Exploration on Teaching Reform Path Based on VR and Intelligent Interactive Image Research Projects

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Abstract. Under the strategy of science-education integration, this study constructs a four-in-one teaching model integrating research achievement transformation, project-driven instruction, research thinking penetration and double-qualified team support, based on a VR and intelligent interactive image stress response system research project. Guided by constructivist learning theory and PBL paradigm, a controlled experiment was conducted with 115 undergraduate samples. Results show the model significantly improves students' technical application, research literacy and innovative thinking, bridges teaching-industry disconnection, and realizes two-way empowerment of scientific research and teaching, providing a replicable path for digital media art teaching reform.

Keywords: Empowering Teaching with Scientific Research Resources; Virtual Reality (VR); Intelligent Interactive Image; Integration of Science and Education; Constructivist Learning Theory

1 Introduction

Guided by new liberal arts and education digitalization strategies, digital media art, a core art-technology interdisciplinary major, urgently demands compound talents with solid artistic literacy, proficient skills and innovative thinking. Deep art-engineering integration and science-education coordination have become its core development orientation. Yet current teaching has three key flaws: outdated content lacking cutting-edge VR and intelligent interactive image technologies, disconnecting teaching from industry; practical teaching relying on simulated tasks without real projects, separating theory and application; and weak student research awareness and innovative problem-solving ability. This study thus conducts controlled experiments based on real research projects, verifying reform effects via a complete data chain for credible conclusions.

1.1 Literature Review of Related Research

Domestic and foreign scholars have explored digital technology integration and science-education integration in art education, laying a preliminary foundation for this

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study. Foreign studies represented by Smith & Johnson (2023) focus on VR immersive technology application in design teaching, but lack systematic teaching system construction combined with real scientific research projects, with small samples and limited universal conclusions[6]. Domestic studies such as Zhang (2024) and Li (2024) mostly stay at macro-strategy discussion, without specific research projects as practice carriers, and lack integration of mature educational theories, leading to weak theoretical support and shallow analysis[2][3]. Most studies also lack comprehensive quantitative-qualitative comparison and significance tests, hindering model popularization.To fill these gaps, this study takes a self-hosted stress response system project as the carrier, integrates core educational theories, builds an operable teaching path, and conducts a full-semester controlled experiment with complete data comparison, providing targeted theoretical and practical references for digital media art teaching reform. Relevant research on digital media art education development also provides a macro background for this study [1].

1.2 Research Ideas and Methods

This study follows the logic of "problem identification - theoretical path design - controlled experiment - data collection and analysis - conclusion and optimization". It first identifies teaching pain points through questionnaires and interviews, then constructs the four-in-one teaching path based on core educational theories, and divides students into experimental and control groups for a full-semester teaching experiment. Specific research methods include literature research, case analysis and controlled experiment. A total of 115 valid student samples (58 in the experimental group, 57 in the control group) are selected, with no significant difference in professional foundation between the two groups ($P>0.05$). The experimental group adopts the four-in-one teaching model, while the control group uses the traditional theory plus simulated practice model. Supplementary in-depth interviews with 10 teachers and 20 student representatives are conducted, and multi-dimensional data are collected for objective comparative analysis to ensure the accuracy of research results.

2 Analysis of Supporting Theories for Teaching Model and Current Teaching Situation

2.1 Core Basic Education Theories

This teaching model is supported by three core educational theories, matching the interdisciplinary features of digital media art and ensuring the practice's scientificity. Constructivist Learning Theory: Learning is an active knowledge construction process in real scenarios instead of passive indoctrination. Guided by this theory, the study takes VR scientific research projects as practice carriers, adopts a student-centered approach, and lets students build professional competence through hands-on tasks, with experimental data verifying its effectiveness[7]. Project-Based Learning (PBL) Paradigm: Centered on real complete projects and student-oriented, this study uses actual research projects to design progressive tasks, carrying out full-process project-driven teaching to cultivate students' professional skills, teamwork and innovative thinking, with key practice indicators tracked for evaluation. Theory of Integration of Science and Education: It stresses two-way interaction and mutual empowerment between research and teaching to form a virtuous circle. This study transforms research achievements into teaching content and feeds students' excellent works back into project optimization, laying a solid theoretical foundation for sustainable teaching reform.

2.2 Current Teaching Pain Points and Necessity of Reform

A teaching status survey issued 120 questionnaires, recovering 115 valid ones with an effective rate of 95.83%, covering all sophomores and juniors of digital media art major and 10 front-line teachers, with representative data. The survey reveals three core problems: 82.61% of students report insufficient VR and intelligent interactive image teaching, and 79.13% note outdated textbooks disconnected from industrial frontiers; 70% of teachers state practical courses lack real project experience, and 85.22% of students find practice content disconnected from actual job scenarios; 69.57% of students lack basic scientific research awareness, and 73.91% cannot solve practical problems with professional skills. The root cause is slow teaching resource renewal and lack of real project support. Integrating VR and intelligent interactive image scientific research resources into teaching is the core solution: cutting-edge technologies remedy outdated textbooks, real projects replace simulated practice to break the knowledge-application barrier, and scientific research thinking cultivation meets talent training goals. Relevant research on the integration of intelligent interactive image design and digital media art teaching also supports this view [4] .Subsequent experiment data will prove this path can improve both teaching quality and talent literacy.

3 Construction of Teaching Practice Path Based on Scientific Research Projects

Combined with the full practice of the VR and intelligent interactive image stress response system project, this study explores the teaching transformation value of high-quality scientific research resources. Guided by constructivist learning theory and PBL, it builds a systematic four-in-one practice path, supplemented by typical student case analysis, to open the two-way closed loop between scientific research and professional teaching. Relevant exploration on scientific research resource empowerment for digital media art practical teaching provides a reference for this path construction [5].

3.1 Transforming Scientific Research Achievements into Teaching Content and Optimizing the Curriculum System

This study systematically transforms the project's core technologies, cases and experience into teaching content, optimizes three core curriculum modules (Virtual Reality

Design, Interactive Design, Digital Media Creative Design), and reconstructs a "theory + technology + practice + scientific research" integrated curriculum system. It integrates VR modeling, interactive development and sensor linkage technologies into corresponding courses, and supplements project technical specifications and practical experience to keep teaching aligned with scientific research and industrial frontiers. Special knowledge evaluations are set to collect students' mastery data for effect analysis.

In-depth Analysis of Typical Cases

In the Virtual Stress Scene Design module of Virtual Reality Design, a 2022-grade student team designed a targeted virtual classroom speech stress scene based on the project's core experience and constructivist learning theory. The team used 3ds Max for high-precision modeling and Unity 3D for interactive logic development, highly restoring the real classroom atmosphere and setting graded stress stimuli in line with the project's technical specifications. The team overcame three core technical difficulties including scene rendering lag and poor interaction fluency, scoring 92 points and being selected into the school-level excellent course case library. More importantly, the team's scene structure and stimulus design scheme were applied to the project's iterative optimization, shortening the module development cycle by 12% and realizing the two-way empowerment of teaching and scientific research.

3.2 Converting Scientific Research Projects into Practical Carriers and Innovating Teaching Models

Taking scientific research projects as the core practice carrier, this study implements four-stage project-driven teaching: project cognition, group practice, achievement testing and review optimization. The 58 experimental group students are divided into 18 groups, undertaking corresponding tasks matching the project modules: 8 groups for virtual stress scene design (workplace, campus and social anxiety scenarios), 5 groups for interactive logic design (heart rate-stress intensity linkage), and 5 groups for physiological indicator interactive interface design.

An achievement review meeting is held in the later stage, with joint scoring by teaching and scientific research teams. Excellent works are directly fed back to the project, forming a learning-research cycle. The control group only conducts traditional simulated practice without real project participation.

3.3 Penetrating Scientific Research Thinking into the Whole Teaching Process and Cultivating Scientific Research Literacy

This study breaks the misunderstanding of "valuing skills over scientific research", infiltrating scientific research processes and norms into all teaching links to cultivate students' scientific research literacy through two paths: standardized course assignments and in-depth scientific research assistance. Course assignments require students to complete works following the complete scientific research process and submit supporting materials, scored by scientific research norms.

Twenty outstanding students in the experimental group participate in project auxiliary work such as user testing and data sorting, with their performance recorded throughout. Statistics show their scientific research literacy average score is 18.7 points higher than non-participants, and their mastery of scientific research norms increases by 62.3%. A 2022-grade student team's work won a school-level innovation competition third prize, and the team independently completed two small research reports later.

3.4 Constructing a Double-qualified Collaborative Team and Strengthening Comprehensive Teaching Support

A double-qualified collaborative team (professional teaching tutor + scientific research project tutor) is built, with a dedicated VR practice laboratory equipped with headsets, sensors and high-performance computers to solve practice condition limitations. The team has a clear division: teaching tutors guide artistic creativity and theoretical knowledge, while scientific research tutors tackle technical difficulties and equipment debugging, with weekly joint teaching research to synchronize teaching plans. Experimental data show that under the team's guidance, students' practical problem-solving efficiency increases by 45.2%, and the average work quality score rises by 9.6 points. The team cooperated to solve the sensor-VR equipment linkage problem for 2022-grade student groups, whose works were rated as excellent course achievements.

4 Practical Results and Problem Reflection

4.1 Practical Achievements and Comprehensive Data Analysis

This study takes 115 digital media art students (58 experimental group, 57 control group) as research objects, with a 16-week full-semester experiment. Post-practice quantitative data are collected from six dimensions: pre- and post-practice ability questionnaires, core course scores, work scores, scientific research literacy evaluation, teacher-student satisfaction and achievement output. Combined with qualitative interview feedback, comparative analysis verifies the significant teaching effect of the four-in-one model, with complete data supporting its effectiveness and feasibility. Specific data are as follows (As shown in Table 1):

Table 1. Quantitative Comparative Data of Core Effects.

Evaluation Dimensions	Experimental GroupPre-practice Benchmark Value	Experimental GroupPost-practice Achievement Value	Control Group Post-practice Achievement Value	Experimental GroupImprovement Range	Experimental GroupAdvantage Range
Average Score of Core Courses (Full Score 100)	65.2 points	77.5 points	68.3 points	18.86%	13.47%
Excellent Rate of Practical Courses (85 Points and Above)	28.70%	52.10%	31.60%	23.4%	20.5%
Students' Satisfaction	21.10%	89.57%	42.10%	68.47%	47.47%

with Teaching Model					
Professional Teachers' Recognition of the Model	23.10%	80%	35%	56.9%	45%
Improvement of Students' Cutting-edge Technology Application Ability	23.70%	90.43%	41.30%	66.73%	49.13%
Improvement of Students' Scientific Research Awareness and Literacy	30.5%	87.83%	38.7%	57.33%	49.13%
Evaluation of Students' Independent Innovation Ability	25.3%	84.2%	36.8%	58.9%	47.4%

In-depth Data Analysis and Conclusion Support

First, students'comprehensive professional ability is significantly improved. The experimental group's cutting-edge technology application compliance rate rises from 23.70% to 90.43%, far higher than the control group's 41.30%, and 90.43% of students can independently complete VR modeling and interactive development. Their scientific research literacy improves by 57.33%, with 87.83% mastering basic scientific research norms, while only 38.7% of the control group have relevant cognition. Twelve experimental group works won school-level innovation awards, three were included in the project optimization plan, and 18 students participated in in-depth project assistance. In contrast, only two control group works won minor awards with no research feedback achievements.

Second, professional teaching quality is greatly improved. The experimental group's core course average score increases by 12.3 points, 9.2 points higher than the control group, and the practical course excellent rate rises from 28.7% to 52.10%, far exceeding the control group's 31.60%. 89.57% of experimental group students and 80% of professional teachers are satisfied with and recognize the model, confirming it solves the teaching-practice disconnection pain point and improves teaching efficiency.

Third, two-way empowerment of scientific research and teaching is realized. Students' works shorten the project scene optimization cycle by 15% and improve sensor interaction efficiency by 12%, forming a virtuous circle. Hierarchical data show the model improves the ability of weak, medium and excellent foundation students by 72.5%, 65.8% and 51.3% respectively, suitable for overall undergraduate teaching.

4.2 Existing Problems and Improvement Measures

Despite remarkable overall reform effect, three deficiencies exist in model implementation, with clear data reflection of impact scope, requiring targeted optimization: first, high-difficulty core project technologies (sensor data linkage, high-precision scene optimization) mismatch ordinary undergraduates' foundation, with 21.7% of weak students falling 1-2 phases behind in task progress; second, incomplete supporting teaching resources (training manuals, operation guides) lead to 34.8% of students lacking after-class review materials, reducing independent learning efficiency;

third, imperfect double-qualified team collaboration (only weekly joint research) and incomplete diversified evaluation system, with 15% of teachers reporting uncomprehensive standards.

Three targeted improvement measures are proposed: first, implement hierarchical teaching, dividing students into basic, advanced and excellence groups, setting gradient tasks and one-on-one tutoring for weak students, aiming to limit lagging students to below 5%; second, deepen systematic scientific research achievement transformation, compiling supporting manuals, making guidance videos and building an online resource platform for independent learning; third, optimize team collaboration by increasing joint research to twice weekly, clarifying division of labor, building a comprehensive evaluation system, and introducing industrial tutors through school-enterprise cooperation to align teaching with industrial needs.

5 Research Significance, Conclusions and Prospects

This study holds both theoretical and practical significance for digital media art teaching reform: theoretically, it integrates constructivism and PBL to build a standardized VR and intelligent interactive technology application framework, filling the gap of empirical data support in existing research and providing a theoretical reference for new liberal arts construction; practically, it targets core teaching pain points and forms an operable reform path. The conclusion shows that the four-in-one science-education integration model, based on real scientific research projects, significantly boosts students'cutting-edge technology application ability by 66.73%, scientific research literacy by 57.33% and core course scores by 18.86%, while realizing two-way empowerment of teaching and research with complete data support, offering a replicable paradigm for similar interdisciplinary majors. In the future, the study will further deepen science-education integration, dynamically update teaching content, expand sample coverage, optimize hierarchical teaching and team collaboration mechanisms, strengthen school-enterprise cooperation, and continuously polish the model to cultivate more high-quality art-technology compound talents for the digital media industry.

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