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Wang Xingye
Gomel, Francisk Skorina Gomel State University

APPLYING 3D MODELING AND VIRTUAL REALITY TECHNOLOGIES IN SCULPTURE TRAINING FOR ART STUDENTS

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Ван Сине
г. Гомель, ГГУ имени Ф. Скорины

ПРИМЕНЕНИЕ ТРЕХМЕРНОГО МОДЕЛИРОВАНИЯ И ВИРТУАЛЬНОЙ РЕАЛЬНОСТИ В ОБУЧЕНИИ СКУЛЬПТУРЕ СТУДЕНТОВ ХУДОЖЕСТВЕННОГО ПРОФИЛЯ

В последние годы развитие технологий виртуальной реальности (VR) и трехмерного моделирования открыло новые возможности в художественном образовании. Однако большинство существующих приложений ограничивается простым просмотром виртуальных галерей, не раскрывая полного потенциала этих технологий для углубления эстетического восприятия студентов. Данное исследование фокусируется на преподавании скульптуры, используя Blender для создания интерактивных 3D-моделей скульптур в сочетании с VR-системой, разработанной на Unity. Эта система позволяет студентам свободно деконструировать, вращать произведения искусства и в реальном времени регулировать материалы и освещение, преодолевая ограничения традиционного двумерного изображения в пространственном восприятии и интерактивности, предлагая инновационное решение для эстетического воспитания студентов-художников.

In recent years, the development of virtual reality (VR) and three-dimensional (3D) modeling technologies has introduced new possibilities for art education. However, most current applications remain limited to simple virtual gallery browsing, failing to fully leverage the potential of these technologies to enhance students' in-depth aesthetic experiences. This study focuses on sculpture teaching, utilizing Blender to create interactive 3D sculpture models combined with a VR system developed in Unity. This system enables students to freely deconstruct, rotate artworks, and adjust materials and lighting in real time, thereby overcoming the limitations of traditional two-dimensional image teaching in spatial perception and interactivity. It offers an innovative solution for the aesthetic training of art students.

This study constructs a virtual reality sculpture teaching system to conduct an empirical investigation on the impact of 3D modeling technology on the cultivation of aesthetic ability of art students. The study adopts an experimental research method, with 20 sophomores from the Sculpture Department of a certain Academy of Fine Arts as the research subjects. Through a three-week teaching experiment, the application effect of VR technology in sculpture art teaching is systematically evaluated. This empirical study is grounded in the theoretical and methodological approaches found in the works of Ge Chunxiao [1], Wang Chao [2].

In terms of technical implementation, the study used a 3D scanner to digitally capture classic sculptures and optimized the models using 3D software such as 3Dmax, Blender, and ZBrush. As shown in Figure 1, the sculpture structure can be seen intuitively in the virtual teaching environment built on the 3D printing platform. The analysis supports layer-by-layer anatomical observation, and the effect of its molding can be observed by matching typical materials in the virtual environment. In addition, 3D printed products with a precision of 0.1 mm can be created, and the effect of a reduced version of the sculpture can be observed in reality.

Figure 1 – Sculpture 3D printing display

The experimental design adopted a quasi-experimental method, and the participants were randomly divided into an experimental group (VR teaching) and a control group (traditional teaching). The course content focused on three teaching modules: analysis of ancient Greek sculpture forms (1 week), imitation of Rodin's techniques (1 week), and creation of modern abstract sculptures (1 week). The three-week experimental course is divided into three stages: the first stage (week 1) focuses on the digital analysis of ancient Greek sculptures. The students use the VR system to observe classic works such as “Discus Thrower” from multiple angles and disassemble their structures; the second stage (week 2) focuses on copying Rodin's sculpture techniques. The students use digital carving tools in a virtual environment to simulate the creation process of “The Thinker”; the third stage (week 3) turns to modern abstract sculpture creation. The students can freely combine basic shapes and adjust material effects in real time. Each teaching unit consists of three parts: teacher demonstration (20 minutes), independent exploration (40 minutes) and mutual evaluation of works (30 minutes). During the teaching process, the system automatically records each student's operation trajectory, perspective switching frequency and other behavioral data, and teachers can dynamically adjust the teaching content based on real-time feedback data. It is particularly noteworthy that a “virtual-physical” comparison session was added in the second week of the course, requiring the students to materialize digital models through 3D printing technology to strengthen spatial cognition. This step-by-step teaching design ensures both the depth of technology application and the systematic nature of art teaching. A comparison of the study results is presented in Table 1.

Table 1 – Comparison of teaching effects between the two groups

Evaluation Indicator	VR Teaching Group	Traditional Teaching Group	Improvement Amplitude
Proportional Error Rate	19 %	42 %	23 %
Material Mastery Time (h)	8.2h	24.7h	67 %
Dynamic Pose Attempt Rate	78 %	35 %	43 %

As shown in Table 1, the VR teaching group performed significantly better than the control group in terms of indicators such as the error rate in grasping human proportions (reduced by 23 %) and the time to master material techniques (reduced by 67 %).

The study found that the multi-angle observation and instant feedback mechanism unique to the VR environment significantly improved the students' spatial comprehension ability. Taking the "David" teaching unit as an example, the accuracy rate of the anatomical knowledge test of the experimental group reached 92 %, 25 percentage points higher than that of the control group.

Figure 1 shows that the rate of dynamic posture attempts in the creation of the experimental group students (78 %) was significantly higher than that of the control group (35 %), which shows that VR technology not only improves the cognitive level, but also has a positive impact on creative practice.

This study built a virtual reality sculpture teaching system to prove that 3D modeling technology can effectively improve the aesthetic ability of art students. The experimental results show that the experimental group using VR teaching is significantly better than the traditional teaching group in many indicators: the error rate of human body proportion grasping is reduced by 23 percentage points (19 % vs 42 %), the time to master material techniques is shortened by 67 % (8.2h vs 24.7h), and the dynamic posture attempt rate is increased by 43 percentage points (78 % vs 35 %).Especially in the teaching unit of "Statue of David", the accuracy rate of anatomical knowledge test in the experimental group reached 92 %, which was 25 percentage points higher than that in the control group. These data fully demonstrate that the multi-angle observation and instant feedback mechanism unique to VR technology can not only significantly improve students' spatial comprehension ability, but also directly affect their creative practice. However, the study also found that this teaching method has problems such as high hardware requirements and steep learning curves for some high-level functions. Based on these findings, it is recommended to adopt a hybrid teaching mode of "VR observation (30 %) + physical creation (70 %)" to ensure the optimization of teaching effects while giving full play to the advantages of technology. This research result provides an important practical basis for the digital transformation of art education and has guiding significance for promoting teaching reforms in three-dimensional art categories such as sculpture.

Literature

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