The Application of Virtual Reality Technology in Art Education

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Abstract.

Virtual Reality (VR) technology is a cutting-edge technology that uses computer-generated virtual environments to provide users with an immersive experience. With the continuous advancement of technology, VR has gradually been widely applied in various industries. This research paper explores the development and application of VR technology in education. Through a questionnaire survey, this study investigates the satisfaction levels of relevant groups to understand user perceptions and experiences of VR in educational environments. It also presents a case study of creating a virtual reality art museum using related 3D software, highlighting VR as an effective tool for enhancing art education. The research results indicate a high level of user satisfaction and demonstrate the potential of VR technology in transforming traditional educational methods. Overall, VR, as an emerging digital technology, has promising prospects for future educational applications. In conclusion, this study comprehensively examines the potential of VR technology in education through satisfaction surveys and practical case analyses, aiming to provide a reference for related research, offer theoretical support for VR's application in education, and propose suggestions for future research and practice.

Keywords: virtual reality technology, immersive experience, satisfaction survey, art education, 3D technology

1. Introduction

With the rapid development of digital technology, the application of Virtual Reality (VR) technology is becoming increasingly widespread across various industries. In the field of education, the introduction of VR technology has brought new vitality and energy to traditional teaching methods. By creating immersive and interactive learning environments, VR provides students with a completely new learning experience. Particularly in art education, VR technology can break the limitations of traditional teaching methods, allowing students to engage with artworks in a more intuitive way, thereby stimulating their creativity and imagination.

In recent years, many studies have explored the potential applications of VR in education, showing its positive impact on improving learning motivation, enhancing learning outcomes, and increasing student engagement. However, empirical research on user satisfaction with the application of VR technology in education and its specific effects remains relatively scarce.

Therefore, this study aims to gain a deeper understanding of users' perceptions and experiences of VR technology in art education through a questionnaire survey.

Additionally, as part of this research, the paper will present a case study of a virtual reality art museum created using relevant 3D software. This case not only offers a new teaching tool for art education but also provides a practical demonstration of VR technology’s application in education.

1.1 Research Objective

The main objectives of this study are to explore the application of Virtual Reality (VR) technology in education in depth, specifically focusing on the following aspects.

Assessing User Satisfaction: Through a questionnaire survey, this study aims to understand users' satisfaction with the application of VR technology, analyze the factors influencing satisfaction, and explore both the advantages and challenges of VR technology.

Presenting Practical Case Studies: By creating a virtual reality art museum, this study will demonstrate the specific application of VR technology in art education, analyzing the design and implementation process, as well as its impact on user experience.

1.2 Research Background and Significance

With the rapid development of information technology, Virtual Reality (VR) technology has gradually infiltrated various fields, particularly in education, where it demonstrates significant potential for application. Traditional teaching methods often face issues such as insufficient interactivity, low student engagement, and limited opportunities for hands-on practice. In contrast, VR technology creates immersive, interactive learning environments, providing students with more intuitive and vivid learning experiences, thus effectively increasing participation and interest in learning.

In art education, students not only need to master theoretical knowledge but also need practical experience to enhance their artistic perception and creativity. VR technology offers a new teaching tool for art education, allowing students to freely explore artworks, create their own pieces, and interact with other learners in a virtual environment. This unique learning method not only enhances students' understanding of art but also helps them experiment and innovate in a safe environment.

The significance of this study lies in collecting user feedback through a questionnaire survey, providing data support for understanding the practical application of virtual reality technology in art education. Furthermore, through a case study, this research demonstrates the design and implementation of a virtual reality art museum, offering feasible teaching solutions for educators and promoting innovation and improvement in educational methods.

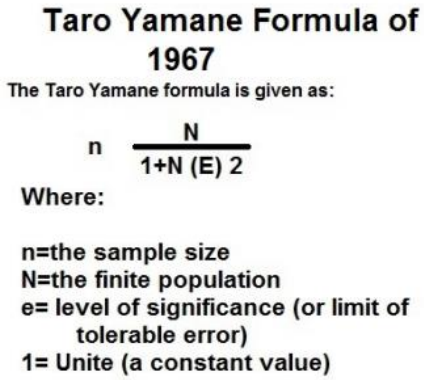
2.Research Methodology

This study collected 400 valid questionnaires through a random survey conducted in Guangdong Province, China. The research subjects were individuals related to the field of

education, primarily including teachers and students. These participants are currently undergoing professional and systematic education, providing them with direct experience and feedback on the application of Virtual Reality (VR) technology in education. They also possess professional insights into the potential and practical applications of VR technology in education.

The data for this study was mainly collected through platforms such as WeChat, email, and social media. The survey was distributed online in the form of a questionnaire to ensure wide distribution and efficient collection. The questionnaire was created using the "Wenjuanxing" platform, and to improve the response rate and accuracy of the data, the questionnaire was designed with closed-ended questions.

Figure 1: Taro Yamane Formula



Source: OnivisInfo.com

The sample size for this study was determined using the Taro Yamane formula, a statistical method that helps researchers calculate an appropriate sample size by considering the population size and the required confidence level. This method is commonly used in social science research. According to the "2023 Guangdong Province Education Development Statistical Bulletin," the total number of students and teachers in regular high schools, secondary vocational schools, and higher education institutions in Guangdong Province in 2023 is approximately 8.049 million. Using the Taro Yamane formula, the required sample size is estimated to be around 400.

3.Research Results

3.1 Participants' Awareness of Virtual Reality Technology

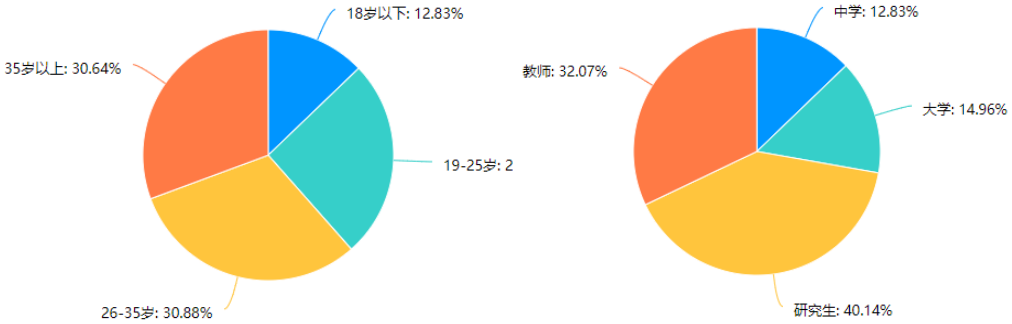
A total of 450 electronic questionnaires were distributed in this study, and 421 valid responses were collected, resulting in a response rate of 93.56%. Basic information was gathered from the participants, including gender, age, and education level. According to the results, among the valid responses, 52.02% of the participants were female, while 47.98% were male, showing a nearly equal distribution between the two genders.

Figure 2: Basic Information

Source: Survey results

In terms of age distribution, the groups aged 19-25 and 26-35 represent the highest proportion of survey participants, accounting for 56.53% of the total responses. This indicates a higher level of interest in virtual reality among younger individuals. Regarding educational background, the highest proportion of participants holds a graduate degree or higher, accounting for 40.14%. This suggests that individuals with higher education levels were more actively engaged in this survey.

Figure 3: Basic Information



Source: Survey results

Regarding the survey respondents' attitudes toward virtual reality technology, 32.07% of respondents expressed interest in VR, 35.63% had a neutral attitude, and 32.3% were not interested. It can be observed that the proportions of those interested and not interested in VR are similar, while the highest proportion of respondents expressed a neutral attitude.

A Pearson correlation analysis of the data shows a correlation coefficient of 0.01, indicating a slight positive correlation, with a p-value smaller than 0.05, suggesting that this correlation is statistically significant. This implies that within the scope of this study, there is a positive correlation between educational level and interest in virtual reality technology, indicating that as the educational level increases, the respondents' interest in VR technology slightly increases.

Figure 4: Data Dependence Analysis

项目	平均值	标准差	您所在的教育阶段：	您是否对虚拟现实技术（VR）感兴趣?
您所在的教育阶段：	2.91	0.99	1	
您是否对虚拟现实技术（VR）感兴趣?	2.00	0.80	0.01	1
* p<0.05 ** p<0.01				

Source: Survey results

Regarding the respondents' understanding of virtual reality technology, over half (50.12%) indicated a certain level of understanding. In comparison, the proportion of those who claimed to have no understanding is relatively low, at 23.99%.

Concerning the purchase of virtual reality devices, only 12.83% of the respondents have ever purchased VR equipment, while the majority (87.17%) have never bought such devices. In contrast to the interest in virtual reality, the purchase rate of related devices is very low among the respondents.

According to the survey results, the frequency of virtual reality device usage among the respondents is fairly evenly distributed. The percentages for using the devices several times a week, several times a month, and several times a year are 28.03%, 23.28%, and 23.04%, respectively. Meanwhile, 25.65% of respondents rarely use virtual reality devices. A Pearson correlation analysis of the data between age and VR device usage frequency reveals a significant negative correlation ($r = 0.34$, $p < 0.01$). This suggests that age may be an important factor influencing the use of VR devices, with younger respondents tending to use VR equipment more frequently.

Figure 5: Data Dependence Analysis

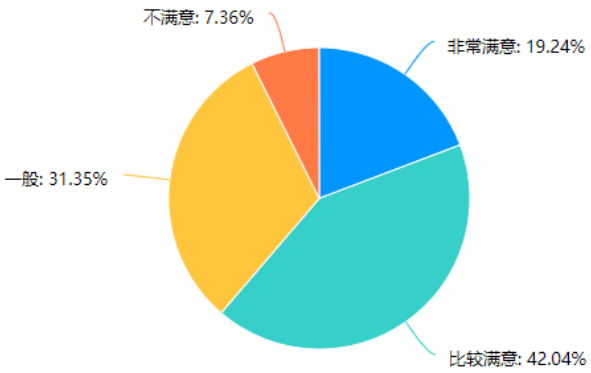
项目	平均值	标准差	您的年龄：	您使用虚拟现实设备的频率大概是?
您的年龄：	2.79	1.02	1	
您使用虚拟现实设备的频率大概是?	2.46	1.15	-0.34**	1
* p<0.05 ** p<0.01				

Source: Survey results

3.2 Participants' Interest in the Application of VR Technology in Art Education

In this survey sample, only 12.83% of respondents reported that their school or institution has used virtual reality technology for educational purposes, while 44.18% indicated that they have not used VR for education, and 42.99% were unsure. This suggests that the application of virtual reality technology in domestic education is still not widespread.

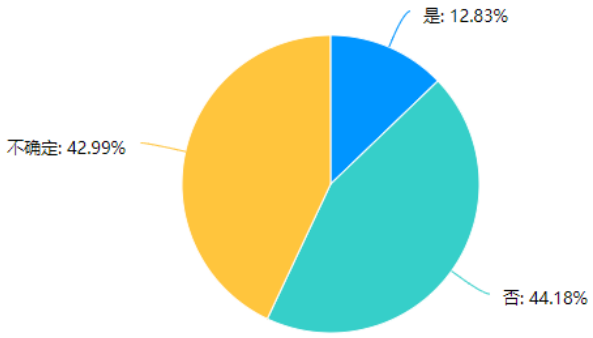
Figure 6: Survey Results Data



Source: Survey results

Regarding the willingness to use virtual reality technology for learning in the classroom, 32.78% of respondents expressed a willingness to use VR in their learning, 28.98% were neutral, and 38.24% indicated they were unwilling. When asked whether virtual reality technology could enhance learning interest and experience, 31.35% agreed, 34.2% were neutral, and 34.44% disagreed.

Figure 7: Survey Results Data



Source: Survey results

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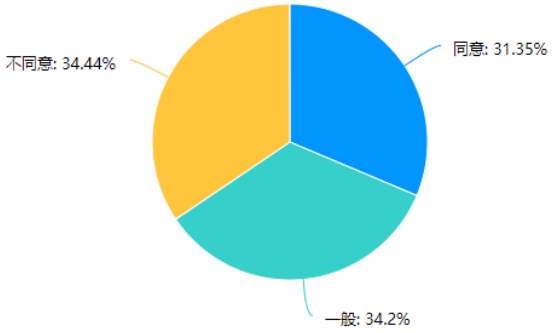
Figure 8: Survey Results Data



Source: Survey results

3.3 Future Outlook on Virtual Reality Technology

According to the statistical data from this survey, more than 60% of respondents hold an optimistic view about the future application of virtual reality technology in education, while only 4.99% are not optimistic. This suggests that the majority of people believe in a promising future for the use of virtual reality in education.

Regarding the correlation between respondents' views on the future of virtual reality technology in education and their age, a Pearson correlation analysis revealed a correlation coefficient of 0.75, with a p-value < 0.01. This indicates a significant negative correlation between the two factors. Specifically, as participants' age increases, their assessment of the future of virtual reality in education tends to decrease. This suggests that younger participants are more likely to have a more positive attitude towards the potential application of virtual reality in education.

Figure 9: Data Dependence Analysis

项目	平均值	标准差	您的年龄：	您认为未来虚拟现实技术在教育应用中的发展前景如何?
您的年龄：	2.79	1.02	1	
您认为未来虚拟现实技术在教育应用中的发展前景如何?	2.26	0.77	0.00	1
* p<0.05 ** p<0.01				

Source: Survey results

Regarding respondents' expectations for the future application of virtual reality technology in art education, the most anticipated scenario is immersive art experiences, with a proportion of 39.67%. Virtual art creation and virtual classrooms also garnered attention, with proportions of 25.18% and 19.95%, respectively. Remote art guidance had relatively lower expectations, at 15.2%.

For the overall satisfaction with virtual reality technology, the majority of respondents selected "fairly satisfied" (47.03%) or "neutral" (32.54%), with 14.73% expressing "very satisfied" and the smallest group (5.7%) indicating dissatisfaction.

Analysis of the correlation between participants' education level and their satisfaction with virtual reality technology showed a correlation coefficient of 0.78 with $p < 0.01$, indicating a significant positive correlation. This suggests that participants with higher education levels tend to express higher satisfaction with virtual reality technology.

Figure 10: Data Dependence Analysis

项目	平均值	标准差	您的年龄：	您所在的教育阶段：	总体来说，您对虚拟现实技术的满意程度如何。
您的年龄：	2.79	1.02	1		
您所在的教育阶段：	2.91	0.99	0.78**	1	
总体来说，您对虚拟现实技术的满意程度如何。	2.29	0.79	-0.01	0.00	1
* p<0.05 ** p<0.01					

Source: Survey results

4.The Production of the Virtual Reality Art Museum

4.1 Software Selection

In the actual design and production process of the digital virtual reality art museum, choosing the appropriate software and platform tools is one of the key factors for the project's success. Given the high immersion and strong interactivity characteristics of the digital virtual reality art museum, careful consideration was given in selecting the software, with the main choices being 3ds Max, Unreal Engine 5, and Photoshop.

3ds Max, developed by Autodesk, is a powerful 3D modeling and animation software widely used in game development, film production, and architectural visualization. It offers various modeling tools and techniques, such as polygon modeling, NURBS modeling, and surface modeling, which enable the creation of complex 3D structures and intricate details. These technologies help accurately replicate every detail of exhibition halls and artwork, which is crucial for the environmental modeling of the art museum.

Unreal Engine 5, released by Epic Games, is a powerful game engine known for its outstanding graphical performance and flexible development tools. One of the most significant features of UE5, compared to other game engines, is its use of Lumen global illumination and Nanite virtualized geometry technologies. These technologies allow for extremely realistic

environmental rendering, enabling high-quality dynamic lighting and detailed visual effects. This is essential for creating an immersive art museum experience, allowing users to appreciate the fine details of both the artwork and the environment.

Photoshop, developed by Adobe, is a powerful image editing software with widespread applications in image creation and editing. It provides a rich set of drawing and editing tools that enable efficient creation of textures for artwork and environmental elements. This is crucial for enhancing the visual effects, detail, and realism of the models, making the art museum environment more vivid and lifelike.

4.2 3D Modeling

3D modeling is one of the core components in the creation of a virtual reality art museum. This process is used to model every detail of the artwork and exhibition space. The precision of the modeling process is crucial for creating a sense of immersion and enhancing the user experience in virtual reality. The 3D modeling process in this study primarily uses the software 3ds Max.

Before beginning the modeling, the basic layout of the art museum is first determined, including the exhibition halls, corridors, rest areas, entrances, and other spaces. The design of each area must be customized according to the display needs of the artworks and the visitors' viewing experience. Next, the overall architectural and decorative style needs to be determined. To ensure that visitors have an immersive experience, the architecture and decoration should align with the style of the artworks on display. As this museum primarily showcases representative works of Western classical art, the overall design adopts a Gothic architectural style and Western classical decorative elements to ensure a harmonious environment. The design elements are primarily based on world-renowned classical museums, such as the Louvre Museum, the Metropolitan Museum of Art, and the Vatican Museums.

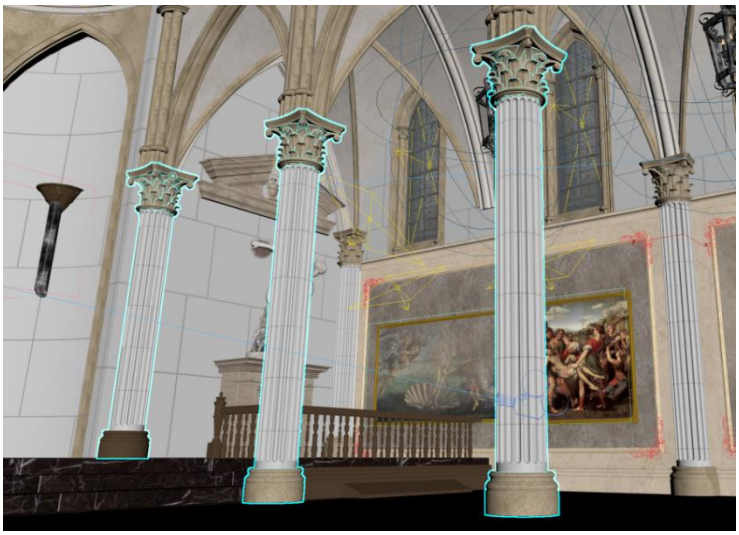
Figure 11: Metropolitan Museum of Art

Source: Google

The internal walls, columns, and floor tiles of the art museum are among the key modeling elements. The walls not only need to adhere to the actual proportions and scale of the

architecture but also must leave enough space to display the artworks. These models are designed with materials and textures that align with the overall ambiance of the environment, such as marble walls, Roman columns, and classical wallpaper. Simpler models for the walls and floors can be created using geometric shapes or 2D graphics modeling, then adjusted for thickness, proportions, and other design aspects according to the style. More complex models, such as Roman columns and roofs, are primarily created using a combination of 3ds Max’s geometric modeling and modifiers.

Figure 12: Roman Column

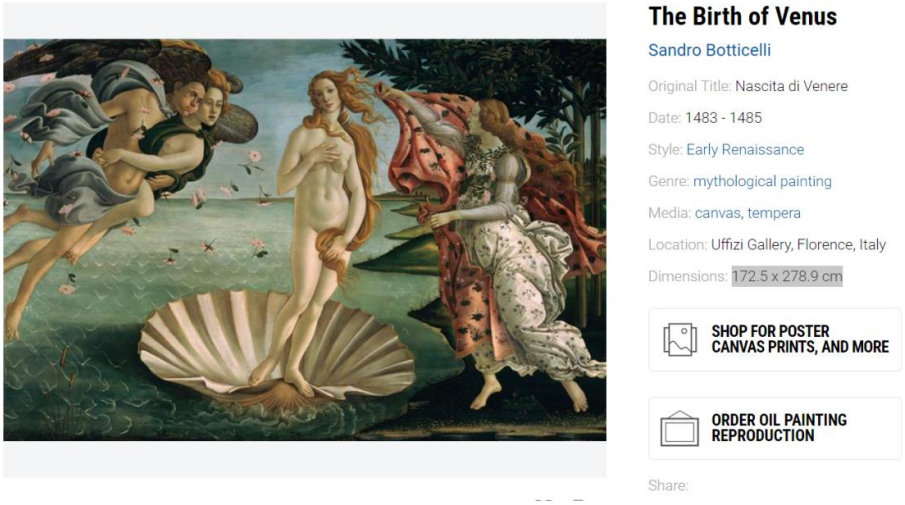


Source: self-made

The texture mapping is mainly done through UV mapping, creating a reasonable space for textures on the walls and floor, preparing for subsequent texture and material design. After completing the basic structure, the next step is detailed modeling, including lighting, curtains, and other small objects. These additions not only enhance the realism of the art museum's space but also provide users with a better virtual reality experience.

Artworks are the central display objects in the virtual art museum and need to be meticulously reproduced using 3ds Max modeling tools to ensure their authenticity in the virtual environment. In traditional teaching, artworks are often presented to students in the form of images or prints, which can cause the details of the artwork to be lost, along with the loss of real size and material texture details. Therefore, detailed information about the exhibits should be gathered through books and online resources and applied to the virtual museum. For example, the famous painting The Birth of Venus by Italian artist Sandro Botticelli measures 172.5 x 278.9 cm, which cannot be accurately represented on a typical screen or in publications. Viewers also cannot experience the awe of such a large-scale work in these formats. Additionally, this painting differs from common oil paintings as it was created using egg tempera, a medium that has a translucent quality, filled with light−a texture that is difficult to convey through traditional paper-based mediums.

Figure 13: The Birth of Venus



Source: Wikiart

During the modeling process, it's also important to consider the material representation of the artworks. For example, sculptures may be made of stone or wood, while oil paintings have the texture of oil-based paints on their surface. These materials behave differently in terms of reflection, gloss, and roughness, so it is necessary to assign different materials to each artwork in 3ds Max to ensure they present a realistic texture in virtual reality.

Textures and materials are also crucial for ensuring the realism of the virtual art museum. After the 3D modeling is complete, each model needs to be applied with appropriate materials and textures to enhance the detail and realism. For artworks, high-resolution texture resources with at least 2k resolution should be sourced from online resources to ensure a true visual experience for the users. Textures for materials such as wood, stone, and metal are imported into Photoshop for optimization before they are applied. Photoshop offers powerful layering and filtering tools that allow for the creation of complex texture effects by blending different layers. It also allows seamless processing of the textures, ensuring their authenticity and coherence within the scene. In 3ds Max, the processed textures are imported and applied to the corresponding surfaces of the models, using UV mapping technology to precisely fit the textures to the models, avoiding stretching or misalignment.

The effect of textures and materials not only depends on their inherent properties but also on the configuration of lighting. In this study's production process, the V-Ray plugin was used for rendering. V-Ray, developed by Chaos Group, is an advanced rendering engine known for its efficient, realistic light and shadow simulation and powerful material capabilities. It is widely used in architectural visualization, movie special effects, and game development. The reason for choosing V-Ray as the rendering tool is its excellent graphic quality and realistic lighting effects, which can significantly enhance the visual representation of the virtual art museum.

Figure 14: Marble Texture

Source: self-made

4.2 Interaction Design

Interactive design is an indispensable part of creating a virtual reality art museum. It not only determines the user experience in the virtual environment but also effectively enhances user engagement and immersion. The main goal of interactive design is to enable users to freely browse and explore the virtual art museum through natural interactions, and even interact with the exhibits, thereby enhancing their understanding and interest in the artwork.

In the virtual art museum, the design of information displays for the exhibits enriches the visitor experience and increases the understanding of the artwork. The design of information panels is kept simple and clear to avoid excessive text that could interfere with the user’s viewing experience. Careful consideration of interactive design and optimization of user experience not only enhances the aesthetic appeal of the virtual reality art museum but also showcases the application value and development potential of virtual reality technology in art education.

Figure 15: rendering （museum）

Source: self-made

Figure 16: rendering （decoration）

Source: self-made

Figure 17: rendering （artwork）

Source: self-made

5. Conclusion

This study focuses on the application of virtual reality (VR) technology in art education, analyzing the advantages, limitations, and future prospects of VR in this field through user satisfaction surveys and the actual creation of a virtual reality art museum.

The results of the survey indicate that the vast majority of respondents were satisfied with the immersive experience and interactivity of the virtual reality art museum, believing that VR technology effectively enhanced the immersive experience of art learning. Most students and teachers considered the application of VR technology in education to have significant advantages over traditional teaching methods. However, technical barriers in using VR technology, as well as the lack of educational resources, remain among the biggest challenges.

According to the findings and correlation analysis, younger groups showed higher interest and frequency of use of VR technology, and held more positive attitudes towards its future development. Therefore, when promoting VR technology, more innovative teaching methods should be introduced, especially for younger and student groups, to stimulate their interest and creativity in learning.

Through the actual creation of the virtual reality art museum, this study showcases the rich and diverse ways VR can be applied in art education. The process of developing the virtual art museum, which integrates 3D modeling using 3ds Max, texture creation with Photoshop, and the use of the UE5 VR platform, demonstrates the unique advantages of VR technology in showcasing and deconstructing artworks. For example, the 360-degree rotation viewing function allows users to fully appreciate sculptures and even zoom in on the details of the works. These innovative methods break through the limitations of traditional art displays and offer new possibilities for art education.

The findings of this study lay the foundation for the broader application of VR technology in art education in the future. It also provides valuable references for educators and researchers in the development of VR-based teaching applications. As technology continues to evolve, VR technology will play an even greater role in promoting innovation and progress in art education.

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