

Article

Research on Teaching Reform and Practice of "Environmental Design Materials and Construction Technology" Course Based on Artificial Intelligence

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Abstract: With the rapid development of a new generation of information technology such as artificial intelligence, the environmental art design industry is undergoing an unprecedented reshaping. The traditional curriculum teaching mode in vocational education is therefore facing severe challenges such as prominent discipline barriers, weak practical teaching, and fracture of students' comprehensive ability chain. This paper takes the course of "Environmental Design Materials and Construction Technology" as the practical carrier, and carries out the teaching reform and practical research with the deep empowerment of artificial intelligence as the core. By constructing a new curriculum system of "three integration and three stages," the "discipline integration, virtual and real integration, and education and training integration" are horizontally realized. The teaching content is vertically sequenced into three progressive stages of "intelligent design generation, intelligent process formulation, and intelligent achievement display," and the whole process ability training of "design-process-construction" is connected. In the process of teaching implementation, the teaching mode of "AI-driven and task-led" is innovatively adopted. Relying on the virtual simulation training platform of interior decoration construction technology and the real project of enterprises, students are guided to gradually complete the complete workflow from parameter input, AI scheme generation, intelligent review to virtual verification. It has improved students' practical and innovative ability, and constructed the distinctive characteristics of forming the "task matrix" curriculum paradigm, the "AI + imitation" twin engine drive and the "moistening silent" curriculum ideological and political education as the core, which provides some experience and reference for the reform and innovation of similar courses in vocational colleges.

Keywords: artificial intelligence; environmental design; teaching reform; fusion of virtual and real

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1. Introduction

In recent years, with the deepening of China's new round of digital technology revolution and industrial transformation, the new ecology of the design industry is being reconstructed with unprecedented depth and breadth. The digital intelligence technology cluster represented by artificial intelligence (AI), generative design (Generative Design), building information model (BIM) and virtual simulation (VR / AR) has given birth to the current new design paradigm and new workflow, which puts forward higher requirements and challenges for the knowledge and skills of professional personnel training positions in the field of environmental art design. The traditional design and construction management mode, which relies on experience and manual skill inheritance, is also difficult to adapt to the increasingly complex personalized customization and sustainable development needs in the current project. As the main channel of cultivating

technical and skilled talents in China, the structural disconnection between the content and effectiveness of existing teaching courses and the actual needs of industry posts has become increasingly prominent. Therefore, promoting the digital transformation and upgrading of vocational education curriculum and teaching system has become one of the important tasks for higher vocational colleges to improve the quality of personnel training and enhance the core competitiveness of the industry in the future [1-4].

This paper focuses on the course of "Environmental Design Materials and Construction Technology" of environmental art design major in higher vocational colleges. As the core course connecting design creativity and engineering practice, its teaching effectiveness directly determines whether students can be qualified for professional positions from program deepening to on-site management [5-7]. At present, the main problems in the implementation and effect improvement of professional skills courses are as follows: (1) At the level of knowledge structure, there are obvious "discipline barriers". The traditional curriculum is mostly based on the linear division logic of "design theory", "material selection" and "construction technology". There is a lack of organic integration between modules, especially with the cutting-edge intelligent tool chain. (2) At the level of teaching implementation, it faces the challenge of "practical dilemma". The teaching of material cognition and construction technology is highly dependent on embodied cognition and situational learning. However, subject to teaching cost, safety risk, time and space constraints and material loss, the traditional teaching mode often falls into the dilemma of "emphasizing theoretical teaching and neglecting practical verification" or "replacing the whole process with partial observation". This makes students' understanding of key skills such as hidden engineering and complex node technology stay on the surface, and it is difficult to form profound and transferable engineering literacy. (3) At the level of ability training, the disadvantages of "chain fracture" are presented. In the past, the teaching process was mostly one-way indoctrination, and there was a lack of simulation of the complete, non-linear and iterative cycle of "demand analysis-creativity generation-technical decision-results evaluation" in the real work situation. The knowledge and skills acquired by students are distributed in a point-like manner, which cannot be effectively connected in series into a chain of ability to solve practical problems such as comprehensiveness and structure, and it is difficult to meet the training requirements of "post class competition certificate" comprehensive education for higher-order thinking ability.

At the same time, the national vocational education reform plan clearly puts forward the specific requirements of deepening the reform of "three teachings", "promoting the integration of "post class competition certificate" and strengthening the ideological and political education of curriculum. Therefore, exploring a reform path of curriculum teaching implementation with intelligent technology as the engine, which can effectively penetrate the discipline boundary, break the bottleneck of practice and reshape the ability chain, not only has the theoretical reference value to promote the research of vocational education reform, but also has the practical significance of service industry industrial upgrading [8-9].

Therefore, this paper takes the course of "Environmental Design Materials and Construction Technology" as the research object of reform practice, and studies the teaching reform mode and curriculum implementation effect under the deep empowerment of artificial intelligence technology. Explore and construct a new curriculum paradigm characterized by "AI-driven, virtual and real integration, multidisciplinary intersection, and ideological and political integration". In order to provide a set of theoretical framework and practical cases for the reform of professional courses in similar colleges and universities.

2. Course Teaching Reform Path and Curriculum System Construction

2.1. The Innovative Construction of the "Three-In-One Three-Order" Curriculum System

In order to break through the structural dilemma of traditional courses, this paper constructs a new curriculum system of "three integration and three stages." The "three integrations" aim to break the barriers of disciplines, create a mixed teaching field, connect professional standards, and form the horizontal dimension of the system, as shown in table 1.

Table 1. Core Structure of the "Three Integrations & Three Stages" Curriculum System.

Structural Dimension	Core Connotation	Specific Content & Implementation Methods
Three Integrations (Horizontal Dimension)	Disciplinary Integration	Breaking the boundaries between "Environmental Design," "Materials Science," and "Construction Technology," using Artificial Intelligence technology as a link to reorganize knowledge (e.g., using AI algorithms to intelligently match and optimize material combinations based on design style and physical performance requirements).
	Virtual-Real Integration	Constructing a "Dual-Virtual & Dual-Real" teaching closed-loop: "Virtual Design" and "Virtual Process" are realized through VR/AR and AI generation technology; "Real-world Cognition" and "Real-world Operation" focus on the perception of real material properties and hands-on practice in simulated workstations, with the two iterating cyclically.
	Education-Training Integration	Deeply embedding corporate post standards, certificate assessment points, and skills competition regulations into the curriculum objectives and evaluation system, achieving the integration of "Post, Course, Competition, and Certificate."
	Stage 1: Intelligent Design Generation	Focus on learning the application of AI-assisted design tools based on multi-modal client needs, enabling rapid scheme generation and multi-scheme comparison.
Three Stages (Vertical Progression)	Stage 2: Intelligent Process Formulation	Intelligently linking design schemes with material databases and process knowledge bases to formulate technically feasible and economically reasonable construction organization plans and process details.
	Stage 3: Intelligent Outcome Presentation	Using 3D cloud platforms to generate construction drawings, material lists, process simulation videos with one click, and conducting immersive experience and optimization through VR, forming a complete set of digital deliverables.

"Three integration" refers to the integration of disciplines, the integration of virtual and real, and the integration of education and training. The integration of disciplines uses

artificial intelligence technology as a link to reorganize the knowledge modules of "environmental design", "material science" and "construction technology", and cultivate students to form integrated technical thinking. For example, learn to use AI algorithms to intelligently match and optimize material combinations according to design style and physical performance requirements. The integration of virtual and real is realized by constructing a closed loop of "double virtual and double real" teaching: "virtual design" and "virtual process" complete scheme deduction and simulation with VR / AR and AI generation technology; "Real-life cognition" and "real-life operation" focus on the attribute perception of real materials and the hands-on practice of simulated stations. The two iterations effectively break the bottleneck of practical teaching. The integration of education and training ensures that teaching and industry frontier needs resonate at the same frequency by deeply integrating enterprise post standards, certificate examination points and skill competition procedures into the curriculum objectives and evaluation system.

The "third-order" is the vertical organizational logic of the course content. Following the progressive law of professional ability, the teaching process is divided into three core stages: "intelligent design generation → intelligent process formulation → intelligent result display". This three-stage constitutes a complete project workflow from conceptual creativity to technical delivery, ensuring the coherence and systematicness of students' ability training, and realizing the transformation from discrete teaching of knowledge points to the construction of ability chain to solve comprehensive engineering problems.

2.2." Ai-Driven, Task-Led "Teaching Mode and Practice

Based on the "three-in-three" curriculum system, this study implements the "AI-driven, task-led" teaching mode, and deeply integrates digital technology tools with teaching methods to ensure the implementation of the teaching reform concept. The teaching mode design is shown in Table 2.

Table 2. Teaching Model Process and Outcomes of "AI-Driven, Task-Oriented Guiding".

Teaching Phase	Core Activities (AI-Driven)	Roles of Teacher & Student	Cultivated Abilities & Preliminary Outcomes
Project Introduction	Selecting simulation projects from the "Multi-Client Task Pool" and analyzing requirements.	Teacher: Scenario Creator Student: Requirements Analyst	Cultivates requirements analysis and communication skills.
Task Decomposition/ Knowledge Embedding	Decomposing projects into specific tasks, driving the learning of relevant knowledge (materials, AI software, standards).	Teacher: Facilitator, Resource Provider Student: Active Constructor	Cultivates self-learning and knowledge integration abilities.
Practical Implementation	Executing the "Parameter Input → AI Generation → Intelligent Review → Virtual Verification" workflow to	Teacher: Coach, Coordinator Student:	Core technical capabilities: AI tool application, integrated design, specification

	complete a full set of digital outcomes.	Lead Practitioner	review, and virtual construction.
Multi-dimensional 1 Evaluation	Automated standards scoring by the system, procedural evaluation by the teacher, peer assessment within groups, project defense.	Teacher: One of the evaluators Student: Evaluatee and Evaluator	Cultivates critical thinking, quality awareness, and teamwork skills.

(1) AI-driven reshapes the core workflow of teaching and forms a highly integrated intelligent work chain. Students extract simulation projects from the "multi-owner task library", and input the design parameters into the AI-assisted design tool to generate multiple sets of preliminary schemes. The scheme is imported into the digital design cloud platform. According to the embedded material library and specification library, the system generates the related material list, construction drawing and three-dimensional process node model by one key, and can carry out automatic normative review. Students can verify and optimize the immersive scheme through VR equipment. So that students can fully grasp the new paradigm of AI-enabled design workflow.

(2) The task-oriented model creates a real teaching situation for the application of digital technology. Taking the real project of the enterprise (such as the whole case design of the residential living room) as the core, the teaching process is divided into key links such as project introduction, task decomposition, knowledge embedding, practical implementation and multiple evaluation. Students complete the specific content according to the task design, and actively learn and master the knowledge points; teachers turn to guidance and support. Therefore, the discrete knowledge points are integrated into the continuous workflow, so that "learning by doing" and "doing by learning" are integrated, and the comprehensive professional ability of students to deal with complex working situations is effectively improved.

3. Implementation Effectiveness and Characteristic Innovation

3.1. The Implementation Guarantee of Curriculum Reform

As shown in Table 3, the project relies on a solid foundation for the implementation of pre-curriculum teaching and multiple guarantees of school policies. (1) The course team has independently developed the "virtual simulation training platform for interior decoration construction technology," which provides the core carrier for the teaching of "virtual and real integration." (2) The deep integration of industry and education established with the head enterprises such as Gujia Group and Yajia Decoration has ensured the continuous injection of real project library, cutting-edge process standards and industry expert resources. (3) A teaching team led by professional leaders, with interdisciplinary background and school-enterprise mixed compilation is constructed, which provides human and intellectual support for the interdisciplinary characteristics and practical orientation of the curriculum.

Table 3. Closed Loop of Implementation Support and Innovative Value of the Reform.

Phase	Core Elements	Specific Content & Manifestation
	Resource Support	The self-developed "Interior Decoration Construction Process Virtual Simulation Training Platform" has been

Implementation Support	Mechanism Support	launched; Chief-edited provincial-level new-form textbook published.
		Established deep industry-education integration with leading enterprises like Kuka Group and Yajia Decoration, ensuring continuous injection of real projects and advanced process standards.
	Team Support	A cross-disciplinary, mixed teaching team composed of school teachers and enterprise experts, led by the program director.
Practical Outcomes	Student Level	Significant leap in comprehensive practical and innovative ability
	Teacher Level	The teaching innovation ability has been improved, and he has won many awards in the teaching ability competition of vocational colleges.
	Curriculum Level	Established a virtual simulation training platform and supporting resource package, forming a replicable and scalable modern teaching solution.
Features & Innovation	Paradigm Innovation	Constructed the nation's first "Task-Matrix Model" intelligent environmental design course, shifting from "knowledge instillation" to "ability generation."
	Technology Drive	Realized "AI + Virtual Simulation" dual-engine drive for the entire teaching process, empowering the entire chain from "design - process - outcome."
	Ideological Integration	Achieved "Seamless Integration" of ideological education into technical practice, cultivating new-quality talent with "initial heart, craftsmanship spirit, and blue innovation."

Through the verification of teaching practice, the curriculum reform has achieved certain teaching implementation results. (1) Students' comprehensive practice and innovation ability have achieved a substantial leap. Students have outstanding performance in high-level skill competitions, and have shown strong ability to implement technology and transform innovation in solving real project problems. The virtual simulation training platform and the supporting digital teaching resource package together constitute a set of replicable and replicable modern teaching solutions, which lays a solid foundation for the sustainable development of the curriculum and inter-school sharing.

3.2. The Characteristics and Innovative Value of Curriculum Reform

(1) The intelligent curriculum paradigm of "task matrix" environmental design is proposed. It overcomes the traditional curriculum structure with subject logic as the main line, and turns to the real project of the enterprise as the core, combined with the gradient task, to construct a crisscross "task matrix". The horizontal dimension of the matrix reflects the integration of knowledge and skills of "three integrations," and the vertical dimension shows the progressive level of "three levels." Based on AI technology as the core variable, it is embedded into each key node, thus realizing the close combination of theory and practice. In the process of solving specific tasks, students can learn to construct

an interdisciplinary and networked knowledge system and comprehensive ability independently, thus realizing the fundamental transformation from " knowledge infusion " to " ability generation. "

(2) The whole process teaching reconstruction of " AI + imitation " dual-engine drive is realized. The course promotes artificial intelligence and virtual simulation from auxiliary tools to the core engine driving the whole process of teaching. AI is responsible for processing cognitive tasks such as scheme generation, data association and normative review, liberating students from repetitive labor and focusing on creative decision-making and optimization. Virtual simulation technology is responsible for building a high-simulation, interactive, zero-risk construction technology training environment, which solves the teaching problems of high-risk and high-cost operation. It is jointly empowered to the whole process of " design-process-result ", which realizes the doubling of teaching efficiency and depth.

(3) The " salt in water " integration of technical practice and curriculum ideological and political education has been achieved. The course effectively avoids the traditional ideological and political education method of blunt preaching, and internalizes the craftsman spirit (reflected in the millimeter-level pursuit of process details), green concept (through the environmental protection selection of materials and the sustainability assessment of schemes) and innovative thinking (contained in the critical optimization of AI generation schemes) into the operation specifications and evaluation criteria of each technical task. Ideological and political education has thus become the inherent appeal of completing high-quality technical achievements, realizing the same frequency resonance of value guidance and technology teaching, and effectively cultivating new quality design talents with the characteristics of " red original intention, green ingenuity and blue innovation. "

4. Conclusions and Prospects

4.1. Main Conclusions

This paper systematically summarizes the practice and exploration of the teaching reform of " Environmental Design Materials and Construction Technology " course in higher vocational colleges enabled by artificial intelligence. The research results show that by constructing the " three-level three - level " curriculum system and implementing the " AI-driven, task-led " teaching mode, the core dilemma of strict discipline barriers, weak practical teaching and broken professional ability chain in traditional courses can be effectively solved. AI and virtual simulation technology are upgraded from auxiliary tools to the core engine of reshaping the teaching process, and a new teaching field of " integration of virtual and real, integration of education and training " is successfully created, which can significantly improve students " comprehensive practical ability and innovative quality in dealing with complex " design-construction " integration projects.

4.2. Reflection and Prospect

This paper has achieved certain research results, but in the process of practical research, it also faces problems such as weak digital literacy of teachers and long-term operation mechanism of virtual simulation system to be further improved. In the face of the rapid development of artificial intelligence and other technologies, it is necessary to establish a normalized teacher development mechanism, so that it can continuously update its knowledge structure and teaching skills, and also need to master various intelligent education tools, so as to effectively adapt to and lead the teaching reform. (2) In order to ensure that the resource upgrading of the virtual simulation training system is synchronized with the development of the industry, it is necessary to establish a sustainable technology update and resource maintenance and update system. Through the close integration of industry and education, it is necessary to ensure that the core tools

such as the simulation platform and AI design software can be updated in time and accurately meet the needs of the frontier vocational education and industry.

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