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"Dual-Environment Coupling and Mutual Promotion Through Dual Integration": Research on the Digital Training Model for Higher Vocational Environmental Art Design Majors

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ABSTRACT

Against the backdrop of accelerating digital transformation, the training model for higher vocational environmental art design majors faces the dual challenges of adapting to industry needs and improving talent cultivation quality. This paper proposes a "dual-environment coupling and mutual promotion through dual integration" digital training model, which is based on the characteristics of higher vocational education, deeply integrates virtual simulation environments with real project environments, and promotes the two-way integration of professional teaching with digital technology, and training processes with industry workflows. By systematically analyzing the predicaments of traditional training models, explaining the connotation and construction logic of this model, and demonstrating its implementation effects with practical cases, data, and student feedback, it provides theoretical support and practical paths for the innovation of training models in higher vocational environmental art design majors and similar majors, helping to cultivate high-quality technical and skilled talents who meet the needs of the digital era.

KEYWORDS

Higher vocational education; Environmental art design; Digital training; Dual-environment coupling; Talent cultivation model

1 Introduction

As a professional field integrating artistry, technology, and practicality, environmental art design plays a key role in urban and rural construction and the optimization of human settlements. With the rapid development of digital technology, from 3D modeling and parametric design in the design and creative stage to BIM technology and VR virtual acceptance in the construction management link, digitalization has deeply penetrated the entire process of the environmental art design industry. Higher vocational education, as the main position for cultivating high-quality technical and skilled talents, its environmental art design professional training model needs to keep up with the pace of the industry's digital transformation and solve the problem of disconnection between traditional training and industrial needs.

2 Analysis of the predicaments of traditional training models for higher vocational environmental art design majors

2.1 Lag and one-sidedness in digital skills training

Over 75% of enterprises report that higher vocational graduates need 3-6 months of adaptation period after employment. The root cause is that traditional training relies on fictional topics, and students do not need to deal with real issues such as client needs, cost control, and construction collaboration in an idealized environment, resulting in a structural mismatch between practical ability and workplace needs. In the industry, BIM technology is applied in 65% of construction projects, and VR/AR scheme display accounts for 60%. However, only 42% of higher vocational colleges systematically offer BIM training, focusing on basic modeling; VR/AR is mostly used as an auxiliary tool and not integrated into the entire process, and cutting-edge technologies such as parametric design and digital twins are rarely involved.

2.2 Inefficiency in the integration of training resources

The digital resources of higher vocational environmental art design majors are scattered. Teaching materials for design software are mostly collected by individual teachers, lacking the construction of standardized and systematic training case databases. There are large differences in teaching content among different teachers, making it difficult to ensure teaching quality; the connection between virtual simulation platforms and professional courses is low. For example, virtual simulation training in landscape design fails to deeply integrate with course modules such as plant configuration, terrain analysis, and ecological simulation, and cannot form a complete knowledge application chain. School-enterprise cooperation projects are difficult to be deeply introduced due to restrictions such as commercial secrets and cycles, so students cannot participate in the entire process. There is a "layer of separation" between training content and industrial reality, and the educational effectiveness of resources is not released.

2.3 Singularity and inadaptability of the training evaluation system

The traditional training evaluation system is mainly based on teachers' subjective evaluation, with a single evaluation dimension, over-focusing on the final presentation of design results, while ignoring the consideration of the training process and students' comprehensive abilities. In terms of evaluation content, it focuses on the quality of drawing and the performance of design creativity, but lacks evaluation of key vocational abilities such as students' ability to use digital tools, teamwork ability, project process control ability, and problem-solving ability; in terms of evaluation subjects, enterprise mentors have extremely low participation, and industry standards and enterprise needs are difficult to integrate into the evaluation system, resulting in evaluation results that cannot truly reflect students' workplace adaptability. At the same time, the evaluation process lacks dynamics, and one-time evaluation is mostly conducted after the training, which cannot timely find problems in students at various stages of training and give targeted guidance, which is not conducive to the continuous improvement of students' practical ability and the comprehensive development of professional quality.

3 Connotation of the "dual-environment coupling and mutual promotion through dual integration" model

3.1 Dual-environment coupling: a collaborative education ecosystem of virtual and real scenes

Construct a "virtual simulation + real project" collaborative environment: The virtual environment simulates design and construction scenes through VR and BIM, providing a low-cost and adjustable practice space for students to preview project risks; the real environment introduces enterprise projects, allowing students to deeply participate in the entire process from concept to implementation, and face real problems such as customer needs and cost pressures. The coupling of the two realizes skill training in the virtual environment and result testing in the real environment, reducing trial and error costs and strengthening the perception of industry scenes.

3.2 Mutual promotion through dual integration: in-depth integration of technology, teaching and industry processes

The integration of professional teaching and digital technology integrates technologies such as BIM and VR into courses at the "basic-application-comprehensive" levels, reconstructing content and methods, such as replacing traditional experience models with parametric design; the integration of training processes and industry processes designs training links in accordance with the industry norms of "conceptual design → construction coordination → acceptance", strengthening the compliance with standards and collaborative ability. The two levels of logic promote each other: technology integration provides means reserves, and process integration provides practical verification, promoting the precise alignment of talent cultivation with industry needs.

4 Specific construction elements and implementation paths of the "dual-environment coupling and mutual promotion through dual integration" training model

The construction of the "dual-environment coupling and mutual promotion through dual integration" training model needs to focus on the core connotation of "dual environments" and "dual integration", systematically design key elements such as training environment, teaching content, evaluation system, and guarantee mechanisms, and form a logically closed-loop implementation path.

4.1 Construction of the dual-environment coupling training environment

4.1.1 Construction of the virtual simulation training environment

The construction of the virtual simulation training environment aims at "empowering training with technology and restoring reality in scenes", focusing on the digital simulation of the entire process of environmental art design, including the following three systems: 1. Core platform system: develop a virtual training system covering two directions of interior design and landscape design. The interior design module includes: "intelligent apartment layout analysis", which accesses a large amount of real apartment layout data of local real estates; "VR real-time interactive design", which supports real-time calling and effect preview of material libraries and lighting libraries; "3D simulation of construction processes", including process animations such as water and electricity transformation and wall paving. The landscape design module includes: "parametric terrain generation", which quickly models based on GIS terrain data; "plant ecological configuration system", including a database of plant growth cycles and ecological characteristics; "sponge city simulation", dynamic demonstration of rainwater runoff and infiltration effects. 2. Technical support system: use the Unity3D engine to build 3D scenes to ensure VR fluency with a frame rate stable above 90fps; store basic data such as apartment layouts, plants, and processes through SQL Server database, supporting cloud storage and sharing of students' design results; develop a teacher-side management system that can real-time monitor students' operation processes and retrieve training data for analysis. 3. System for coupling design with real scenes: case data in the virtual environment are all from real enterprise projects to ensure that the scene restoration degree is above 85%; set up a "virtual-real" conversion interface, so that the design schemes completed by students in the virtual environment can be exported into formats commonly used by enterprises, directly used for pre-communication of real projects.

4.1.2 Construction of the real project training environment

The construction of the real project training environment follows the principle of "school-enterprise collaboration and project carrier", forming a practice system linking campus and off-campus. First, establish an on-campus project workshop: according to the "studio system" model, divide functional areas such as "community micro-renewal design center" and "small commercial space renovation studio", equipped with design software synchronized with enterprises and hardware equipment such as graphics workstations and VR headsets. Sign cooperation agreements with sub-district offices and small commercial entities, undertake a number of real projects annually, with project cycles adapted to teaching progress, and students participate in the entire process of design, construction and acceptance in groups. Second, establish off-campus training bases: build training bases at different levels, co-build "actual combat training bases" with local small and medium-sized decoration enterprises, arrange students for internship, and participate in the entire process of residential interior design, small landscape renovation and other projects. Co-build "high-end project training bases" with large enterprises, where students participate in auxiliary design and construction management of large projects such as commercial complexes and municipal landscapes.

Establish a dual-environment connection mechanism, setting up a connection process of "virtual preview → real implementation → virtual review". Before undertaking real projects, students need to complete the preliminary design and feasibility simulation of the scheme in the virtual environment. During the project implementation, the problems encountered are entered into the virtual platform for simulation analysis. After the project is completed, compare the differences between the design scheme and the actual results through the virtual platform, conduct iterative optimization, and form a closed loop of ability improvement.

4.2 Construction of the mutual promotion through dual integration teaching system

4.2.1 Implementation of the integration of professional teaching and digital technology

Reconstruct the curriculum content, integrating digital technology into courses at three levels: "basic-application-comprehensive". The basic level offers "Fundamentals of Digitalization in Environmental Art Design", teaching software operations such as CAD and SketchUp to ensure that all students can master them; the application level offers courses such as "BIM Application in Interior Design" and "VR Landscape Scheme Presentation" by direction, requiring students to independently complete digital design of small and medium-sized projects; the comprehensive level offers "Comprehensive Training in Digital Projects", integrating BIM, VR, and parametric design technologies to complete the entire process of digital design of complex projects. Teachers compile supporting loose-leaf textbooks, with each chapter including four parts: "technical principles - software operation - project cases - actual combat tasks", and integrating real enterprise project cases.

Innovate teaching methods, implementing a three-stage teaching method of "technical tool operation + virtual case exercise + real project application". In the course "Parametric Landscape Design", first guide students to master the basic operation of Grasshopper software through micro-course videos; then let students conduct parametric generation and optimization of the "urban square landscape" case on the virtual platform; finally, combine the real project of on-campus square renovation, use parametric technology to solve practical problems such as terrain elevation and pedestrian flow guidance. Introduce "flipped classroom", make software operation tutorials, technical principles and other content into online courses, students learn independently before class, and focus on project actual combat and problem solving in class.

4.2.2 Implementation of the integration of training processes and industry processes

Training links are benchmarked against industry processes, dividing the training process into four links: conceptual design stage, scheme deepening stage, construction coordination stage, and project acceptance stage. Each link sets clear output standards. For example, the conceptual design stage needs to submit a customer demand analysis report and two sets of preliminary schemes, including VR preview content; the scheme deepening stage needs to submit "deepened design drawings + BIM model + cost calculation table" to ensure consistency with industry requirements.

Introduce industry management norms into training links, implant industry standards such as "Code for Quality Acceptance of Building Decoration Engineering" and "Specifications for Landscape Engineering Construction" in training, requiring students' design schemes to meet the specification requirements; adopt enterprise project management models, implement the "project manager responsibility system", each group selects 1 project manager responsible for schedule control, task allocation, internal and external communication, and teachers only provide technical guidance and process supervision. In a commercial space renovation training, students strictly follow the industry process, completely experiencing 8 key nodes from signing a simulated contract to final project acceptance.

4.3 Construction of the whole-process training evaluation system

4.3.1 Design of diversified evaluation dimensions

Construct a "four-dimensional and three-level" evaluation system, covering skills, literacy, innovation, and industry adaptability. The four-dimensional evaluation content includes: skill dimension (40%) assesses the application of digital tools and the quality of design results; literacy dimension (25%) assesses teamwork and professional norms; innovation dimension (15%) assesses design creativity and technology integration; industry adaptability dimension (20%) introduces enterprise mentor evaluation, focusing on assessing the feasibility of the scheme and the rationality of cost control. The three-level evaluation subjects include: student self-evaluation (10%) focusing on reflecting on their own contributions and shortcomings in the team; group mutual evaluation (20%) focusing on performance in team collaboration; joint evaluation by teachers and enterprise mentors (70%), with enterprise mentors focusing on evaluating the industry adaptability of results, and school teachers focusing on technical application and the achievement of teaching goals.

4.3.2 Implementation of the dynamic evaluation process

Rely on digital platforms to realize full-process tracking and timely feedback of evaluation. Process data collection automatically records students' operation trajectories and frequency of technical application through the virtual training platform; in real project training, record data such as the number of meetings students participate in, the timeliness of submitting results, and customer communication feedback through the "project management APP". Phased evaluation and feedback generate phased evaluation reports after the end of each training link, pointing out students' problems in skill application and process compliance. For example, in the construction coordination stage, if there is a large deviation between students' BIM models and on-site construction, the platform will automatically mark and push relevant case tutorials, and teachers will carry out targeted guidance. The final comprehensive evaluation combines the whole-process data and performance in various dimensions to generate a student ability radar chart, clearly showing their strengths and weaknesses in digital skills, teamwork, etc., providing guidance for subsequent learning and career development.

4.4 Construction of the school-enterprise collaborative guarantee mechanism

4.4.1 Organizational structure construction

Establish a three-level organizational structure of "professional construction committee - school-enterprise joint teaching and research office - project guidance group". The professional construction committee, composed of school leaders, enterprise executives, and industry experts, holds a meeting once a semester to approve the reform direction of the training model and resource investment plans; the school-enterprise joint teaching and research office, composed of professional leaders and enterprise technical backbones, carries out teaching and research activities monthly to jointly develop courses and design training projects; the project guidance group, composed of enterprise designers and school teachers, provides real-time guidance for specific projects to ensure that training is consistent with industry standards.

4.4.2 Incentive and constraint mechanisms

Enterprise incentive mechanisms include the school awarding "Talent Cultivation Base" plaques to cooperative enterprises and giving priority to recommending outstanding graduates; enterprises participating in the development of courses and teaching materials can be credited with their names, and jointly developed technical achievements can be given priority in transformation; enterprises with outstanding contributions are included in the school's "School-Enterprise Cooperation Demonstration Units" list and provided with media publicity support. Teacher incentives involve converting the workload of teachers who participate in school-enterprise cooperation and guide students in real projects into teaching hours at a ratio of 1:1.5; teachers who, together with enterprises, develop training projects recognized at or above the provincial level are awarded teaching achievement prizes; teachers are regularly organized to practice and train in enterprises, with the expenses covered by the school's special funds. Student incentives mean that students who participate in real project training and perform excellently will be given priority in obtaining enterprise internship offers; training results are linked to scholarship evaluation and recommendations for skill competitions; students who put forward innovative solutions in projects are awarded the "Innovative Practice Award" and funded to participate in industry exhibitions..

5 Conclusion

The "dual-environment coupling and mutual promotion through dual integration" digital training model effectively solves the predicaments of the traditional training model for higher vocational environmental art design majors through the organic coupling of virtual and real scenes and the in-depth integration of technology with teaching and industry processes. Practical data and student feedback show that this model has significantly improved students' digital skills, design innovation ability, and professional quality, enhanced the adaptability of talent cultivation to industry needs, and provided replicable and promotable experience for the reform of the training model for higher vocational environmental art design majors.

However, the model still faces challenges in the promotion process: first, the rapid iteration of digital technology requires the establishment of a dynamic update mechanism for training platforms and course content to avoid technical lag; second, the depth and breadth of school-enterprise collaboration need to be expanded, and the enthusiasm of some enterprises to participate in teaching still needs policy incentives and interest coordination. Future research can focus on building a digital technology dynamic tracking and course update model to realize real-time synchronization of teaching content and industry technology; explore the construction path of "school-enterprise interest community" to improve the sustainability of school-enterprise collaboration through technology research and development sharing and targeted talent cultivation.

With the in-depth application of meta-universe, artificial intelligence and other technologies in the field of environmental art design, the "dual-environment coupling and mutual promotion through dual integration" model needs to be continuously iterated and upgraded, further expanding the immersion of virtual scenes and the participation of real projects, cultivating more high-quality technical and skilled talents with both artistic creativity and digital skills, and providing solid talent support for promoting the high-quality development of the environmental art design industry.

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