pillar builds an analysis toolset containing core technologies such as Dijkstra's algorithm and cellular automata, supporting students in practical training such as multi-criteria evaluation of land suitability and urban expansion simulation. The BIM technology pillar relies on the Revit+EnergyPlus coupling platform to develop a 3D verification system for architectural design schemes, which can real-time check 28 design specifications including sunlight spacing and fire evacuation. The digital twin pillar uses the Unity3D engine to construct virtual-real mapping teaching scenarios. By accessing real-time IoT data, it supports virtual roaming and interactive debugging of planning schemes, enabling multi-dimensional evaluation of schemes in practical courses such as historical block renewal. The system connects to government databases such as the "One Map" of natural resources and the big data platform for population migration through standardized API interfaces, establishing a dynamic data update mechanism.

2.2 Innovation in teaching model

The innovation of the territorial spatial planning teaching model driven by digital technology adopts a "four-stage progressive" teaching process design, realizing the hierarchical leap of teaching goals through technology empowerment: Stage 1: Cognitive Construction – Focusing on the cultivation of spatial data literacy, a data collection system integrating virtual and real technologies (such as UAV oblique photography and mobile laser point cloud scanning) is built to guide students in completing basic training such as urban texture analysis and land ownership identification. Stage 2: Simulation Deduction– Focusing on the training of multi-scenario planning response capabilities, machine learning algorithms are used to build spatial development prediction models. Stage 3: Collaborative Decision-Making – Breaking through traditional professional barriers, a BIM+GIS collaborative platform is built to establish cross-professional workflows, organizing students from disciplines such as urban-rural planning and environmental science to carry out collaborative design. Stage 4: Implementation Evaluation – A dynamic feedback mechanism is created, using digital twin technology to connect to real-time data from the urban operation and management platform.

2.3 Collaborative mechanism of virtual and real scenarios

The innovation of the collaborative mechanism of virtual and real scenarios for territorial spatial planning driven by digital technology builds a closed-loop verification chain of "model construction - dynamic simulation - intelligent optimization" by developing a three-level practical system:

Level 1: Digital Sandbox – Based on the integration of BIM+GIS technology, a 3D model library with a precision of 1:500 is built, covering 12 types of spatial elements such as individual buildings and underground pipe networks.

Level 2: Real-Scenario Deduction – Relying on edge computing nodes to deploy an IoT data center, 6 types of real-time data sources are accessed, including video streams from urban traffic checkpoints and atmospheric pollutant concentration monitoring.

Level 3: Decision Simulation – Integrating evolutionary computing and machine learning technologies, a multi-objective function covering 15 dimensions (such as land development costs and ecological benefit indices) is built, supporting intelligent search and visual comparison of the Pareto frontier of planning schemes.

3 Key challenges and countermeasures

3.1 Key challenges

In specific practice, the interconnection of multi-platform data requires handling multiple format conversions, which may easily form technical barriers; programming and algorithms place higher demands on the capabilities of teachers; at the same time, the design of specific schemes may involve some sensitive geographic information data, thereby bringing ethical risks.

3.2 Suggestions for optimization paths

It is suggested to: 1. construct a "digital skill certification system" and set up compulsory modules such as Python spatial analysis; 2. develop a lightweight teaching toolkit to reduce the model calculation time to an acceptable range for classroom teaching (preferably less than 15 minutes). 3. establish a three-level security protection system of "data desensitization - permission classification - blockchain certification".

4 Conclusion

This study confirms that digital technology can reshape planning education through three paths: first, technologies such as digital twin reconstruct the paradigm of spatial cognition, materializing abstract concepts; second, intelligent algorithms drive teaching to shift from experience-oriented to data-driven; third, cloud-based collaborative platforms break down disciplinary barriers and cultivate comprehensive planning talents. Future research should focus on the mechanism of generative AI in fostering creative schemes and the optimization of cognitive load in metaverse educational scenarios. The framework constructed in this study provides a systematic solution for the digital transformation of territorial spatial planning education, contributing to the realization of the "Digital China" strategic goal.

Acknowledgments

Planning Project of Philosophy and Social Sciences in Haikou: "Study on the Paths and Methods of Innovative Investment and Financing Modes for Key Projects in Urban Comprehensive Improvement Work" (2024-ZCKT-67)

Planning Project of Philosophy and Social Sciences in Haikou: "Study on Urban Renewal under the Background of Territorial Spatial Planning" (Project No.: 2025-ZCKT-115)

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Tang SB. 2025. Digital technology empowers rural revitalization: village planning and territorial spatial planning

management. *Intelligent Building & Smart City*, 6: 65-67.

[2] Li XL, Hu ZY. 2024 . Exploration on the teaching reform of urban-rural planning major based on the concept of smart city. *Modern Urban Research*, 11: 125-127.

[3] Zhao K, Duan LL, Li JL. 2025. Knowledge graph technology support: smart city planning method inspired by the DIKW model. *Urban Planning International*, 40 (02): 110-116.

[4] Wang YF, et al. 2022. Construction of a virtual simulation experimental teaching system for NB-IoT network planning and design for smart cities. *Experimental Technology and Management*, 39(09): 211-216.

[5] Gui XG. 2021. Smart city planning for the core area of Fuzhou Binhai New City. *Planners*, 37(14): 78-84.