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Research on Innovation and Entrepreneurship Course and Practice Based on Project-driven 3D Printing Landscape Model Production

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Abstract: In the context of digital technology, project-driven 3D printing of landscape models enhances course content quality through real-world project integration, transforms teaching methodologies, and emphasizes industry-academia collaboration with practical application focus in curriculum reform. This study employs literature review and field investigation methods to analyze model-making courses, enabling students to develop innovative thinking and digital hands-on skills through practical project implementation. The course outcomes also serve as a reference for industry-academia collaboration initiatives in other higher education institutions.

Keywords: Project-driven; landscape model fabrication; 3D printing; Industry-academia-research collaboration.

1. Introduction

With the rapid advancement of digital technologies and the high-quality development of the landscaping industry, landscape model production has gradually transcended the limitations of traditional manual methods, entering a new phase characterized by deep integration of digital design and technological applications. As the core medium for presenting design concepts, refining proposals, and showcasing outcomes, the digital transformation of landscape models has not only restructured design processes but also propelled the industrys transition from "experience -driven" approaches to "technology-driven" methodologies. This paper systematically reviews domestic and international research achievements on digital design and technological applications in landscape model production, summarizes current research status, analyzes existing challenges, and outlines future development trends to provide valuable references for subsequent studies and practical implementations.

2. Current Status of Landscape Model Production Domestically and Internationally

The technology for creating landscape models has experienced rapid development in China. As the core medium for conceptual refinement and spatial visualization, landscape modeling is undergoing a profound transformation from physical to virtual representation and from manual craftsmanship to digitalization. Early models primarily relied on physical materials like foam and cardboard for manual cutting and assembly. While intuitive, this approach faced challenges including high modification costs, precision control difficulties, and limitations in depicting complex terrains. Recent advancements in digital technologies have propelled landscape modeling into a new phase. During site surveys, Geographic Information Systems (GIS) and oblique photogrammetry techniques are widely employed. By collecting high-precision Digital Elevation Models (DEMs)and orthophoto imagery, engineers can rapidly reconstruct and quantitatively analyze complex terrains, significantly enhancing the objectivity of preliminary site assessments. In conceptual design stages, parametric modeling software like Grasshopper has revolutionized model generation logic. Designers can now automatically generate models through parameter-driven adjustments, enabling swift exploration of diverse design possibilities during initial phases. Meanwhile, mainstream collaborative workflows such as SketchUp+CAD+Lumion and Rhino+Revit+Mars have established clear application priorities and integration processes across software components, providing practical references for engineering practices. Real-world project implementations further demonstrate the application of digital technologies in creating region-specific landscape models, achieving innovative integration of cultural, ecological, and spatial values.

Digital research on landscape model production abroad has established a relatively mature technical framework. In terms of technological application, Redweik et al. (2023) developed a 3D dynamic model based on GIS and CityEngine using the Lisbon Tropical Botanical Garden as a case study. Through procedural modeling (CGA rules), they achieved efficient representation of plants, buildings, and sculptures, which was published on ArcGIS Online for public and academic use, demonstrating the dual value of digital models in heritage management and public engagement. Regarding parametric integration and ecological modeling, Vogler et al. (2025) created the Rhino/Grasshopper plugin RHINO.ECOLOGIC®, employing voxelization strategies to integrate ecological models (including soil conditions, light patterns, and species distribution) into 3D CAD systems, providing landscape designers with early-stage sustainable decision support. Additionally, the Holographic Visualization System (HGLSS) leveraging L-systems and fractal algorithms achieved 1:1 terrain and vegetation replication through Unity3D and OSG real-time rendering, with interactive weighting reaching 0.583 in evaluation metrics. In educational and open-source practices, Korean researchers developed a digital twin platform for landscape planning using Blender and OpenStreetMap, incorporating 36 legal regulations and over 70 project plans to create a cost-effective, scalable technical framework.

In the current digital era, the "Landscape Model Production" curriculum must continuously enhance its quality to keep pace with societal advancements. The State Councils Guidelines on Promoting High-Quality Innovation and Entrepreneurship Development and Building a Digital Upgrade Edition emphasize the integration of academic institutions and enterprises, advocating collaborative efforts among industry, academia, research, and application to advance specialized course development and foster student innovation capabilities. This necessitates adopting project-driven approaches in landscape model production courses, not only cultivating technical skills but also strengthening competencies in innovative modeling thinking, model development, and landscape project implementation. It requires establishing curriculum frameworks and assessment methods aligned with contemporary demands to support students learning, research, and professional growth in landscape architecture. Currently, our universitys landscape architecture program leverages Ministry of Education industry-academia-research projects to develop innovative teaching models for landscape model production courses.

3. Objectives and Approaches for Project-Oriented Curriculum Development

3.1. Construction Objectives

Based on the demands of the landscape architecture industry and relevant job classifications, this study analyzes the professional competencies required for these positions, aligning them with various certification capabilities in model production. The primary objectives are project-driven approaches in landscape architecture and the cultivation of vocational skills, which correspond to the overarching goals of landscape architecture project development (see Table 1) [1].

Table 1. Landscape Modeling Course at Zhaoqing University

Teaching grade	Teaching aims	Content of courses
Grade 1 (Model Perception)	Model spatial cognition	Basic Training of Three-Dimensional Modeling
Grade 2 (Model Introduction)	3D Landscape Model Experience	Landscape Architecture Model Planning and Design Based on Spatial Experience In-depth Research on Model Materials
Grade 3 (Model Design)	Learning Classic Garden Models	Landscape Architecture Planning Model Design and 3D Printing Model Research
Grade 4 (Practical Model)	Design of Practical Model Project for Landscape Architecture	Landscape Architecture Model Project Practice and Graduation Design

3.2. Teaching Objectives

1) Through systematic analysis of the knowledge and skills required in landscape architecture, repeated research on garden model production emphasizes cultivating students practical operational skills with modeling equipment, three-dimensional spatial transformation capabilities, project management competencies, and hands-on model-making abilities.

2) Based on teaching objectives, schools and enterprises jointly develop flexible assessment methods and evaluation criteria for landscape model production.

3) Guided by industry demands, we adopt school-enterprise collaboration to align student training with corporate job requirements. By engaging enterprises and organizing field trips, students gain firsthand experience in the landscape model market. This approach enhances their professional knowledge acquisition in landscape architecture while developing model presentation skills, with a strong emphasis on practical application capabilities in real-world landscape projects.

4) Establishing a landscape architecture model teaching system. Investigate the professional demands of contemporary landscape architecture, and integrate current landscape architecture disciplines with practical project applications to construct a landscape architecture model teaching system. The following resources need to be consolidated: including teaching syllabi, instructional courseware, teaching cases, and instructional process videos.

3.3. Teaching Methods

1) case system

In the landscape model production course, selected classic landscape design cases are integrated into teaching methodologies. By focusing on practical engineering model projects as implementation tools, students undergo systematic training in landscape modeling techniques. Key challenges and critical elements of case models are analyzed to guide targeted skill development. This approach cultivates students comprehensive problem-solving capabilities through real-world applications. For instance, the Zhaoqing Innovation and Entrepreneurship Center model case emphasizes environmental design principles while addressing technical challenges such as harmonizing new and existing architectural structures. These practical exercises effectively enhance students ability to tackle real-world engineering challenges.

2) Project-Based Learning Method

In landscape model teaching, we integrate completed projects into the instructional framework. By analyzing real-world projects, providing explanations, and developing relevant theoretical knowledge and practical skills, students learn to execute projects and apply the project-based approach to address challenges encountered in routine landscape model courses.

3) Demonstration teaching method.

The demonstration teaching method integrates landscape model production classes into enterprises, where corporate mentors provide on-site explanations of model creation cases. Through practical demonstrations, students gain a deep understanding of the model production process. Figure 1 illustrates the creation of renovation models for four villages, where real-world examples effectively boosted student engagement. The completed case studies are also shared with local villagers as references for rural revitalization projects. (Figure 1)

Figure 1. Application of Case-Based Teaching Method in Classroom Settings

4. Project-Oriented Curriculum Development Measures for "Landscape Model Making" Course

Optimization of Course Content

Based on social demands and job competency requirements, the Landscape Architecture program adopts a training model that integrates job orientation with regional needs. It analyzes societal job requirements and corresponding competencies, determines the curriculum structure according to competency-based training objectives, and subsequently establishes teaching content for specialized courses.

1) Focus on strengthening the operational procedures for experimental equipment required in training model development, ensuring standardized and safe practices, and cultivating students operational proficiency in equipment application.

2) In the early stages of the course, students will familiarize themselves with model-making materials and engage in creative training using single-material 3D spatial models, thereby developing their ability to transform three-dimensional spatial concepts.

3) Integrate real-world projects into classroom instruction by systematically organizing the learning process through project initiation, data collection, feasibility analysis, market research, model preparation materials, base platform design and fabrication, model assembly, and lighting design. This approach cultivates students comprehensive project management skills, hands-on operational competencies, ability to evaluate project outcomes, and teamwork capabilities.

4) Adhere to the teaching philosophy of "emphasizing fundamentals, highlighting competencies, pursuing innovation, and developing applications," optimize course content, and completely disrupt the original logical structure of teaching materials in the syllabus. While training skills, ensure project integration throughout the curriculum (see Figure 2).

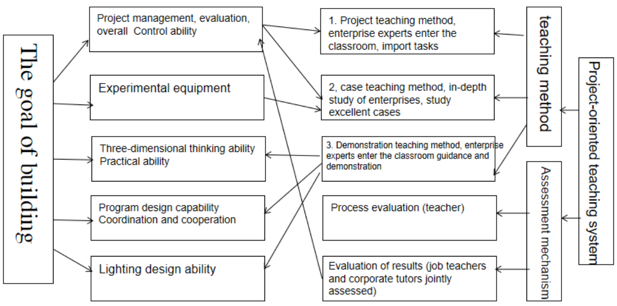

Figure 2. Relationship Diagram between Teaching Methods and Evaluation Assessment

5. Construction of Assessment and Evaluation System

1) Course evaluation. Strict control over course process stages facilitates achieving optimal outcomes later on. The final grade is calculated based on the syllabus, project content, and production process performance, accounting for 30%-40% of the total score. This approach encourages students to prioritize both results and learning processes, cultivates problem-solving skills for real-world projects, and ultimately embodies the core value of the course.

2) Final course evaluation. Based on the final course evaluation criteria and in conjunction with enterprise project acceptance requirements, the school and enterprise jointly establish a comprehensive evaluation system to assess the practicality, innovativeness, and aesthetic quality of the final model outcomes.

3) Evaluation of innovative achievements. During model course instruction, students who actively participate in curriculum-related competitions or apply model outcomes for patent applications will have their efforts graded as success levels, which will be factored into the final course grade. For instance, students recently designed a 3D printing model for Zhaoqing Innovation and Entrepreneurship Town, which received widespread acclaim from industry experts (see Figure 3-4).

Figure 3. Intra-industry experts visit and discuss the model

Figure 4. 3D Printing Model of Zhaoqing Innovation and Entrepreneurship Town

6. Conclusion

Through analyzing the applied characteristics of the "Landscape Model Production" course, we adopt project-driven approaches that integrate industry-academia-research collaboration. By utilizing practical training platforms, we establish collaborative innovation frameworks to enhance applied training. Through optimized teaching content and real-world case studies in landscape model production, we collaborate with model enterprises to complete practical projects while exploring new materials and techniques for 3D-printed landscape models. This aims to develop an applied teaching model and practical training system aligned with modern curricula, evolving trends, and innovative concepts. Such strategies effectively improve students societal adaptability and hi ghlight professional innovation capabilities. The project-oriented teaching model achieves "Three Transformations and One Shift": progressive enhancement from "innovative design thinking" and "planar design approaches" to "three-dimensional design frameworks," while fundamentally transforming educational philosophies centered on "professional development as the foundation" and "student-centered growth" to promote holistic student development. This innovative teaching methodology also enhances educators abi lity to integrate teaching resources efficiently, elevating the professional competence of dual-qualified teachers in local communities.

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