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Exploration of Teaching Mode Integrating GIS Technology into Landscape Architecture Planning Courses

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Abstract: Against the dual backdrop of the digital transformation of the landscape architecture discipline and emerging engineering construction, Geographic Information System (GIS) has become an indispensable technical tool in the field of landscape architecture planning and design. Nevertheless, prominent problems still exist in curriculum teaching, including fragmented content, disconnection between technical skills and design, and lack of practical scenarios. Based on the actual teaching of landscape architecture planning courses, this paper analyzes the practical dilemmas of integrating GIS into teaching, constructs a three-stage progressive teaching mode featuring "Principle Cognition – Skill Training – Comprehensive Application" as the main line, and proposes implementation paths from the perspectives of problem chain organization, online-offline hybrid teaching, and local case database construction. The research shows that deeply embedding GIS into landscape architecture planning courses helps cultivate students' spatial analysis capabilities and evidence-based design thinking, and drives curriculum teaching to shift from experience-oriented to data-oriented.

Keywords: Landscape architecture; Geographic information system; Planning course; Teaching mode

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1. Introduction

As a core discipline that coordinates the relationship between human beings and nature and shapes high-quality human settlements, landscape architecture is undergoing profound restructuring of its knowledge system. Major national strategies, including ecological civilization construction, territorial spatial planning reform, urban renewal, and the dual carbon goals, have raised higher requirements for the scientific literacy and spatial analysis capabilities of professional talents. Cheng Yuning et al. pointed out that while maintaining the core disciplinary characteristics, the knowledge system of landscape architecture in the new era should actively absorb methodologies of digital technology and ecological science and evolve toward scientization and refinement [1]. Zhao Jijun et al. also held that China's theoretical system of landscape architecture is experiencing a transformation from an empirical paradigm to a scientific paradigm [2]. Chen Chongxian et al.

further indicated that the scientization and quantification of research methods are inevitable accompaniments to the evolution of disciplinary theoretical systems [3]. When discussing practice-oriented postgraduate education in landscape architecture, Zheng Xi et al. emphasized that the industry's demand for compound literacy integrating "science – art – engineering" among talents keeps rising, and strengthening spatial analysis and data processing capabilities has become an unavoidable link in talent training [4].

As a core technology for comprehensively processing spatial information, Geographic Information System (GIS) has been widely applied to key links of landscape architecture planning and design, such as site analysis, ecological sensitivity evaluation, green space system planning, and landscape pattern measurement. The landscape architecture planning methods elaborated by Lin Guangsi et al. stress taking site data and stakeholders' demands as the basis for deducing design objectives, reflecting the inherent pursuit of scientization in planning and design [5]. Liu Shujuan et al. pointed out that digital technologies represented by GIS, BIM and parametric design have deeply intervened in the whole process of landscape architecture design, greatly improving the efficiency and precision of planning and design [6]. Li Guoying et al. also emphasized that the combination of artificial intelligence and GIS is reshaping the working modes of site diagnosis and scheme generation [7]. Liu Zhao further noted that GIS integrates spatial data collection, management, analysis and visualization, and can effectively reveal the correlations and spatial patterns among geographic elements [8]. However, compared with the high reliance on GIS in industrial practice, most domestic universities introduce GIS superficially in landscape architecture planning courses, accompanied by problems such as separation between technical teaching and design teaching, lack of practical scenarios, and single evaluation mechanisms.

On this basis, taking landscape architecture planning courses as the research object, this paper systematically discusses the practical dilemmas and implementation paths of integrating GIS technology into curriculum teaching, and attempts to construct a three-stage progressive teaching mode of "Principle Cognition – Skill Training – Comprehensive Application", so as to provide references for relevant curriculum reforms.

2. Existing problems and challenges in current teaching

2.1. Prominent separation between GIS and design courses

Most domestic universities set GIS as an independent tool course, which is offered in different semesters and taught by different teachers from landscape architecture planning and design courses, lacking systematic content connection. The exercises completed by students in GIS courses mostly adopt geographic or surveying and mapping cases, which are weakly related to professional issues such as site planning, green space layout and ecological evaluation. After entering design courses, students find it difficult to apply GIS methods to practical schemes due to tight tasks and insufficient teacher guidance, resulting in the phenomenon of "having learned but unable to apply". This problem reflects the deep imbalance in teaching objectives, contents and rhythms between courses, and is one of the core cruxes leading to the generally low integration degree of GIS teaching.

2.2. Fragmented teaching content and insufficient localized cases

Current GIS teaching mostly takes software operation as the main line, focusing on buttons, commands and processes while ignoring the geographic and ecological principles behind spatial analysis methods. Students master "how to operate" but rarely reflect on "why operate in this way", let alone take the initiative to select appropriate analysis methods according to planning and design objectives. Meanwhile, teaching cases mostly adopt foreign public data or general cases irrelevant to landscape architecture, lacking localized teaching materials combined with nearby sites and local policies. A bibliometric analysis conducted by Li Jialing et al. found that although domestic research on digital landscapes maintains continuous popularity, localized research and high-quality cases at the teaching level remain relatively scarce [9]. Such fragmented content and alienated cases trap GIS teaching in the dual dilemma of being tedious yet insufficient in depth.

2.3. Lack of practical scenarios and single competence evaluation

Landscape architecture planning courses feature strong comprehensiveness and situationality, yet current GIS teaching is mostly carried out in computer rooms, lacking real situational links associated with actual sites, including field surveys, questionnaires, and participatory mapping. Students cannot experience the complete chain of “data – analysis – decision-making”. In addition, assessment methods mainly consist of software operation questions or single assignments, which fail to evaluate students’ comprehensive analysis capabilities and design transformation abilities. Single-process assessment also cannot reflect students’ in-depth understanding of GIS spatial analysis principles, which urgently needs to be replaced by diversified outcome-oriented evaluation. The singularity of competence evaluation further restrains students’ motivation for active exploration and weakens the educational effectiveness of the course.

3. Construction of the three-stage progressive teaching mode

Targeting the above problems, this paper proposes a three-stage progressive teaching mode of “Principle Cognition – Skill Training – Comprehensive Application”. By reorganizing GIS knowledge points and embedding them into key links of landscape architecture planning courses, the deep integration of technology and design can be realized. This mode emphasizes the gradual deepening of cognitive levels and the gradual realignment of teaching scenarios.

3.1. Stage one: Principle cognition – establishment of spatial thinking and data awareness

The core task of this stage is to guide students to establish spatial data awareness and spatial thinking, rather than simply stacking software operation skills. Teaching contents revolve around basic GIS principles, including geographic coordinate systems and projections, vector and raster data models, attribute database structures, topological relations and spatial indexes. Drawing on the experience of mixed teaching based on the OBE concept proposed by Zhang Ying et al., the form of “flipped classroom + classroom seminar” can be adopted: students complete principle-related video learning before class, while classroom sessions focus on discussing “how GIS changes our understanding of sites”[10]. Contents concerning spatial data ethics, geographic information security and public data usage specifications should also be embedded in this stage to cultivate students’ data literacy and sense of social responsibility, which is consistent with Liu Xianfeng et al.’s exploration of integrating curriculum ideological and political education into GIS teaching [11].

3.2. Stage two: Skill training – method toolkit oriented to planning scenarios

This stage focuses on common GIS analysis methods in landscape architecture planning work, and integrates originally scattered skill points into a “method toolkit” oriented to planning scenarios, mainly including: site substrate analysis (DEM, slope and aspect, surface cover), ecological sensitivity evaluation (multi-factor weighted superposition), visual landscape analysis (viewshed analysis, visual impact assessment), accessibility and service scope analysis (buffer zone, network analysis), landscape pattern measurement, as well as participatory mapping and multi-source data integration. Each special topic is equipped with small assignments targeting real sites, emphasizing method selection and result interpretation. For example, drawing on the research path of landscape pattern index and habitat quality spatial correlation analysis proposed by Liao Lingyun et al., students can be guided to select local parks or suburban scenic spots as research objects and experience the whole process from index calculation to spatial interpretation [12]. Every analysis method in the skill training stage shall answer a specific professional question of landscape architecture, ensuring that technical training always centers on professional objectives.

3.3. Stage three: Comprehensive application – project-driven collaborative design practice

This stage deeply embeds GIS technology into the design tasks of landscape architecture planning courses, adopting a project-driven mode of "real topics for real practice". Students undertake complete planning projects in groups, such as urban green space system optimization, suburban park site selection and zoning planning, and landscape conservation planning of historical blocks. The projects cover complete links including data collection, field research, spatial analysis, scheme generation and effect evaluation, and each link shall be supported by corresponding GIS analysis. In the guidance process, teachers act both as design tutors and technical coaches, urging students to truly transform GIS analysis conclusions into design decisions and avoiding formal analysis of "supplementing drawings after design". This stage also encourages the introduction of Participatory GIS (PGIS) and other methods. Liu Xuan et al.'s research indicates that PGIS can effectively combine stakeholders' perceptual data with spatial analysis to form planning achievements with richer humanistic connotations [13].

4. Teaching implementation paths

4.1. Organize teaching contents through problem chains

Traditional GIS teaching often takes software functions as the main line. This paper proposes reorganizing teaching contents centered on the "problem chain of landscape architecture planning". For instance, surrounding the problem of "how to identify ecologically sensitive areas of a suburban park", knowledge points including slope analysis, land use interpretation, habitat quality evaluation and multi-factor weighting can be connected; surrounding the problem of "whether urban green space systems feature equitable accessibility", contents covering population data processing, network analysis, buffer zone analysis and statistical visualization can be integrated. Problem-chain teaching helps students form the professional thinking mode of "driving methods with problems and responding to problems with methods", and naturally connects GIS teaching and landscape architecture planning tasks in content structure.

4.2. Online-offline hybrid teaching and cross-course collaboration

Drawing on the experience of WebGIS curriculum teaching mode under the background of emerging engineering, a mixed teaching structure of "online theories + offline practice + extracurricular expansion" can be constructed [14]. Online resources provide principle explanation videos, operation demonstrations and open data resources; offline sessions focus on case seminars, computer room practice and group reports; extracurricular activities encourage students to participate in disciplinary competitions, teachers' research projects and industrial internships. Meanwhile, cross-course collaboration between GIS courses and landscape architecture planning and design courses should be promoted, such as offering them simultaneously in the same semester and sharing the same project site, so that GIS analysis results can directly serve design tasks. Where conditions permit, interdisciplinary joint teaching can be carried out with majors including urban and rural planning, ecology and geographic information science.

4.3. Teaching resource construction and development of local case database

Teaching resources form the material foundation for the implementation of the teaching mode. It is recommended that university teacher teams systematically build a localized GIS case database for landscape architecture majors. Case materials shall include multi-source data of sites such as high-precision DEM, land use, vegetation, population, POI and social media check-in data, covering multiple types of objects including urban parks, scenic spots, suburban parks and greenway systems. Li Mingyu et al.'s research shows that a large number of practical cases integrating digital technologies with plant landscape and scenic area planning are available for reference in China, which can be transformed into classroom teaching materials with high feasibility [15]. Meanwhile, a continuous update mechanism shall be established to timely incorporate new industrial methods and tools into the case database and prevent curriculum content from aging rapidly due to technological iteration.

5. Conclusion

Integrating GIS technology into landscape architecture planning courses is not merely an upgrade of teaching means, but a transformation of teaching paradigm. It means landscape architecture education shifts from single graphic expression to integrated training of diversified "data – space – decision-making", and students transform from passive scheme drawers to active solvers of spatial problems. The three-stage progressive mode of "Principle Cognition – Skill Training – Comprehensive Application" constructed in this paper emphasizes the deep coupling between GIS methods and landscape architecture planning scenarios, and focuses on cultivating students' evidence-based design thinking and comprehensive application capabilities in real scenarios. The actual implementation of the teaching mode still relies on multiple conditions, including faculty team construction, accumulation of teaching resources, and innovation of teaching systems. In the future, with the continuous penetration of emerging technologies such as artificial intelligence, big data and digital twins, landscape architecture planning courses need to continuously absorb new methods and respond to new problems, making GIS technology truly the second language for landscape architecture majors.

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