

The Integration of VR Museum and School Education— The Case Study Based on the Kremer Collection

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Abstract: The development of media technology has profoundly influenced the way contemporary museums presenting their content and information dissemination, and has brought about changes in the way museums and schools work together. As the world's first VR museum, the Kremer Collection has brought innovation in content and format to school education through its 'virtual gallery design', 'personalized exhibition approach', 'immersive audio-visual tours' and 'multi-platform delivery strategy'.

1. Introduction

In recent years, "education" has gradually become an important role for museums. For example, the National Palace Museum in China, the Metropolitan Museum of Art, the Louvre, etc. have established educational institutions to serve the offline and online education, social training, and cooperation between museums and schools in order to promote the development of museums in the field of public education. However, changes in the technological environment have also profoundly influenced the form of visual presentation, the dissemination of exhibition information, and the approach to education in contemporary museums. Under the new media environment, museums use information technology to store their collection resources in digital form such as texts, images, sounds, videos, and set up virtual display platforms and use the Internet for information sharing. However, the appearance of the COVID-19 has accelerated the digitization of museums and the construction of virtual museum. In 2020, the Louvre collaborated with Google to launch their Virtual Gallery project. By using 360 panoramic technologies, the viewers all over the world can visit the exhibition through the web or wearing a VR headset without leaving home, while the space of the exhibition hall is based on the reproduction of the real space of the Louvre. In addition, other institutions use CG technology to recreate the VR scenes, placing the exhibits in the completely virtual space by 3D modelling. For example, the VR project developed by the British Museum and the Samsung Digital Discovery Centre brings visitors to a virtual Bronze Age [1], and a similar project was launched in 2017 at the Kremer Collection. As the first museum in the world that exists in a totally virtual form, the Kremer Collection is completely free from the real physical space, which not only changes the way the exhibition information delivered, but also expands the visual experience of visitors [2]. The emergence of these different forms of virtual museums has also

brought new development opportunities for museum-school cooperation. On the one hand, students can enjoy the educational resources of the museum without leaving school, which enriches the educational resources of schools; on the other hand, the virtual museum brings innovation to schools in terms of spatial experience, exhibition approach and guided tour design in terms of content and format.

2. The integration of the Kremer Museum and school education

The Kremer Collection is the world's first VR museum founded by the Dutch collectors Mr. and Mrs. Kremer. The collectors plan to establish a permanent location for their collection of 74 Dutch and Flemish classical paintings from the 17th century, which they have been collecting since 1994. However, building a physical museum would cost a lot of time and money, and the visitors would be geographically limited, while building a virtual museum would solve all these problems.

2.1. Museum virtual space, expanding the educational scenes

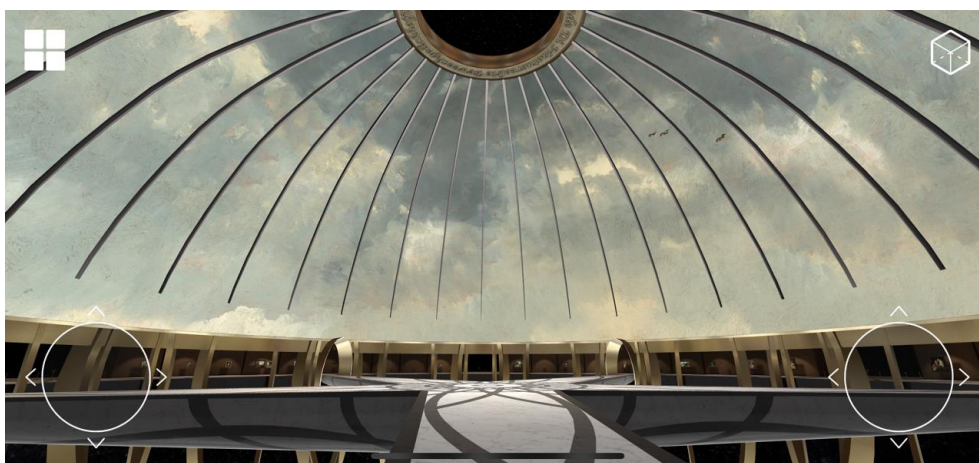


Figure 1: The Kremer Museum Exhibition Hall (From the Kremer Collection App)

The spatial design of the Kremer Collection is an integral part of its digital resources, and an important reflection of the VR museum's distinction from physical museums. Unlike most VR museum space design teams, the Kremer Museum did not choose a game company to develop the space, but chose architect Johan van Lierop to lead the space design, and Moyosa Media in the Netherlands to develop the program. As a VR museum, the Kremer Collection breaks the space and layout limitations of a physical museum in terms of space design. The spherical design of the museum's overall space features a Romanesque vault in the upper half of the sphere; the atrium consists of five passageways to the exhibits, suspended in the middle of the sphere, while 74 works are distributed around the circumference of the spherical space. The lower half of the sphere consists of a metal skeleton frame through which the VR Museum can be seen to be actually placed in outer space. The design of this classical and futuristic exhibition space is inspired by the Roman Pantheon and the Star ship Enterprise from the movie "Star Trek". (Figure 1) When conceiving this virtual museum, architect Van Lierop mentioned that "VR has opened up a whole new realm for architectural practice, where ideas and concepts are no longer limited to passive visuals, but can become a fully immersive experience." The designer suggests that VR technology in the 21st century is as important as Dutch realist painting in the golden age of art history, both of which can transport the viewer to a whole new reality [3]. In the Kremer Collection, visitors feel as if they are in the outer space, able to experience both classical and modern exhibitions at the same time. In

addition, the display space of the virtual museum can be continuously expanded and new artworks and galleries are added along with the system updates. From the perspective of school education, the Kremer Collection exhibition space effectively broadens the educational scenes, so that students are no longer limited to the physical space, and can expand their experience and imagination of space; still, in the process of design, the museum combines classical architectural elements and modern elements, and uses part of the images of exhibits for space decoration, so that the virtual space itself becomes an object of appreciation, and It becomes a part of education, thus enriching the educational content.

2.2. VR techniques to meet personalized exhibition needs

To create a realistic visual effect and an immersive art experience for visitors, each work in the Kremer Collection requires the use of photogrammetry to create an ultra-high resolution 3D visual model. In the process of building the model, between 2,500 and 3,500 high-definition images are captured for each work. Unlike the two-dimensional images captured by high-definition photography technology, photogrammetry can restore the brushstrokes of paintings through model building, which presents a three-dimensional viewing effect. In addition, the use of virtual reality technology can effectively avoid many of the problems that viewers encounter when viewing a physical painting. Taking the light of artworks as an example, when exhibiting physical artworks, the light source cannot be adjusted arbitrarily. Therefore, the problem of partial reflection and partial over-darkness often occurs in the exhibition of classical oil paintings. Virtual reality technology, on the other hand, can design the most suitable lighting for works of different sizes and tones. In addition to the light problem, the height of the works can be adjusted in the Kremer Collection to meet the viewing needs of the audiences to the greatest extent. In contrast to physical exhibitions, the height of the works is fixed and cannot be changed. In terms of viewing distance, the viewer can get close to the museum's collection and appreciate the brushstrokes, colours and every detail of the frames. Because the works are presented as 3D images, the viewer is also able to explore the backs of the paintings at the same time to understand the provenance and markings of the works, breaking the traditional museum perspective of viewing the works. (Figure 2) For school education, this flexible way of exhibiting artworks and the super close viewing method help provide personalized viewing services for students of different ages and heights.



Figure 2: Back of the Painting (From the Kremer Collection App)

2.3. Immersive audio-visual tours to improve concentration of the viewers

In the Kremer Collection, each work is accompanied by an audio narration that covers the background information and history of the work. Audio information is very crucial to the VR experience of the exhibition. High-quality spatial audio could enhance the immersion and presence

of the audience, making visitors feel as if they are really in the exhibition hall and listening to the narration of the works. The Kremer VR Museum's voice narration function imitates the real sound transmission and reception environment by means of environmental modelling, allowing the audience to receive different levels of narration volume at different locations near and far from the work. As viewers get closer to the artwork, they are able to access a greater volume of narration, and vice versa, the volume gradually decreases. For those unable to receive audio information, the museum also provides textual information including the title, author, size, material, historical context, and narration of the work. (Figure 3) In the virtual space, the size of the text message can be automatically adjusted according to the distance of the viewer from the work, and the reflections in the oil paintings will be adjusted at any time according to the position of the viewer. In addition, the guided tour of the exhibition and narration of the works is done by holograms of the Kremer's. When entering the exhibition hall, the virtual Kremer's will elaborate on the background of the Kremer Collection, the works in the exhibition and the VR project. This immersive audio and visual information enhance students' concentration during the educational process without the distraction of other viewers. In the interview, George Kremer mentioned that he visited the Dutch National Museum with his classmates when he was 10 years old and was so captivated by a work of art by Rembrandt that he became separated from his classmates due to his prolonged stopping to look at it. However, the Kremer Collection provides students with the greatest freedom. The exhibition does not have a uniform viewing line, and students are able to selectively access information about the works according to their preferences and choose how long to stay according to their interests.

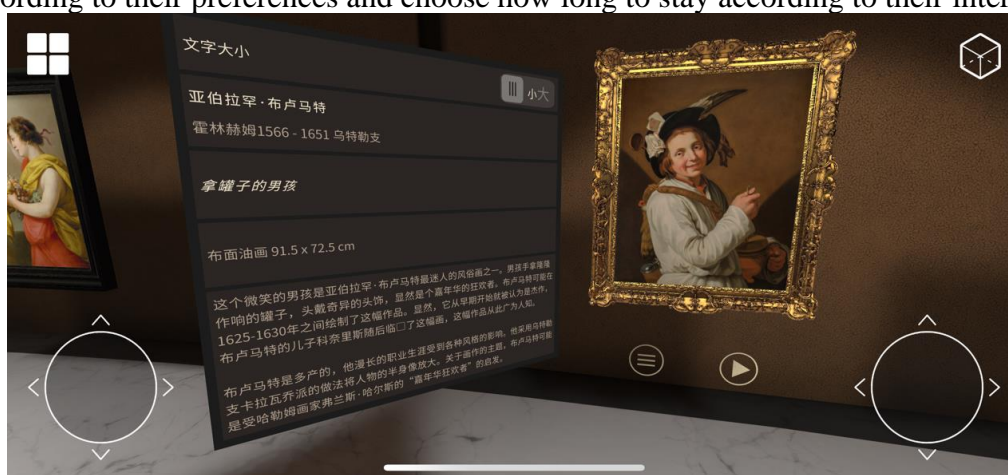


Figure 3: Text Introduction of the Artwork (From the Kremer Collection App)

2.4. Multi-platform launch strategy to enrich educational channels

The Kremer Collection first launched a VR platform version in 2017, with content available on HTC Viveport as well as the SteamVR platform. In 2018, to continue expanding the dissemination of the exhibition, the museum developed its mobile app (The Kremer Collection Mobile). Visitors are able to access a similar taster experience to that of a VR headset through the smartphone. Kremer said in an interview, "For years, we've been trying to spread knowledge about our collection as widely as possible, and this is a way to reach as many people as possible faster. When you have a mobile app, you have a worldwide market." The smartphone version of the museum is overlaid with AR capabilities, a new feature that uses the phone's camera and gyroscope to determine the physical movement of viewers and project it into the virtual museum. Visitors can "look around" the museum in 360 degrees through the phone's camera and control their movement on the screen by moving in real-world directions. In addition, the smartphone version of the Kremer Collection is

able to output multiple exhibition languages to meet the exhibition viewing needs of visitors from different countries. For school education, the multi-platform strategy can help students access the exhibition content through different channels, anytime and anywhere; while the multi-lingual environment helps the museum platform to share and disseminate cultural resources beyond national boundaries.

3. Ways of cooperation between the Kremer Collection and schools

The Kremer Collection is accompanied by the TKC Mighty Masters program, one of the museum's school education programs, which aims to "make art universally accessible and enjoyable to as many schoolchildren as possible around the world. ". By providing free smartphones and VR hardware to schools around the world, the program allows art to reach relatively under-resourced areas, thereby inspiring the next generation of art lovers. In terms of collaboration, the Mighty Masters program works primarily by providing VR devices to schools and organizing art events.

3.1. Providing VR devices to expand the reach of artworks

The Mighty Masters program began with India as a pilot, bringing the first VR hardware devices to schools in Maharashtra with support from the local foundation Delivering Change Foundation. With more than 200 million schoolchildren between the ages of 6 and 13, India has one of the largest elementary school populations in the world. As such, the Kremer Museum's art exhibition format that transcends space can make a significant impact on local school education. At present, this program has covered some schools in the Netherlands, India and Nigeria. In the process of implementing the Mighty Masters program, the Kremer Collection has built a framework of cooperation to help promote the program, including project implementation, marketing, hardware sponsorship, and corporate sponsorship. In this regard, the Kremer Collection is coordinating resource management and maintaining the basic operation of the project through museum income; at the same time, it relies on local foundations to implement the project; and uses corporate sponsorship to obtain more funds, equipment and technical support.

3.2. Organizing art exhibition and realizing art content co-creation

In addition to providing VR hardware and equipment, the Mighty Masters program also combines VR experiences with student art creation, enabling co-creation of content between museums and schools. For example, at the "Rainbow" elementary school in Assen, the Netherlands, students aged 7 to 9 years old visited the Kremer Collection with VR headsets and then expressed their experiences in the form of drawings and paintings based on the exhibition experience. After the creations were completed, the Kremer Collection's technology team, Moyosa Media, scanned each piece and created a new VR museum based on the creations, using the children's stories to illustrate what they had drawn and inviting their parents to participate in the experience. (Figure 4) This form of content co-creation enable students to participate in the educational process and also brings localized content to the VR museum. Before the advent of VR museums, content co-creation between museums and schools was mainly done in the form of "museum schools". In other words, museums and schools entered into a long-term partnership, combining formal and informal education to promote student development based on the effective use of museum resources [4]. On the one hand, schools bring students into museums for classes; on the other hand, museums assist students in designing their own museums within the school. However, traditional forms of collaboration rely on local museum resources and the physical movement of students and museum staff. The use of VR museums, on the other hand, allows for effective access to remote museum

teaching resources and freedom from site constraints.



Figure 4: Children's VR Museum (From the Mighty Masters)

4. Conclusions

The Kremer Collection has used different virtual reality technologies to provide new content and teaching formats for school education by building virtual exhibition halls, and providing equipment and financial support for students through the Mighty Masters program. However, there are still some problems in the process of integrating VR museums with school education. First, the educational process lacks physical space perception. "Artworks are not perceived in isolation, but are part of the viewer's entire museum experience." The scholar George E. Hein has suggested the important role that spatial experience plays in the museum visit conducted by the audience [5]. In conducting museum cultural perception, museum architectural style, exhibition line design, interior furnishings, and materials can all add value to the viewer. The current VR museums, on the other hand, although they can bring more innovation and interest in spatial design and bring a visual perception similar to that of the physical space, the tactile sensation and scent of materials in the real environment cannot be restored.

In addition, the exhibition narrative, exhibition line design, and presentation of texts and works in the current VR museum still follow the form of physical museums in the past and do not give full play to the characteristics and advantages of the VR technologies. For example, the interactivity between the exhibition and the audience is insufficient. Take the Kremer Collection as an example, the exhibition information stays in the one-way communication stage, and the audience can only acquire the exhibition content, but cannot export the content to the exhibition, and similar phenomena also appear in the virtual exhibition halls of the Louvre, the National Museum of Natural History, the Metropolitan Museum of Art and other museums around the world. At the same time, the exhibition interaction is relatively simple, mainly through the function of direction tracking to control the viewing route, and lack of voice interaction and haptic feedback mechanism. As for VR technology, interactivity is one of the most important advantages that distinguishes it from other passive media. In addition, in terms of information richness, the audience can only get information based on the text introduction and audio guide of the exhibits, which lacks the extension of the artworks and exhibition contents. However, these problems are not only faced within the Kremer Collection, but are also common to numerous virtual museum projects around the world today.

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