VR Aesthetic Education Courses from a Computational Aesthetics Perspective: Interdisciplinary Framework and Practical Strategies

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Abstract: ***This paper proposes an innovative pedagogical framework for large-scale Virtual Reality (VR) aesthetic education within Location-Based Entertainment (LBE) environments, grounded in the principles of computational aesthetics and interdisciplinary collaboration. The model is designed to transcend the limitations of traditional art education by leveraging algorithmically generated, dynamic content coupled with fully immersive VR experiences. This synergy aims to create a more engaging, personalized, and scalable learning ecosystem. Through structured implementation, our empirical findings demonstrate that the proposed model significantly enhances key student competencies, including refined aesthetic perception, robust interdisciplinary thinking, and practical artistic creation skills. The study further confirms that this approach effectively addresses the challenges of delivering standardized yet qualitatively high art education to a broad audience. Consequently, this research provides both a solid theoretical foundation and a replicable practical paradigm for the integration of advanced VR technology into the aesthetic education curriculum in China, offering valuable insights for future technological and pedagogical innovations in the field.***

Keywords: Computational aesthetics; Virtual reality; Aesthetic education curriculum; Interdisciplinary collaboration.

1. INTRODUCTION

With the rapid development of artificial intelligence, virtual reality (VR) has moved from concept to practical application and is demonstrating enormous potential in education. Aesthetic education, a vital pathway for cultivating students' aesthetic literacy and creativity, is now deeply integrating with technology to generate new teaching models and methods. Aesthetic education in China has a century-long history and has produced numerous models suited to national conditions. Drawing on computational aesthetics theory and methods and leveraging interdisciplinary collaboration, this study constructs a VR-based aesthetic education curriculum model and validates its effectiveness through practical cases. The research focuses on the application of computational aesthetics in curriculum design, the integration of multidisciplinary resources, and the evaluation system for course outcomes, aiming to advance theoretical innovation and practical implementation of VR aesthetic education and to provide a reference for the modernization of a Chinese-characteristic aesthetic education model. Zhang and Needleman (2021) developed methods for identifying power-law creep parameters from conical indentation [1] and characterized plastically compressible solids via spherical indentation [3]. Medical imaging has been significantly advanced by Chen et al.'s (2023) generative text-guided 3D vision-language pretraining for unified segmentation [2] and their self-supervised neuron segmentation using multi-agent reinforcement learning [7], complemented by Wang's (2025) RAGNet transformer-GNN-enhanced model for rheumatoid arthritis risk prediction [12]. Computer vision research includes Shao, Wang, and Liu's (2023) salient object detection using diversity features and global guidance [4], Chen et al.'s (2022) one-stage object referring with gaze estimation [14], and Gong et al.'s (2023) review of neural network lightweighting techniques [13]. Natural language processing advances through Yu et al.'s (2025) automatic text summarization using transformer networks [5] and Sun et al.'s (2025) AutoML framework construction based on large language models [6]. Financial technology applications include Pal et al.'s (2025) AI-based credit risk assessment in supply chain finance [8] and Cheng et al.'s (2025) analysis of executive human capital premium on stock volatility [18], while energy systems optimization features Gao and Gorinevsky's probabilistic modeling research (2018, 2020) [9-10]. Foundational data analysis techniques are explored by Chen (2023) through data mining applications [11]. Urban computing and visualization advances include Xu's (2025) UrbanMod for accelerated city planning [16] and CivicMorph for public space development [33], Yuan and Xue's (2025) multimodal integration framework using graph neural networks [15], and Hsu et al.'s (2025) MEDPLAN for personalized medical plans [17]. Digital marketing and web technologies progress through Yang's (2025) website optimization using Dijkstra's algorithm [19], Zhu's (2025) ReliBridge for platform stability

[20], and Zhang's (2025) reinforcement learning for ad campaign optimization [21]. Content creation innovations feature Hu's (2025) low-cost 3D authoring [22] and UnrealAdBlend for immersive ad content [29], while industrial applications include Tan et al.'s (2024) reliable convolutional networks for fault diagnosis [23]. Digital transformation extends to Zhuang's (2025) real estate marketing strategies [24], while recommendation systems evolve through Han and Dou's (2025) graph attention networks [25], Yang's (2025) Prompt-Biomrc model for intelligent consultation [26], and Yang et al.'s (2025) parallelism optimization in LLM-based systems [27]. Business intelligence features Zhang et al.'s (2025) AI-driven sales forecasting [28], Xie and Chen's (2025) CoreViz for business dashboards [30], Zhu's (2025) RAID for reliability automation [31], Zhang's (2025) SafeServe for release safety [32], Li et al.'s (2025) privacy-preserving advertising framework [34] and graph neural recommendation method [35], Tu's (2025) AutoNetTest for 5G network automation [36], and Xie and Liu's (2025) DataFuse for interview analytics [37].

2. CORE CONCEPTS AND THEORETICAL FOUNDATIONS

2.1 Computational Aesthetics and Its Educational Implications

Computational aesthetics encompasses two key domains: computational generative art and computational aesthetic metrics. The former revolutionizes artistic creation through "computational creativity," exploring the deep linkage between algorithms and human aesthetics; the latter quantitatively evaluates artistic quality via computer vision and machine learning, seeking to reveal the dynamic relationship between human aesthetics and AI computation [2].

In education, computational aesthetics offers new perspectives and methods for aesthetic education. It enables students to understand aesthetic phenomena from both perceptual experience and rational analysis, fostering a cognitive mode that integrates scientific and artistic thinking.

2.2 The Aesthetic Education Value of VR Technology

As VR technology deepens its application in education, its immersive and interactive features provide crucial technical support for designing and developing teaching resources that meet experiential learning needs [3]. Immersion allows learners to experience artistic environments firsthand, while interactivity enables them to engage with artistic elements in virtual settings, transcending physical limitations to create and experience aesthetic spaces impossible in reality.

2.3 Theoretical Framework for Interdisciplinary Collaboration

From an interdisciplinary perspective, collaborative innovation in university curriculum systems and teaching management helps cultivate versatile innovative talent, promotes the connotative development of disciplines, and improves the efficiency of educational resource utilization [4]. In VR aesthetic education courses, interdisciplinary collaboration is manifested in three areas: content integration, teaching method coordination, and faculty collaboration.

2.4 LBE Large-Space Technology and Its Educational Applications

As one of the fastest-growing forms in the global metaverse market, large-scale immersive LBE projects take enclosed physical space as their core foundation, augmented-reality experiences as their central scenario, the fusion of digital and physical consumption as their primary business model, and the creation, playback, and operation of 3D digital assets as their key processes, representing a new generation of immersive experience formats [5].

The 2024 Immersive Technology & Sci-Fi LBE Large-Space Annual Conference was held in Beijing, unveiling ten outstanding offline large-space cases including "The Lost Old Summer Palace" and "Night Banquet in the Tang Palace" [6]. In education, LBE large-space technology can create highly realistic learning environments that allow students to learn through bodily movement and multi-sensory channels.

Table 1: Interdisciplinary Collaboration Framework for VR Aesthetic Education Courses

Collaborative dimension	Collaborative content	Implementation

Collaboration of disciplinary content	Physics, Science, History, Technology	Theme based project-based learning, such as the "Museum of Ancient Chinese Physics Achievements"
Collaborative teaching methods	Experiential learning, inquiry based learning, collaborative learning	VR exploration+field investigation+group discussion+creative practice
Collaboration among teaching staff	Art teacher, technical teacher, subject teacher from different directions	Joint lesson preparation, collaborative teaching, and joint evaluation
Collaborative learning environment	The integration of physical space and virtual space	LBE large space+traditional classroom+outdoor venue
Collaborative evaluation methods	Combining process evaluation with outcome evaluation	Work evaluation+performance evaluation+data analysis

3. CONSTRUCTION OF A VR AESTHETIC EDUCATION COURSE MODEL BASED ON COMPUTATIONAL AESTHETICS

3.1 Construction Principles

Based on the characteristics of computational aesthetics and VR technology, we propose the following course-construction principles:

(1) Unity of Artistry and Scientific Rigor: the course must cultivate students' aesthetic sensibility and artistic expression while integrating scientific thinking and methods;

(2) Balance of Experiential and Inquiry-Based Learning: the course must provide rich immersive experiences and design challenging problems that guide students to solve issues through inquiry;

(3) Interdisciplinary Theme Leadership: organize course content around macro-themes of an interdisciplinary nature to achieve organic integration of multidisciplinary knowledge;

(4) Technology as Enabler, Not Showpiece: technology must serve educational goals and content rather than be displayed for its own sake, avoiding excessive technological interference with learning.

3.2 Core Element Design

The core elements of a VR aesthetic education course consist of four layers: tool layer, content layer, activity layer, and assessment layer.

The tool layer refers to the hardware and software platforms used in the course. Hardware includes VR headsets, positional tracking devices, controllers, etc.; software includes VR content-creation tools, algorithmic art-generation platforms, etc. When selecting tools, their educational suitability, reliability, and ease of use should be considered.

The content layer refers to the knowledge and skills taught in the course. Based on computational-aesthetics theory, we have designed four content modules:

(1) Fundamentals of Algorithmic Aesthetics—introducing basic aesthetic elements and algorithmic generation methods;

(2) Cultural Aesthetic Understanding—understanding aesthetic concepts within different cultural contexts;

(3) Interdisciplinary Aesthetic Application—exploring aesthetic phenomena across different disciplines;

(4) VR Art Creation—learning to use VR tools to create artworks.

The activity layer refers to the design of student learning activities. We adopt the flow "create context → independent inquiry → collaborative creation → presentation & evaluation." In the context-creation stage, the teacher sparks interest through questions, cases, or scenarios; in the independent-inquiry stage, students explore and discover on their own in the VR environment; in the collaborative-creation stage, student teams jointly complete an art project; in the presentation & evaluation stage, students display their works and receive multi-faceted feedback.

The evaluation layer refers to the course assessment system. We combine process-oriented and product-oriented evaluation, quantitative and qualitative evaluation, using multiple methods such as learning-process data analysis, work assessment, performance assessment, and self-assessment.

Table 2: Content Framework of the VR Aesthetic Education Course

Content Module	Learning objectives	Typical activities	Application of Computational Aesthetics
Fundamentals of Algorithm Aesthetics	Understand aesthetic elements and algorithm generation principles	Analyzing the algorithmic patterns in classic works of art	Using algorithms to analyze aesthetic elements such as color and composition
Understanding of Cultural Aesthetics	Understand aesthetic concepts in different cultural backgrounds	Comparing the Differences and Similarities of Aesthetic Concepts between China and the West	Analyzing the influence of culture on aesthetics through algorithms
Interdisciplinary Aesthetics Application	Discovering aesthetic phenomena in different disciplines	Exploring Aesthetics in Physics, Mathematics, Biology, and Other Disciplines	Using computational tools to analyze and simulate interdisciplinary aesthetics
VR Art Creation	Master VR art creation tools and methods	Creating 3D artworks in a VR environment	Applying algorithms to generate artistic elements and inspiration

3.3 Interdisciplinary Collaborative Implementation Mechanism

The interdisciplinary collaborative implementation mechanism is key to the success of the VR aesthetic education course. We have established a teacher-collaboration mechanism, a space-collaboration mechanism, and a course-sequence mechanism.

Art, technology, and subject-area teachers jointly prepare lessons, teach, and assess; LBE large-scale spaces, traditional classrooms, and outdoor sites are organically integrated; course content aligns with standards in art, physics, mathematics, and other subjects, forming a cross-curricular learning sequence and achieving multi-dimensional integration.

3.4 Course Model Diagram

The VR aesthetic education course model we constructed is shown below; the model emphasizes the integration of theory and practice, technology and art, and discipline with discipline, forming an organic whole.

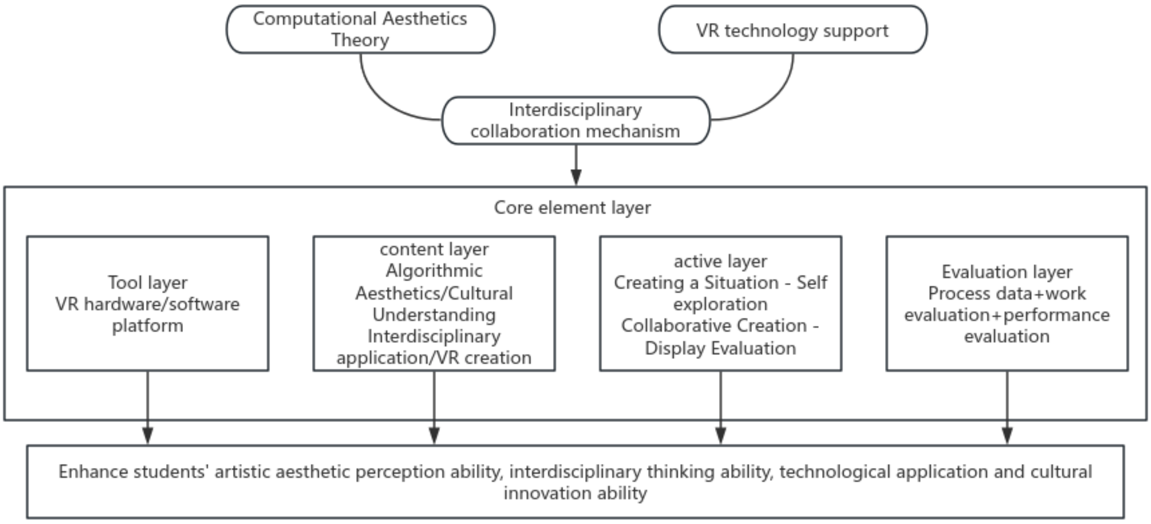

Figure 1: VR Aesthetic Education Course Model

4. CASE PRACTICE

4.1 Case Background

To verify the effectiveness of the VR aesthetic education course model based on computational aesthetics, we selected the LBE large-scale project "Ancient Physics Achievement Museum" as the practical case.

This case was chosen for the following reasons: first, ancient physics achievements are richly interdisciplinary, blending science, technology, culture, and history; second, they possess clear aesthetic value, with ancient instruments exhibiting exquisite structure and form; third, the project employs LBE large-scale technology to provide deep immersive experiences; fourth, it enjoys rich resource support, including professional knowledge content, technical equipment, and expert guidance.

The "Ancient Chinese Physics Achievement Museum" project aims to let students understand ancient Chinese physical wisdom (e.g., mechanics, optics, thermology, electromagnetism, and acoustics) and, through VR technology, recreate the usage scenarios and principle demonstrations of ancient scientific instruments.

4.2 Implementation Process

The course implementation is divided into three phases: in the preparation phase, the teacher team designs the instructional plan, prepares resources, and conducts pre-course surveys and training; in the implementation phase, students follow the sequence of "context creation – independent inquiry – collaborative creation – presentation and evaluation," such as observing ancient instruments in VR and working in groups to create models that blend past and present; in the summary phase, students present their works and conduct multi-dimensional evaluations from the perspectives of science, art, technology, and concept.

5. PRACTICAL OUTCOMES AND REFLECTION

5.1 Practical Outcomes

The course effectively enhanced students' aesthetic perception, artistic creation, and interdisciplinary knowledge integration; the works demonstrated a high level of technical sophistication and creative depth. Students' interest and motivation in learning increased significantly, and VR technology made abstract knowledge vivid and tangible. Through the project, teachers updated their teaching concepts, placing greater emphasis on experiential and inquiry-based learning and interdisciplinary integration, while their instructional design and technology application skills improved markedly.

5.2 Reflection and Challenges

Technically, it faces issues such as high equipment costs, maintenance difficulties, and motion sickness; pedagogically, challenges include insufficient classroom management strategies and inconsistent evaluation criteria; in terms of content, high-quality interdisciplinary resources are scarce, and the deep integration of computational aesthetics with curricula is inadequate; at the theoretical level, mature models clarifying VR learning mechanisms and the application pathways of computational aesthetics in education are lacking. Future efforts should optimize devices and resources, enhance teacher training, and deepen theoretical construction.

6. CONCLUSION AND OUTLOOK

Based on computational aesthetics theory, this study integrates VR technology and interdisciplinary collaboration mechanisms to construct and validate a VR aesthetic education curriculum model. Results show the model significantly enhances students' aesthetic perception, artistic creation, and interdisciplinary thinking while updating teachers' pedagogical concepts and generating replicable curriculum resources. Innovations lie in theoretical framework construction, interdisciplinary method integration, and LBE spatial practice application; limitations include case scope, sample size, and study duration. Future work will explore AIGC integration, develop low-cost solutions, expand application scenarios, strengthen teacher training, and deepen theoretical research to cultivate more versatile talents with aesthetic literacy and innovative capacity.

PROJECT SOURCE

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