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Effectiveness of VR Technology in the Design of the Bali Megarupa V Virtual Exhibition

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Virtual exhibitions offer a promising avenue for art appreciation in the digital age. However, limited research explores how these online spaces can foster emotional connections with art, a crucial aspect of the art experience. This study investigates the potential of immersive virtual reality (VR) to enhance engagement and emotional impact in virtual art exhibitions. Employing a multi-method approach combining literature review, user testing, and prototype development, the research identifies and evaluates design elements contributing to increased user engagement. This research employed a multi-method approach to understand how users engage with virtual art exhibitions. The study identified and evaluated the impact of specific design elements on user engagement by combining a literature review, user testing with a VR prototype, and subsequent analysis. The study focuses on critical elements like interactivity, personalization, storytelling, and multi-sensory experiences. User testing with 55 participants revealed the effectiveness of immersive design in fostering exploration, contemplation, and a sense of presence in the virtual space. This immersive design is the strategic integration of elements like interactivity, personalization, and storytelling within the VR environment. The research underscores the significance of immersive design, defined as the strategic integration of design elements to cultivate an emotional connection within a VR environment. This encompasses aspects like interactivity, personalization, and the incorporation of storytelling within the experience. Finally, the study offers practical recommendations for curators and designers to create virtual art experiences that resonate more deeply with audiences.

Keywords: *virtual exhibition, immersive virtual reality, user experience, story sequencing in virtual environments, art and technology*

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INTRODUCTION

Over the last decade, remote museum familiarisation activities using virtual exhibition media have increased, with some leading museums creating simulations of their physical environments in the virtual realm. Some museums offer various virtual interactivities to their users using techniques such as gamification. (Lichty, 2024). However, research related to virtual exhibition design that covers the needs, creation and level of audience acceptance of virtual art exhibitions still needs to be completed.

Bali Megarupa is a prestigious fine art exhibition held in Bali, Indonesia. It is a platform for local and international artists to showcase their best works. Bali Megarupa is not just an exhibition but also an integral part of the Bali Jani Art Festival (FSBJ). FSBJ is an art event dedicated to modern and contemporary art in various forms and styles. The Bali Megarupa exhibition allows Balinese artists to showcase their talent and creativity to a broader public. This encourages the development of fine arts in Bali and enhances the island's appeal as an arts and cultural destination. Bali Megarupa presents the work of local artists to the public, thus opening up opportunities for cultural exchange and new ideas in art. Bali Megarupa is an art exhibition that plays a vital role in developing art in Bali, promoting cultural exchange, and enhancing art appreciation in the community.

Bali Megarupa V features 99 national and international artworks. The artworks exhibited in this exhibition are two-dimensional (painting, photography, graphic/printmaking) and three-dimensional (sculpture, installation, craft) works presented at Natta-Citta Art Space (N-CAS), Institut Seni Indonesia (ISI) Denpasar, Gedung Kriya Taman Budaya Provinsi Bali, and ARMA Museum, Ubud. The artworks exhibited in this exhibition are two-dimensional (painting, photography, graphic/printmaking) and three-dimensional (sculpture, installation, craft) works presented at Natta-Citta Art Space (N-CAS), Institut Seni Indonesia (ISI) Denpasar, Gedung Kriya Taman Budaya Provinsi Bali, and Museum ARMA, Ubud.

The exhibition is curated by Prof. Dr Wayan Kun Adnyana, Jang Shin Jeung, MA, and Anak Agung Gede Rai. Given the international scale of the exhibition and in order for the exhibition to be enjoyed not only in person at the exhibition site, the curators and organisers of Bali Megarupa V 2023 want to present it in a virtual space so that art lovers and connoisseurs everywhere can also enjoy it. By providing online accessibility for Bali Megarupa V, the curators and organisers hope that the exhibition works can be a source of ideas and inspiration for artists to work without being limited by time and space.

Art exhibitions have been synonymous with physical spaces such as museums and galleries. It is there that art lovers can enjoy the irreplaceable sensory experience of coming face-to-face with a work of art. However, a new trend has emerged in recent years: virtual art exhibitions. Several factors fuel this development, including the increasing availability of high-speed internet. A faster and more stable internet network allows for a more immersive and richer virtual experience (Susanthi et al., 2023). Visitors to virtual art exhibitions can explore high-resolution artworks, magnify details with the zoom feature, and even feel the sensation of being in the exhibition space through 360-degree virtual tours (Kustanti & Nugrahani, 2020). After 2020, the world's internet usage has increased, and almost 60% of the world's population has been connected to the internet (Khuan et al., 2023). This represents an excellent opportunity for virtual art exhibitions to reach a wider audience beyond the geographical and demographic boundaries that have hitherto constrained physical exhibitions.

Recent research shows a significant increase in the use of online platforms for arts activities. These include social media, art-specific websites and the metaverse (Lee & Lee, 2019). Online platforms have been utilised for art activities by people with dementia during the COVID-19 pandemic. This suggests that certain groups within the arts community have utilised digital platforms due to external circumstances (Wiseman et al., 2023). Online platforms such as social media allow artists to overcome various barriers. This further emphasises the role of online platforms in mitigating the challenges in the art world (Mak Mon et al., 2021). Recent research on virtual museums and online art exhibitions shows that these platforms can provide authentic experiences for online visitors (Sundar et al., 2015). The transformation of physical exhibitions into digital formats, such as Instagram, has been studied. This study shows how online platforms can extend the reach of art exhibitions beyond geographical boundaries (O'Hagan, 2021).

As technology advances, entertainment and cultural content consumption trends shift towards digital platforms (Nieborg & Poell, 2018). Art institutions face the challenge of reaching a wider audience beyond the traditional gallery space. Virtual art exhibitions present an innovative solution to overcome the access gap between the public and art,

opening up new opportunities for art education and appreciation in the digital age. The high cost of organising physical exhibitions is also often an obstacle for artists, especially those in remote areas, to exhibit their work. Virtual art exhibitions offer several other advantages, such as enriching the visitor experience and providing a deeper understanding of the artworks on display by integrating multimedia elements such as video, sound and text. Virtual exhibitions can also be well documented and digitally archived so that future generations can access and enjoy them in the long run.

Virtual art exhibitions have the potential to bridge the access gap and expand the reach of art to a broader audience. This is possible because geographical and time constraints do not bind virtual exhibitions. Visitors worldwide can access virtual exhibitions anytime and anywhere without visiting a physical gallery. This advantage is significant for people living in remote areas or developing countries, where access to traditional art galleries may be limited. Virtual art exhibitions allow them to enjoy and learn about fine art from different cultures without travelling far. One of the main advantages of virtual art exhibitions is their ability to increase engagement and art appreciation for visitors. The immersive experience offered by virtual exhibitions allows visitors to experience a closer feel to the artworks for visitors, bringing them closer to the artworks in a way unrivalled by traditional exhibitions.

To support immersive outcomes, an excellent virtual exhibition space design should not only present artworks digitally but should also be able to create an immersive and meaningful experience for visitors. (Cotter et al., 2023). To support this experience, virtual exhibitions should be designed with exploration, contemplation and a sense of presence in mind (Kersting et al., 2020). Considering the importance of creating a sense of immersion for visitors to this virtual exhibition, the research question is: How effective is using virtual exhibition space for Bali Megarupa V using an immersive approach to increase visitor acceptance?

RESEARCH METHODOLOGY

This research uses qualitative methods to answer the research questions. The qualitative method was chosen because this research aims to understand visitors' experiences of virtual exhibition spaces, which are subjective and cannot be measured by numbers (Adlini et al., 2022). Data collection was conducted through literature studies and interviews. The collected data is used to develop a virtual exhibition space prototype incorporating immersive design principles and user feedback. The prototype will then be tested with users to determine its effectiveness in encouraging exploration, contemplation, and a sense of presence (Hendriyana, 2022). Using this combination of research methods, the researcher hopes to understand how to design an adequate virtual exhibition space for Bali Megarupa.

RESULT AND DISCUSSION

Virtual art exhibitions offer various advantages contributing to the art world and society. One significant advantage is its ability to increase visitor satisfaction. This improvement occurs through a well-organised collection of digital artworks and enables a more interactive experience for visitors (Samsuddin et al., 2022). These experiences can include features such as zooming in on artwork details, additional information about the artist and his or her work, virtual guided tours, and even virtual reality to immerse visitors in the environment created by the artist (Fukuda & Ishibashi, 2023). As such, virtual art exhibitions improve access to art and increase visitor engagement and satisfaction by presenting well-curated collections and offering personalised interactive experiences (Mu & Murtada Dohan, 2021).

Virtual Exhibition

Despite its many advantages, virtual exhibitions also have drawbacks that must be considered. These drawbacks can affect the aesthetic experience of visitors in enjoying the artworks. Virtual exhibitions cannot fully replicate the sensory experience one gets when viewing artworks in person. This includes the scale of the work, texture, scent, and nuances of colour and light (Lin et al., 2020). For example, details in the brush strokes of a painting or the rough texture of a sculpture would require more work to appreciate optimally through a screen. Unlike physical galleries, where visitors can freely move around and explore the entire exhibition space, virtual exhibitions generally restrict visitors' movement within the virtual space. This can limit the organic exploration and discovery of artworks. Visitors may only be unable to find artworks that catch their attention on the predetermined path of the virtual exhibition designer.

Traditional art fairs can bring communities together through the appreciation of artworks. Visitors can engage in in-depth discussions about artworks, share their interpretations, and connect with others with similar interests. However, while offering ease of access, virtual art exhibitions can only partially

replicate the social experience offered by physical art exhibitions. The lack of physical presence in a virtual exhibition space can create isolation and reduce the sense of community engendered by face-to-face interactions (Parsons, 2023). Virtual exhibitions also limit the viewpoints and perspectives of visitors to the artworks. Visitors can only freely observe the work from one side, which prevents them from having a more nuanced exploration.

Digital interfaces to virtual exhibitions sometimes offer a wide range of information related to the artworks and the exhibition itself. Information overload, such as long descriptive texts, documentary videos, or links to external websites. However, information overload can be a barrier for less tech-savvy individuals who need access to adequate devices or internet connections. This may lead to access gaps and limit their participation in virtual exhibitions (Zhang & Xue, 2023).

Immersive Experience

Immersive experiences in virtual reality (VR) have their characteristics, namely the ability of VR technology to take users to different environments, making them feel as if they are physically present in the simulated reality (Souza et al., 2021). This immersion is achieved through features such as entirely computer-generated environments and head-mounted displays, which create a sense of presence and interaction with objects that may not be accessible in the real world (Dengel, 2020). The immersive nature of VR allows users to engage with content in a way that demands their complete focus, thus enhancing their learning experience (Petersen et al., 2022). Furthermore, immersive VR experiences have been explored in various fields, including heritage education and virtual exhibitions, demonstrating the versatility and applicability of VR technology in creating engaging and interactive environments. To create an immersive experience, it is essential to understand and incorporate elements such as exploration, contemplation, and a sense of presence.

The building blocks of an immersive experience are described as follows (Wang et al., 2023): 1). **Exploration**: Visitors can easily navigate and explore the virtual exhibition space as if they were in a physical gallery; 2). **Contemplation**: Virtual exhibition spaces should be designed to support deep contemplation and appreciation of the displayed artworks; 3). **Sense of Presence**: Visitors should feel virtually present in the exhibition space and connected to the artworks they are viewing.

Immersive approaches are closely related to the user's experience level. They can significantly impact their creativity and cognitive processes (Makransky & Petersen, 2021) by utilising immersive technologies and designing experiences that encourage cognitive memory building in users.

Designing a Virtual Exhibition Based on Immersive Experience Elements

Traditional exhibitions often have limitations in terms of accessibility. Location, cost, and time can be barriers to attending exhibitions. Virtual exhibitions can overcome these barriers by providing accessible and flexible online access. However, online accessibility alone is not enough to ensure inclusivity. Virtual exhibitions must be designed with diverse users in mind, including those with limited technology, devices, or internet connection. Researchers chose an immersive approach to enhance cognitive memory to design the Bali Megarupa virtual exhibition that can encourage exploration, contemplation, and a sense of presence for visitors.

Virtual Reality is a technology using computers that combines various special devices in the form of inputs and outputs so that users seem to be in the real world through vision and can interact with digital environments in depth (Ariatama et al., 2021). The visuals produced for the Bali Megarupa V Virtual Exhibition are in the form of a 360 virtual reality room where visitors can see the artworks displayed on the walls of the virtual space. Visitors will feel like they are in an art gallery and can interact with each artwork. 360-degree visualisation can also encourage the development of new perspectives in understanding events and storytelling, evoking cognitive memory that ensures exhibition works are remembered in the future.

The museum room where the artworks are exhibited uses a modern minimalist concept, like modern museums and art galleries, to increase the user's familiarity. The concept of minimalism itself, in terms of interior aims to provide a simple, clean, and beautiful background by highlighting a few elements that want to be displayed and can stimulate the audience to feel different feelings, such as association, thought, and experience, into the work to be obtained (Yossef, 2014). The minimalist modern interiors in this virtual space, as shown in Figure 1, are also used so visitors can focus on the artworks on display and minimise obstruction.

Figure 1. Edwin Gallery in Jakarta

(Source: edwingallery.com)

Virtual exhibitions offer a unique opportunity to showcase artworks and educate the public. However, to maximise the potential for creating cognitive memory, it is essential to carefully consider how artworks are installed and presented within the virtual exhibition space. Not only are the works displayed in a single room, but they are made accessible through a single door to make it easier for users to move from one room to another. As such, each virtual space in the Bali Megarupa V exhibition will feature a different artwork categorised by the institution that commissioned the work.

This allows visitors to explore various art styles and perspectives easily and organised. Visitors can *click* on the plaques on the exhibition page, as sketched in Figure 2, to conveniently visit the desired exhibition space. If visitors want to change rooms, they can return to this page by clicking on the exit door in the exhibition room.

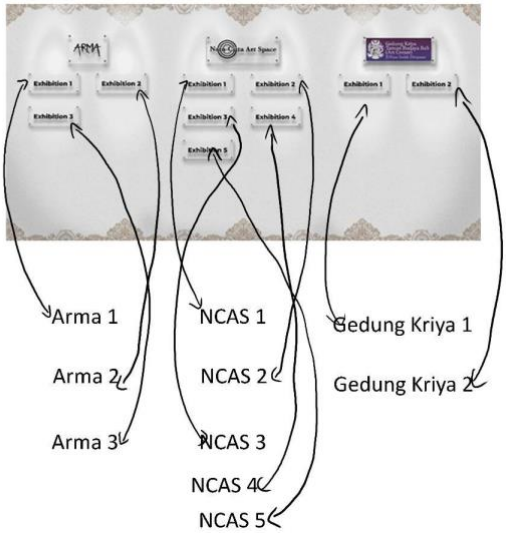

Figure 2. Sketch of the Exhibition Hall One-Door Access Page Divided by Institution

(Source: Researcher Documentation)

Each virtual room will showcase various artworks, such as paintings, photographs and sculptures. Each work is also equipped with a caption plaque containing the work's title and the artist's name (Figure 3). This aims to make it easier for visitors to understand the message and context of the displayed artworks. The base of the room is square with four walls. The top and sides are decorated with Balinese ornaments with subtle colours so as not to disturb the modern minimalist concept of the room. The exhibition walls are white so visitors can focus on the hanging works. The information plaque is also simple in black and white so that the focus of the main object remains on the artwork.

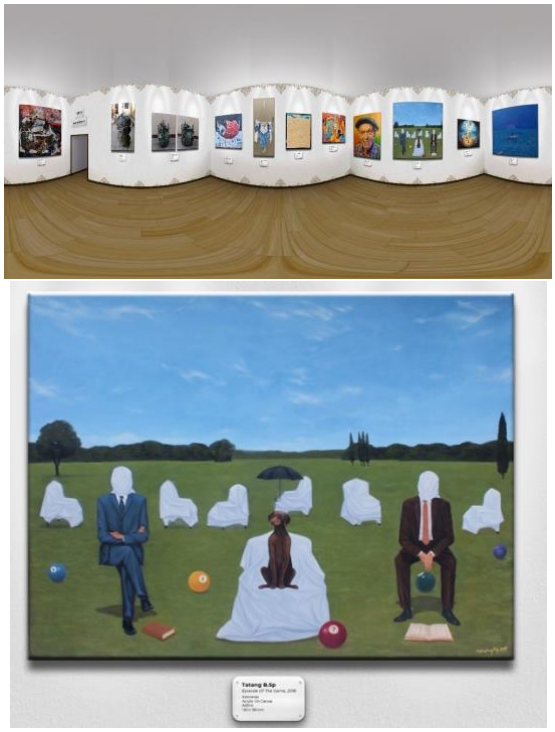

Figure 3. Room Display with Exhibited Works and Detailed Information on Plaques

(Source: Researcher Documentation)

As shown in Figure 4, visitors can freely view artworks in a room and interact using a computer *mouse*. By holding the left click on the *mouse* and moving the *cursor*, the VR display automatically rotates as far as the *mouse cursor* moves. Visitors can also see the artwork more closely by turning the scroll wheel on the *mouse* upwards so that the artwork information plaque can be more visible. If you are satisfied with one room, you can move to another by clicking the blue arrow on the door. Visitors' immersion is evoked as if they are in an art gallery, even though they only see from behind the screen.

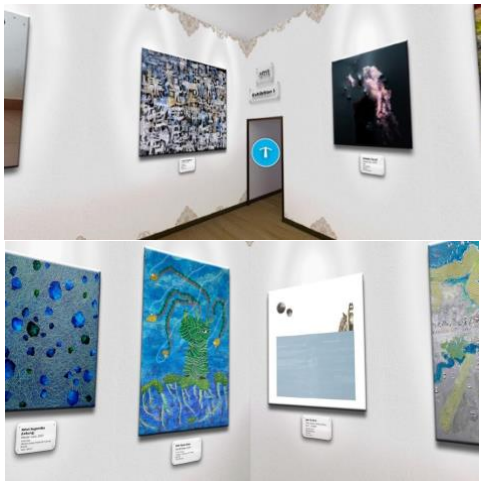

Figure 4. Immersion view of the Bali Megarupa V 2023 Virtual Exhibition

(Source: https://megarupa.isi-dps.ac.id/)

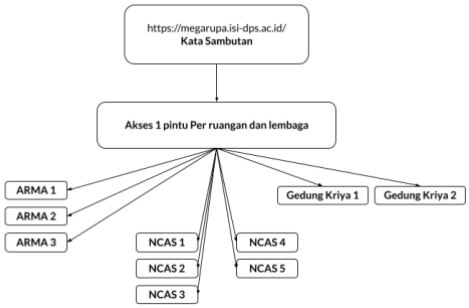

Figure 5. Sitemap of the Bali Megarupa V 2023 Virtual Exhibition

(Source: Researcher Documentation)

The Virtual 360 immersion navigation system in the "Bali Megarupa" exhibition, as shown in the sitemap in Figure 5, is implemented using a website. On the website's main page, there will be a speech from the committee explaining the concept of the virtual exhibition to visitors. After the speech, visitors click the Visit Exhibition button to be directed to the next page. On the second page (Figure 6), visitors experience the 360-immersion display. The room graphics are three-dimensional and move around the visitors as if they are visiting the exhibition room (Marín-Morales et al., 2019).

Figure 6. Second page of the Bali Megarupa V 2023 Virtual Exhibition

(Source: Researcher Documentation)

Visitors to the 360 virtual exhibitions can easily explore the space in depth. To return to the room selection menu, visitors click back on the screen. The 360 virtual immersion begins when visitors select the room they want to go to. After clicking on the desired room, visitors are immediately transported into the room and can enjoy the artwork. Visitors click on the blue arrow at the exit to exit and visit another room, as shown in Figure 4. The sitemap and floor plan is designed to be simple and easy to navigate so visitors can focus on the artwork on display.

Evaluating the Effectiveness of Virtual Exhibitions Based on Immersive Experience

Traditional exhibitions often have limitations in terms of accessibility. Factors such as location, cost, and time can be barriers for many people to attend exhibitions. Virtual exhibitions can overcome these barriers by providing access

To evaluate the effectiveness of the Bali Megarupa V Exhibition in creating an immersive experience for visitors, data was collected from 55 participants regarding their level of engagement while visiting the Bali Megarupa V exhibition. This data was analysed to measure the success of the exhibition design in building visitors' immersive experience through exploration, contemplation and a sense of presence.

Table 1. Data Collection Immersive Experience of Visitors to Bali Megarupa Exhibition

(Source: Researcher Documentation)

Score	Statement		
	Exploration	**Contemplation**	**Attendance**
	I visited at least half of the available virtual exhibition spaces (*visited more than six paintings).	**I tried to interact with the exhibition elements (e.g. zoom in, move around the room, click on the plaque).**	**I felt present in the exhibition space and forgot that I was viewing the exhibition virtually.**
SS	47	39	10
S	7	13	14
RR	0	3	20
TS	1	0	9
STS	0	0	2
TOTAL	**265**	**256**	**186**
(%) Index	**96.4 %**	**93.1 %**	**67.6 %**
Interpretation	**Very good**	**Very good**	**Good**

The overall conclusion of this evaluation shows the success of the Bali Megarupa V Exhibition in creating an immersive experience for visitors. The data in Table 1 clearly illustrates this achievement. Good virtual exhibition design effectively facilitates visitors' exploration, contemplation, and sense of presence. It allows visitors to engage more deeply with the artworks and the overall exhibition experience.

Some of the key points from this evaluation are: 1). The high Exploration index (96.4%) demonstrates the success of the exhibition in creating a very well-designed virtual exhibition space, allowing visitors to move freely and explore the different areas of the exhibition as they would in a physical gallery. This ease of movement and interaction highlights the effectiveness of the exhibition layout in engaging users and encouraging thorough exploration of the space; 2). The Contemplation index was also strong (93.1%), indicating that the virtual exhibition effectively supports deep engagement and appreciation of the artworks. The design successfully provides visitors relevant information and context, encouraging meaningful interaction and contemplation of the displayed pieces; 3). The Sense of Presence index (67.6%) reflects a generally positive, though varied, experience of immersiveness in the virtual exhibition. While most of the visitors felt the virtual space was engaging, with some rating it as good to very good, there were mixed experiences regarding how immersive the environment felt. This suggests that while the exhibition achieved a reasonable level of virtual presence, there is potential for enhancing the overall sense of immersion.

Furthermore, data was also collected from respondents to measure the success of the Bali Megarupa virtual exhibition in creating cognitive memory of its visitors with the results as shown in Table 2.

Table 2. Cognitive Memory Data Collection of Bali Megarupa Exhibition Visitors

(Source: Researcher Documentation)

Score	Cognitive		
	I can recall several names of artists whose works were exhibited at Bali Megarupa V (*remember more than three).	**I can remember some of the artworks exhibited at Bali Megarupa V (*remember more than three).**	**I can remember navigating the virtual space of the Bali Megarupa exhibition.**
SS	2	8	26
S	10	28	23
RR	20	14	5
TS	14	4	1
STS	9	1	0
TOTAL	**147**	**203**	**239**
(%) Index	**53.5 %**	**73.8 %**	**86.9 %**
Interpretation	**Average**	**Good**	**Very good**

Some of the key points from this evaluation are: 1). The high Exploration index (96.4%) demonstrates the success of the exhibition in creating a very well-designed virtual exhibition space, allowing visitors to move freely and explore the different areas of the exhibition as they would in a physical gallery. This ease of movement and interaction highlights the effectiveness of the exhibition layout in engaging users and encouraging thorough exploration of the space; 2). The Contemplation index was also strong (93.1%), indicating that the virtual exhibition effectively supports deep engagement and appreciation of the artworks. The design successfully provides visitors relevant information and context, encouraging meaningful interaction and contemplation of the displayed pieces; 3). The Sense of Presence index (67.6%) reflects a generally positive, though varied, experience of immersiveness in the virtual exhibition. While most of the visitors felt the virtual space was engaging, with some rating it as good to very good, there were mixed experiences regarding how immersive the environment felt. This suggests that while the exhibition achieved a reasonable level of virtual presence, there is potential for enhancing the overall sense of immersion.

CONCLUSION

This research evaluates the effectiveness of the Bali Megarupa V 2023 virtual art exhibition in creating an immersive experience for visitors. The findings show that the exhibition increased visitor engagement using innovative 360 VR technology. Virtual exhibitions offer several essential benefits to visitors, including ease of access, realistic immersive experiences, and improved cognitive memory. Exploration, contemplation, and a sense of presence are essential in building a successful immersive experience. The Bali Megarupa V 2023 exhibition provides an outstanding example of how 360 VR technology can increase visitor engagement and foster art appreciation. Virtual exhibitions can be an effective platform to reach a wider audience and increase public understanding of art.

Based on the evaluation results, the Bali Megarupa virtual exhibition received a positive evaluation from exhibition visitors. Visitors rated the exhibition highly in exploration and contemplation, appreciating the interactive and engaging design. While the sense of presence was generally good, with some visitors feeling like they were in a real gallery, variability was noted. To improve this, VR headsets can be incorporated to enhance immersion so visitors can feel more directly present in the exhibition space.

In terms of cognitive aspects, findings from the study show that the visitors were generally successful in remembering multiple artworks from the exhibition. Additionally, the navigation within the virtual space was rated very positively, indicating that the design is user-friendly and practical. While visitors had difficulty recalling artist names, improvements can be made for future virtual exhibitions by incorporating interactive menus for the artist names to facilitate more accessible access to artist information, thus encouraging engagement and recall.

By implementing these recommendations and building on existing strengths, future virtual exhibitions can continue to deliver immersive experiences that encourage more profound connections with art and enrich cultural engagement.

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