Effect of Display Methods on Intention to Use Virtual Reality in Museum Tourism

Abstract

The application of virtual reality (VR) promises unique visitor experiences in museum tourism; however, the underlying characteristics of the experiences still need to be well-researched. This research used world-famous paintings (Vincent van Gogh's *The Starry Night* and Claude Monet's *Water Lilies*) as examples, combining flow theory and Stimulus-Organism-Response framework and using the experimental research method. The findings were: (1) the display methods of museum exhibits affected visitor flow experience and intention to use VR; (2) flow experience had a significant mediating effect in the main effect, and (3) the familiarity with VR had a moderating effect on flow experience's mediating effect. The findings enriched the research literature on VR usage and display methods in museums, providing a theoretical reference and strategic suggestions for enterprises developing museum exhibits and applying VR technology.

Keywords

Virtual reality (VR); Museum tourism; Virtual tourism; Display methods; Flow experience; Intention to use VR

Introduction

In recent years, museum tourism has been in full swing worldwide (Serravalle et al., 2019). Museum tourism originated in Western countries in the 20th century and refers to a form of tourism that takes culture as the core attraction, relies upon it, carries museum places and

contents, and organically combines cultural activities with sightseeing (Zou et al., 2022). With cultural tourism booming, the number of museums around the world has increased from 22,000 in 1975 to 95,000, according to UNESCO (2021). At the same time, museum attendance is on the rise, with the Louvre Museum in Paris reaching 9.6 million visitors, followed by the National Museum of China with 7.39 million visitors and the Vatican Museums with 6.88 million visitors, according to the Global Museum Visitor Survey 2019 (UNESCO, 2021). Even under the impact of the COVID-19 pandemic in 2020, museums actively sought change and explored ways to minimize negative impacts. With the joint efforts of museums and tourism departments, museum tourism is booming again, and the public's enthusiasm for museum tourism is growing (ICOM, 2020).

The unique cultural attributes of museums are one of the crucial reasons why they can still flourish in different times and backgrounds. Therefore, how to better present and spread culture in museum tourism is a vital issue for managers to consider (Antón et al., 2019). Specifically, the museum's display methods go through three stages: static, dynamic, and interactive (Hashim et al., 2014). Now more museums employ dynamic and interactive display methods with the help of digital means, for example, augmented reality (AR), virtual reality (VR), and mixed reality (MR) (Verhulst et al., 2021). This research aims to explore the influence of the display methods for museums' famous paintings on visitor experiences in virtual tourism, among which the display method refers to the traditional static image display and dynamic interactive VR display.

Virtual reality (VR) has been one of the most important revolutions of visual technology in recent years. It is a technology that simulates real scenes to provide a virtual environment

and immerse users in it to create a sense of perception substitution or perception enhancement (Manis & Choi, 2018). The core of this technology is immersion and interactivity (Sherman & Craig, 2003), which presents exhibits and transmits culture more authentically and interactively, creating a deeper understanding and memorable travel experiences for museum visitors (Verhulst et al., 2021). According to the differences in the degree of immersion and interaction as well as operating modes, scholars divide virtual reality systems into the following three categories (Beck et al., 2019): The first is a non-immersive virtual reality system, in which users interact with the virtual environment through keyboard, mouse, joystick or touchscreen devices (Lombart et al., 2020); the second is the semi-immersive virtual reality system, that is, the virtual world is superimposed on the real world, forming a seamless connection between the two worlds (Maggio et al., 2023); the third category is immersive virtual reality systems, which are equipped with motion sensors to facilitate natural interaction with the automatic virtual environment and head-mounted displays (Lombart et al., 2020). Immersive and non-immersive virtual reality systems are widely used (Lombart et al., 2020). For example, the famous painting of the Mona Lisa in the Louvre Museum in France (Louvre, 2019) and the retrospective of Modigliani at Tate Modern, London (Tate Modern, 2017).

This study was carried out in China, and the application of VR technology in domestic museum tourism has matured. Among them, the Palace Museum started to apply this technology earlier, and now it has been maturely applied in cultural relics, famous paintings, historical buildings, and other aspects, such as The Panoramic Palace Museum, a program released on the official website of the Palace Museum (The Palace Museum, 2022). The

outbreak of COVID-19 in 2020 made it difficult to visit museums offline, so more and more museums achieved remarkable results by applying VR and other new technologies in museum exhibitions (Cheng & Huang, 2022). According to the data released by the State Administration of Cultural Heritage of China, Chinese museums received 779 million visitors, planned more than 3,000 virtual exhibitions and over 10,000 educational events, and the total views reached 4.1 billion in 2021 (China Daily, 2022).

Scholars have proposed that VR technology is often used as a marketing tool (Beck et al., 2019). In the early promotion stage, with the help of VR technology, marketers provide museum preview services for tourists on tourism websites and quick response codes for tourists on tourism brochures (Fan et al., 2022). During the tour phase, VR technology is applied to interactive tools (such as digital guides and cave displays) to increase the perceived value of consumers (Fan et al., 2022). They are also seen as a means of building positive word of mouth later after the tour (for example, uploading short videos of VR experiences to YouTube) (Fan et al., 2022). The use of VR in museums has not only enriched the forms of tourism products in museums but also enabled tourists to participate more deeply and improve the quality of the tourism experience (Verhulst et al., 2021).

Studying the relationship between museum tourism and VR use is significant for optimizing visitor experience and promoting museum management (Beck et al., 2014). Through a review of the existing research, it can be found that the research content of museum tourism mainly focuses on the following aspects: The first is the integrated development of museum, city, community, and heritage tourism (Kim et al., 2016; Hashim et al., 2014). The second is museum tourists' psychological and behavioral characteristics,

motivation, demand, and satisfaction (Cheng & Huang, 2022; Zhou et al., 2022). The third is the development of museum functions (Zou et al., 2022). However, the application research of VR in museum tourism is minimal, and a relatively complete research system has not yet been formed.

Further, existing museum tourism research on VR technology focuses on two aspects. First, tourists' acceptance of virtual tourism and travel experience under the application of new technology (Bogicevic et al., 2019); second, the impact of VR on museum tourism, such as the realization of educational function (Zhou et al., 2022) and promotion of marketing (Regt et al., 2021). However, there still needs to be more studies on the difference in tourists' experience brought about by different display methods and the impact on their future behavior. This is not only limiting the understanding of the psychology and behavior of visitors under the application of VR and other new technologies but also hinders the innovative development of museums in the new era (Alyahya & McLean, 2022).

To make up for the shortcomings of existing research, this study was carried out based on the following two theories: Flow theory studies the state of mind in which a person becomes fully engaged in an activity and achieves a state of extreme pleasure (deMatos et al., 2021), which can better explain visitors' state of being absorbed visiting museum exhibits. S-O-R (Stimulus-Organism-Response) is a theoretical framework used to describe how individuals produce behavioral outcomes under the stimulus of internal and external factors (Mehrabian & Russell, 1974). In context of museum tourism, this study aimed to extend Mehrabian and Russell's (1974) model by integrating different display methods as stimuli, flow experience as the organism's internal states, and intention to use VR as the response. To summarize, the

experimental method was used to address the following three research objectives: explore (1) the influence of different display methods of museum exhibits on flow experiences; (2) the impact of different display methods on intention to use VR; and (3) the moderating effect of familiarity with VR on these processes. The results offer a greater understanding of museum exhibit display methods and visitors' intention to use VR. For museum managers, a new perspective is provided on product development and innovation as well as theoretical implications for VR applications in museum tourism.

Theoretical foundation and literature review

Flow theory

Flow, a concept first proposed by American psychologist Csikszentmihalyi in the 1970s, refers to the overall feeling people have when they are fully engaged in an activity (Csikszentmihalyi, 1975). Jackson and Marsh (1996) state that flow occurs when the performer is connected to the performance in a situation where personal skills equal required challenge. When people are in flow, they are intensely focused on what they are doing, feel at ease with what they are doing, feel that time is flying by, and enjoy the process rather than trying to achieve a specific goal (deMatos et al., 2021). In the earliest stages of development, Csikszentmihalyi (1988) identified nine characteristics of flow, including clear purpose, immediate feedback, matching ability with a challenge, merging action with awareness, preoccupation, a latent sense of control, loss of self-awareness, a sense of time warp, and a purposeful experience. Later, with the deepening of the research on this theory, the characteristics of flow were divided into three stages: antecedents, experience, and results.

The current research adopted this three-stage division method (Liu & Song, 2021).

Flow theory explains the changes in people's attitudes and behavior in the flow state (deMatos et al., 2021). Many scholars have studied this theory in online gaming, online shopping, online education, and other activities (Alan et al., 2022; Hyun et al., 2022). Flow theory has also been applied in tourism settings (such as tourists' satisfaction, behavior, and experiences) by providing empirical evidence and exploring research streams (deMatos et al., 2021). Based on flow theory, Huang et al. (2013) found that the flow state has significant mediating effects between ease and intention to travel as well as between usability and behavioral intention; Gao et al. (2017) found that flow has key mediating roles on the relationships among information quality, system quality, satisfaction, stickiness, and word-of-mouth in virtual travel communities. A theoretically integrated hedonic motivation system adoption model (HMSAM) specifically with enjoyment, flow state, subjective well-being, and continued use was confirmed by Kim and Hall (2019). A review of the literature found that although the role of flow theory in explaining tourists' behaviors and attitudes during tourism activities has been confirmed, the research on tourists' intention to use VR technology still needs to be deepened. Flow theory is used in this paper to better explain the internal mechanism in the formation of visitors' intention to use VR.

Stimulus-organism-response (S-O-R) framework

The stimulus-organism-response (S-O-R) framework suggests that individuals encounter stimuli (S) from the external environment that form internal states (O) that trigger personal responses (R). This theoretical framework (Mehrabian & Russell, 1974) reveals how people

produce behavioral responses corresponding to external environmental factors. The S-O-R framework is frequently applied in research on consumer purchasing behavior, high-tech industries, service industries, online stores, and tourism destinations as a robust analytical framework for explaining people's behavior (Zhang et al., 2014; Zhang & Xu, 2020).

The validity of the S-O-R framework has been verified in the domains of tourist behavior research (Nie et al., 2022). This framework provides a reasonable explanation for tourists' perceptions and behaviors (Hew et al., 2018; Nie et al., 2022). Employing S-O-R framework, Chen et al. (2023) found that connectedness to nature and environmental awareness both have statistically significant influences on tourists' green consumption intentions later in life; in Zhang and Xu's (2020) research, the S-O-R framework is adopted to understand "aesthetic experience" and its impact on tourist loyalty, and results showed that aesthetic quality could influence aesthetic emotion through aesthetic judgment. A literature review shows that the S-O-R theory has been widely applied in tourism in recent years. However, only some scholars have paid attention to studying this theory in the context of museum tourism. Based on the S-O-R framework, this research constructs an integrated model using the display method (Photographic vs. VR) of exhibits as the external stimulus, flow experience as the organism, and intention to use VR as the response, so as to provide a new theoretical explanation for the influence of different exhibition methods on visitors' technical intentions.

Museum tourism

People visit, experience, and are entertained by museums while immersing themselves in cultural environments, acquiring knowledge, and viewing cultural-heritage resources (Antón

et al., 2019). Various museums popularize the past, present, and future by exhibiting cultural-heritage relics and cultural dissemination (Serravalle et al., 2019). The functions of museum tourism have shifted throughout history. For most of the 20th century, museums were seen as institutions that collected, preserved, studied, interpreted, and displayed the material culture of society (Zhou et al., 2022). In the late 20th century, museums began to compete in the expanding leisure market and changed from collection-led institutions to tourist-centered institutions (Zou et al., 2022). In the 21st century, novel tourism experiences and enhanced interactivity are essential for museums to attract visitors (Beck et al., 2014).

It is not difficult to see the increasing importance of visitor experience in museum tourism. Since the appearance of museum tourism, many experts and scholars have conducted research on the experience of tourists and factors that influence museum visitors' experience. Given the different types of museums and tourists, Sheng and Chen (2012) proposed that the museum experience is produced under the mutual influence and interaction of the physical environment, personal background, and social environment; that is, the three factors work together with tourists' experience. Starting from the authenticity of the tourism experience, Prentice (2001) put forward a new concept of museum marketing, the "concentric circle model", which believed that in addition to tangible products, intangible emotional experience is more important for tourists in tourism experience. Nowacki (2005) proposed the SERVQUAL evaluation method, which believed that the overall environment, exhibits, and service level of museums (including exhibition, interpretation, souvenirs, overall environment, and another 36 indicators) affected the satisfaction of visitors. With the increasing popularity of new technologies such as VR and AR, some scholars have explored

the role of different technologies (such as PC desktop, holographic display, 3D stereoscopic projection, head-mounted display, and mobile augmented reality) as well as the characteristics of the technology itself in improving the visitor experience (Leopardi et al., 2021; Errichiello et al., 2019; Verhulst et al., 2021).

Driven by new technology, the display methods of museum exhibits are increasingly diversifying, and these new ways to present and interpret exhibits have more substantial visual impacts and shock effects and deepen visitors' understanding (Serravalle et al., 2019). With the help of newer display methods, people can break through the restrictions of time and space and get rich and novel sensory and emotional experiences (Serravalle et al., 2019). Studies have also shown that VR effectively promotes declarative knowledge learning (Zhou et al., 2022). There have been many studies exploring the influence of different factors, such as museum environment and visitors' characteristics on tourist experience (Sheng & Chen, 2012; Antón et al., 2019), and some papers have also noted the influence of exhibition methods on tourist experience (Leopardi et al., 2021), but have not conducted in-depth research and pointed out the specific mechanism of action. Therefore, from the perspective of flow theory, this research explores the influence of photographs and VR display forms on visitors' experiences and attitudes.

VR in tourism

VR technology is a medium consisting of interactive computer simulations that record the locations and actions of participants and enhance one or more perceptions to give people a sense of immersion or presence in simulated environments (Guttentag, 2010). VR eradicates

the limits of time and space and brings users immersive multi-sensory experiences through virtual environment photos, videos, and audio (Lee, Lee, et al., 2020). This process embodies the essential characteristics of VR, namely the 3Is of immersion, interaction, and imagination (Jia et al., 2020). The novel experience brought by VR stimulates users' positive emotions and attitudes and ultimately affects consumption behaviors (Zhang et al., 2014).

VR was first used in the computer field, and later the technology was introduced to science, education, medicine, tourism, and other fields (Guttentag, 2010). VR helps enterprises develop and promote tourism new and enhanced products and services (Beck et al., 2019). As a tourism marketing tool, VR is more effective than traditional media (including photos and videos) in stimulating positive emotional responses to stimuli (Yung et al., 2021). Managers should fully use VR's immersive and interactive experiences to develop enhanced marketing activities (Regt et al., 2021).

Tourism research on VR has increased with the increasing application of technology in the sector. The existing research tends to have three perspectives. First, the research focuses on VR technology, studying the application of VR technology in fields such as tourism e-commerce and cultural heritage protection (Zhang et al., 2014; Beck et al., 2019). Second, some researchers focus on the relationship between virtual and field tourism to analyze the impact of virtual tourism on field tourism experiences and travel decision-making (Lee, Ahmad, et al., 2020). Third, there are studies on the experiences of tourists, exploring the acceptance of VR (Bogicevic et al., 2019), sensory and emotional experiences during VR experiences (Kim & Ko, 2019; Huang et al., 2020), and attitudes towards destinations and the technology after the experiences (Alyahya & McLean, 2022; Schiopu et al., 2022).

In VR tourism, the perception and experience of tourists are particularly important, and this topic has been the most researched. Yung et al. (2021) discussed the impact of VR on the presence and emotions of tourists in the context of tourism marketing. They emphasized that the immersion should be paid attention to, rather than the pursuit of realistic VR technology, to affect emotional responses. Tussyadiah et al. (2018) verified the positive role of the VR experience in inducing tourists to have a more favorable attitude towards the tourist destination and shaping tourists' willingness to visit. Fan et al. (2022) believe that the application of immersive technology represented by VR can provide customers with immersive experiences and presence/remote presentation by providing: (1) additional information; (2) vivid and pleasant interactive experience; and (3) mental image of the destination. The literature review shows that there are many studies on the experience and behavior of tourists in VR tourism from the perspective of emotional perception, such as immersion, presence, and pleasant experience. However, the research on VR and the willingness to use technology from a psychological perspective still needs to be enriched. In addition, the research on VR tourism in the museum context is limited. Therefore, by applying an extended S-O-R model, this research studies the influence of VR technology on tourists' intention to use technology from the perspective of flow theory in museum tourism.

Hypotheses development

According to the above S-O-R framework and literature review, it can be found that there is a complex influence mechanism between the display methods and visitors' VR use intention in museum tourism. Therefore, to meet the research objectives, based on the flow theory and S-

O-R framework, this research selected four variables, namely display methods (Photographic vs. VR), flow experience, intention to use VR, and familiarity with VR. In addition, the research hypotheses based on the existing relevant research are proposed. The process of proposing is shown below.

Relationship between museum exhibit display methods and flow experiences

Media Richness Theory (MRT) suggests that all types of communication are compared to each other in their ability to convey understanding to another person. When we speak about how rich a source of communication is, we are often referring to how much information is being transferred from the sender to the receiver (Lee, Lee, et al., 2020). According to this theory, this research holds that different display methods of exhibits represent different richness and bring different tourist experiences. Flow experiences are overall feelings that people get when they are fully engaged in an activity, characterized by an integration of action and consciousness, high concentration of attention, loss of self-awareness, distorted sense of time, and internal pleasure (deMatos et al., 2021). From the perspective of flow experience, Kim and Ko (2019) found that VR media types can amplify the flow experience more in Virtual Reality Spectatorship than traditional media (2D screen) through vivid, interactive, and remote presentation. An et al. (2021) believe that two critical attributes of VR travel, sensation, and information quality, positively impact tourists' flow experience. Kim et al. (2022) found that VR experience (i.e., exploring a physical store in a virtual reality environment) enhanced the flow experience of customers, thus increasing their interest in and willingness to visit the store.

Museum visitors have varying feelings about different display methods, and the corresponding flow experience levels are also different (Lee, Jung, et al., 2020). Through two studies, Harvey et al. (1998) found that the exhibits' interactive components, multi-sensory stimuli, and dynamic displays significantly influence the level of immersion in the visitor's flow experience. As VR is a technology mainly characterized by immersion, interaction, and imagination (Jia et al., 2020), we speculate that this display method would yield richer and more pleasant experiences and produce higher levels of flow experience than the photographic display method. Therefore, the first hypothesis was proposed as follows:

H_1: *Compared with traditional photographic displays, museum VR displays give visitors a more substantial flow experience.*

Relationship between museum exhibit display methods and intention to use VR

The advent of VR is bringing people new experiences, but not everyone intends to use this technology. Intention to use VR refers to the subjective probability of whether a visitor will or will not use virtual reality in the future (Schiopu et al., 2022). Analyzing use intentions produces a clearer understanding of the personal and situational factors affecting the acceptance of new technology (Song et al., 2022). Dissimilar display methods produce different external stimuli for users, and many scholars have explored which factors promote intentions to use. In Huang et al.'s (2023) study, compared with the group that just watched the basic introduction of VR surfing, the group that watched the real experience of VR surfing produced stronger intentions to adopt VR. By comparing three sets of pictures, video,

and real VR experience, Yung et al. (2021) argued that the introduction of VR technology into the marketing mix, especially in engagement-based trips such as cruise ships, can provide another level of effectiveness in influencing behavioral intent, on top of existing non-immersive tools. Based on the above literature review, this research asserts that, when compared with the photographic display method, the VR display brings richer sensory experiences, deepens the recognition and acceptance of VR, and improves intention to use VR. Therefore, hypothesis 2 was proposed as follows:

H_2: *Compared with traditional photographic displays, museum VR displays create a greater intention to use VR.*

Relationship between flow experience and intention to use VR

Flow is a positive emotional experience in which one is highly engaged in an activity (Csikszentmihalyi, 1988). Many scholars have explored flow's influence on the intention to use VR in the context of online consumption, gaming, and tourism destination marketing. Han et al. (2020) found that flow experiences correspond to a greater willingness to adopt and utilize VR technology in consumer environments. In the study of mobile games using virtual reality technology, Tsai et al. (2021) found that the flow experience generated during the game would positively affect users' expectations for VR use. However, there are few relevant studies on museum tourism. Errichiello et al. (2019) conducted a study on museum visitors who recognize that VR-mediated experiences add value to visits and are willing to use VR applications in the future and share their visit experiences with friends. Synthesizing the research results of the above studies, we speculated that in museum tourism, flow experiences

positively influence visitors to have positive attitudes toward VR, thus generating greater intention to use VR, and thus hypothesis 3:

H_3: *Flow experience positively impacts visitors' intention to use VR.*

Mediating effect of flow experience

Flow experiences have been applied in research as condition, experience, and outcome factors (deMatos et al., 2021). However, as a psychological construct, it is more often used as a mediating variable to explain the formation of user behaviors and attitudes. Kim and Hall (2019) believe that flow experience plays an intermediary role in tourists' perception, continuous use intention, and subjective well-being. In the context of museums, Harvey et al. (1998) demonstrated that flow experience plays a significant mediating role between the interactive components, multi-sensory stimuli, and dynamic displays of the exhibits and visitor experience. Chang et al.'s (2014) research found that in art museums, compared with audio and non-guided participants, AR-guided tours effectively improved the learning efficiency of visitors, promoted their flow experience, and extended the time visitors focused on the paintings. Zhang and Rahman (2022) found that smart museums' information quality and system quality significantly affected visitor satisfaction and loyalty through the mediating role of flow experience. Through this literature review, it is not difficult to find that flow experience is often used as a mediating variable to explain visitors' behaviors in tourism and museums. So, this research suggests that flow experience can be used to explain the formation of visitor intention to use VR in a mediating role using the S-O-R framework, and thus hypothesis 4:

H_4: *Flow experience mediates the relationship between the display methods and the intention to use VR.*

Moderating effect of familiarity with VR

Familiarity with VR measures visitors' subjective familiarity with VR technology (Mastrogiuseppe et al., 2022). In existing studies, scholars have studied the influence of the objective attributes of VR technology on visitor attitudes and behaviors. For example, Lee, Hong, et al. (2020) found positive effects of content quality, system quality, and vividness on customers' attitudes and behavioral intentions. Wei et al. (2019) explored the measures to improve visitor experiences in theme parks from different perspectives of VR technology, such as participation, effectiveness, control, and enjoyment provided by VR systems. However, only a few scholars noticed the familiarity variable. Kang and Gretzel (2012) argue that visitors' general familiarity with the Internet drives attitudes toward emerging Internet-based technologies in using podcasts in museums. By conducting interviews with museum visitors with intellectual disabilities, Mastrogiuseppe et al. (2022) explored participants' use and familiarity with technology and understanding their interest in using technology tools in different situations; a general agreement was demonstrated between the prior technology use/experience/interests of participants and the choice of products based on the new technology. Through the literature review, studies are paying attention to the variable of familiarity with VR. A few existing studies agree that familiarity with VR impacts visitors' behavior, but there needs to be more research on the specific effects of this variable. Accordingly, this research proposed that familiarity with VR impacts the formation of VR

usage in museum tourism. Familiarity with VR may moderate how display methods affect intention to use VR and the mediating effect of flow experience. Therefore, the following hypotheses were put forward:

H_5: *Familiarity with VR moderates the relationship between the display methods and visitors' intention to use VR.*

H_6: *Familiarity with VR moderates the mediating effect of flow experience.*

Research model

According to the above theoretical review and research hypotheses, museum exhibit display methods (photographic vs. VR display) were taken as external stimuli (S), flow experience as the organism (O), and intention to use VR as the response element (R) to establish the S-O-R framework. The theoretical model (Figure 1) was constructed to explore the effects of display methods on intention to use VR.

Insert Figure 1 here.

Experimental studies

Overview

This investigation consisted of three experiments: Experiment 1 tested the main effect of display methods on intention to use VR (H_2); Experiment 2 tested the effects of display methods on flow experience and intention to use VR, and the mediating effect of flow experience (H_1, H_2, H_3, H_4); and Experiment 3 tested the moderating effect of familiarity with VR on the main effect and mediating effect (H_5, H_6).

Experiment 1

Experiment material selection. The famous painting, *The Starry Night*, by Vincent van Gogh, a Dutch post-impressionist painter, was selected as the experimental material. *The Starry Night* was created in 1889 in a psychiatric hospital in Saint-Remy, France. Vincent van Gogh used an exaggerated technique to vividly depict the starry night full of movement and change. The whole picture is swallowed up by a turbulent turquoise rapid, the swirling, restless, curling nebulae that animate the night sky. The surreal scene reflects Vincent van Gogh's restless emotions and the hallucinatory world (Zelazko, 2020). *The Starry Night* is one of Vincent van Gogh's masterpieces in the Museum of Modern Art in New York (Brower, 2011).

The pictured version of *The Starry Night* was employed for the photographic group as the experimental material (Figure 2). The VR group experienced a VR video of *The Starry Night* recreated by the digital content creation company Motion Magic, which combines various virtual VR design elements to show the content of the painting from a first-person perspective (Motion Magic, 2022). The video used in this experiment was from BiliBili, one of China's most famous video websites (Figure 3).

Insert Figure 2 and Figure 3 here.

More museums, such as the Louvre Museum and New York's Metropolitan Museum of Art, are using VR to display their exhibits better. However, traditional VR equipment is heavy and not easy to carry, has a strong sense of vertigo, has a high price, and has other shortcomings, which become obstacles to the popularity of VR equipment. In contrast,

everyone has mobile phones and computers nowadays, so naked-eye VR based on these devices is an excellent solution to the problems, which ensures the realization of a highly immersive experience and interaction between people and the painting's content in a more natural way. Therefore, the VR group of this experiment adopts the naked-eye VR video. At the start of the experiments, participants were asked to imagine they were visiting the Museum of Modern Art in New York and appreciating the painting with the help of the experimental materials.

There are two main reasons for choosing these experimental materials. First, *The Starry Night* is one of Vincent van Gogh's most representative works, well known worldwide. The painting reflects his bold attempt to express his subjective world. It explores painting expression techniques and is incomparably persistent and loyal to art, which has given endless enlightenment for generations (Brower, 2011). Second, the VR video of *The Starry Night* used in this experiment was produced by a famous Chinese digital content creation company Motion Magic devoted to presenting artistic works in VR form (Motion Magic, 2022). It has been uploaded to major websites since its launch and received unanimous praise.

Pretest. To measure whether the experimental materials were effective, a pretest was conducted. We published the recruitment information through the Credamo data platform (Credamo.com), one of the most popular online survey platforms in China, which includes a sample library of more than three million people from different occupations (Credamo, 2022). In order to ensure the validity and reliability of the experiment, we randomly selected

people from the sample database to participate in the experiment and fill in the questionnaire. In addition, we set the option that users will not repeat after publishing questionnaires multiple times to ensure that each subject can only participate in the survey once and not repeatedly.

A total of 100 participants volunteered to participate in the experiment. Before the questionnaire administration, we explained the purpose of the experiment and briefly introduced the painting *The Starry Night* to the subjects. Next, participants were asked to imagine they were visiting a museum and would randomly see the photographic (or VR) version of *The Starry Night*. In the VR group, we also wrote specific operation instructions so the subjects could get a more real VR experience. In this part, we set a minimum viewing time to ensure that the experimental manipulation of the subjects was effective. The participants were then asked to complete questionnaires about flow experience and intention to use VR to judge whether the experimental materials used were effective.

First, the network recruitment method was adopted to avoid having a single source of subjects in terms of data sources to prevent common method variance (CMV). Besides, Harman's single-factor test was used to evaluate the existence of a potential common bias problem. The results showed that the first factor explained 40.2% of the variation of each variable's measured items without rotation, which was less than 50%, indicating no significant common method bias problem (Podsakoff & Organ, 1986).

Second, flow experience was modified according to the items used in the studies of Choi and Kim (2004) and Novak et al. (2000). Intention to use VR was modified with reference to the items used by Sánchez et al. (2021) and Manis and Choi (2018). Based on soliciting the

opinions of five experts from cultural heritage, museums, and tourism, we modified the questionnaire items according to the situation to improve the scale's reliability. The specific measurement items are shown in Table 1, and all items were measured using seven-point Likert scales (1 = *strongly disagree* and 7 = *strongly agree*). Cronbach's α, the most common statistic in reliability assessment, was used to test the reliability of scales. A Cronbach's α greater than 0.7 indicated high reliability, a Cronbach's α between 0.35 and 0.7 indicated acceptability, and a Cronbach's α lower than 0.35 indicated that the scale had low reliability and should be rejected (Taber, 2018). According to the test results in Table 1, Cronbach's α coefficient of flow experience was greater than 0.8, and Cronbach's α coefficient of intention to use VR was above 0.6. The reliability of the scales passed the tests and could be used in the experiment.

Insert Table 1 here.

Third, the results of the independent sample *t*-test showed that the VR display group's mean values of flow experience ($M_{\text{VR display group}} = 5.63 > M_{\text{Photographic display group}} = 5.27$, $t = -2.206$, $p < 0.05$) and intention to use VR ($M_{\text{VR display group}} = 5.78 > M_{\text{Photographic display group}} = 5.42$, $t = -2.083$, $p < 0.05$) were significantly higher than those in photographic display group. This result indicated that the experimental materials were effective in stimulating the subjects. The experimental materials passed the inspection test and could be used subsequently.

Main experiment. Experiment 1 investigated whether *The Starry Night* display methods (Photographic vs. VR display) significantly impacted visitors' intention to use VR. A one-

factor, two-level (Photographic vs. VR display) intergroup experimental design was used to test whether visitors' intention to use VR differed significantly with different display methods.

First, the recruitment information was also published through the Credamo data platform (Credamo.com) and randomly recruited subjects. In order to ensure the validity and reliability of the experiment, we randomly selected people from the sample database to participate in the experiment and fill in the questionnaire. The option that users will not repeat after publishing questionnaires multiple times was selected to ensure that each subject can only participate in the survey once and not repeatedly. Before the questionnaire, we explained the purpose of the experiment and briefly introduced the painting *The Starry Night* to the subjects. Next, participants were asked to imagine they were visiting a museum and would randomly see the photographic (or VR) version of *The Starry Night*. In the VR group, we also wrote specific operation instructions so the subjects could get a more real VR experience. In this part, we set a minimum viewing time to ensure that the experimental manipulation of the subjects is effective. The participants were then asked to complete questionnaires about their intention to use VR and demographic characteristics. A total of 272 complete questionnaires ($n_{\text{photographic display group}} = 137$ vs. $n_{\text{VR display group}} = 135$) were collected after removing 56 invalid questionnaires (with incomplete answers, all answers the same), with a response rate of 82.9% (Table 2).

Insert Table 2 here.

Second, scale selection and reliability test. Intention to use VR was modified with reference to the items used by Sánchez et al. (2021) and Manis and Choi (2018). Based on

soliciting the opinions of five experts from cultural heritage, museums, and tourism, we modified the questionnaire items according to the situation to improve the scale's reliability. The specific measurement items are shown in Table 3, and all items were measured using seven-point Likert scales (1 = *strongly disagree* and 7 = *strongly agree*). Cronbach's α, the most common statistic in reliability assessment, was used to test the reliability of scales. A Cronbach's α greater than 0.7 indicated high reliability, a Cronbach's α between 0.35 and 0.7 indicated acceptability, and a Cronbach's α lower than 0.35 indicated that the scale had low reliability and should be rejected (Taber, 2018). According to the test results in Table 2, Cronbach's α coefficient of intention to use VR was greater than 0.7. The reliability of the scale passed the test.

Insert Table 3 here.

Third, the independent sample *t*-test was conducted for the display methods and intention to use VR. The results showed that the photographic display group's mean of intention to use VR (5.63) was significantly lower than that of the VR display group (5.84) ($t = –2.073$, $p < 0.05$). Compared with the photographic group, the VR group's novel experience stimulated the subjects' positive emotions and attitudes. Finally, it affected their acceptance of the technology, producing a stronger intention to use VR, supporting H_2.

Experiment 2

Methodology. Experiment 1 proved that the display methods significantly affected visitors' intention to use VR. In order to further explore the specific detail of this relationship, experiment 2 was carried out to examine the effects of display methods on flow experience

and intention to use VR and the mediating effect of flow experience.

The experimental materials are the same as that of experiment 1. In addition, the recruitment information was also published through the Credamo data platform (Credamo.com) and randomly recruited subjects. The option that users will not repeat after publishing questionnaires multiple times was selected to ensure that each subject could only participate in the survey once and not repeatedly. Before the questionnaire, we explained the purpose of the experiment and briefly introduced the painting *The Starry Night* to the subjects. Next, participants were asked to imagine they were visiting a museum and would randomly see the photographic (or VR) version of *The Starry Night*. In the VR group, we also wrote specific operation instructions so the subjects could get a more real VR experience. In this part, we set a minimum viewing time to ensure that the experimental manipulation of the subjects is effective. The participants were then asked to complete questionnaires about flow experience, intention to use VR, and demographic characteristics. A total of 251 complete questionnaires ($n_{\text{photographic display group}} = 121$ vs. $n_{\text{VR display group}} = 130$) were collected after removing 80 invalid questionnaires (with incomplete answers, all answers the same), with a response rate of 75.8% (Table 4).

Insert Table 4 here.

Results. First, scale selection and reliability test. Flow experience was modified according to the items used in the studies of Choi and Kim (2004) and Novak et al. (2000). Intention to use VR's scale was the same as in experiment 1. Based on soliciting the opinions of five experts from cultural heritage, museums, and tourism, the questionnaire items were modified

according to the situation to improve the scales' reliability. The specific measurement items are shown in Table 5, and all items were measured using seven-point Likert scales (1 = *strongly disagree* and 7 = *strongly agree*). According to the test results in Table 5, the Cronbach's α coefficient of flow experience was greater than 0.8, and Cronbach's α coefficient of intention to use VR was greater than 0.7. The scales had high reliability (Taber, 2018) and could be used in the experiments.

Insert Table 5 here.

Second, an independent sample *t*-test was performed to examine the effects of display methods on flow experience and intention to use VR. The results showed that the mean values of flow experience (5.90, 5.45) and intention to use VR (5.78, 5.59) in the VR display group were significantly higher than those in the photographic group. For flow experience, $t = –4.950$, $p < 0.001$; for intention to use VR, $t = –2.012$, $p < 0.05$. Display methods significantly affected the flow experience and intention to use VR. Visitors in the VR display group had higher flow experience and stronger intention to use VR. Hypotheses H_1 and H_2 were supported (Figure 4).

Insert Figure 4 here.

Third, the PROCESS plug-in of SPSS software was used to test the mediation effect. The photographic display group was coded as 1, and the VR display group was coded as 2. Model 4 in the program was selected, and the Bootstrap sampling was set to 5,000 times. The indirect effect analysis was carried out with display methods as the independent variable, intention to use VR as the dependent variable, and flow experience as the mediating variable. The results showed that flow experience had a significant mediating effect between display

methods and intention to use VR (B = 0.0.259, SE = 0.067, 95% CI: 0.1436, 0.4016), and the proportion of mediating effect in the total effect was 100%, that is, it played a complete mediating role (Table 6). From the mediating path, compared with the photographic group, visitors of the VR group were more likely to enter the state of personal skills equal required challenges; in other words, the flow experience level of the VR group was significantly higher (β = 0.446, t = 4.950, p < 0.001); and flow experience significantly improved the intention to use VR (β = 0.581, t = 9.890, p < 0.001) (Table 7). Thus, flow experience plays a mediating role in the influence of display methods on the intention to use VR, which supported Hypotheses H_3 and H_4.

Insert Table 6 and Table 7 here.

Experiment 3

Experiment material selection. *Water Lilies* was chosen as the experimental material for Experiment 3, a group of 181 oil paintings by Claude Monet. These 181 oil paintings were created from 1895 to 1926, and they are currently in the Orange Garden Museum collection in Paris, France. Its creator, Claude Monet, is a representative figure and one of the founders of Impressionism, and he and his works have had a significant influence on later generations. Also, *Water Lilies* represents one of Monet's most outstanding artistic achievements and is one of his most treasured themes: the celebration of nature through his beloved Giverny Gardens. So, different forms (photographic version and VR video) of *Water Lilies* were chosen as materials for experiment 3. Specifically, according to the previous investigation and experts' suggestions, eight of the most famous photographs were selected as the

experimental material for the photographic version of *Water Lilies* (Figure 5). The VR video of *Water Lily* was designed by Gigoia Studios, a well-known company focused on connecting art with people through games (Gigoia Studios, 2022).

Insert Figure 5 here.

As described in Experiment 1, VR is more widely used in museums. While traditional VR devices are heavy and not easy to carry, have a strong sense of vertigo, high price, and other shortcomings, naked eye VR with the help of mobile phones or computer devices has more advantages. Therefore, the VR group of this experiment also adopted the naked-eye VR video. To facilitate the experiment, BiliBili was selected, one of the largest video websites in China, as the carrier so that the subjects could watch the naked-eye VR video of *Water Lilies* on this platform (Figure 6). Participants were asked to imagine viewing this oil painting with the help of the materials in photographic or VR form.

Insert Figure 6 here.

Pretest. In Experiment 3, the experimental materials were changed, and the measurement of familiarity with VR was added to the questionnaire. A pretest was conducted to measure whether these experimental materials had a stimulus effect on the subjects.

We published the recruitment information through the Credamo platform (Credamo.com) and randomly recruited subjects. The option that users will not repeat after publishing questionnaires multiple times was selected to ensure that each subject can only participate in the survey once and not repeatedly. A total of 96 participants volunteered to participate in the experiment. Before the questionnaire, we explained the purpose of the experiment and briefly

introduced the painting *Water Lilies* to the subjects. Next, participants were asked to imagine they were visiting a museum and would randomly see the photographic (or VR) version of *Water Lilies*. In the VR group, we also wrote specific operation instructions so the subjects could get a more real VR experience. In this part, we set a minimum viewing time to ensure that the experimental manipulation of the subjects is effective. The participants were then asked to complete questionnaires about flow experience, intention to use VR, and familiarity with VR to judge whether the experimental materials used were effective. The scales of flow experience and intention to use VR were the same as in the previous experiments. In addition, the scale of moderation variable familiarity with VR was modified according to Mastrogiuseppe et al.'s (2022) scale, namely, "Overall, how familiar you are with VR technology is:", using a seven-point Likert scale (1 = *strongly unfamiliar* and 7 = *strongly familiar*).

First, Cronbach's α statistic was employed to test the reliability of scales. The Cronbach's α coefficients for flow experience and intention to use VR were greater than 0.8, indicating that the scale had high reliability (Taber, 2018) and could be used in the experiments (Table 8).

Insert Table 8 here.

Second, results showed that the mean value of flow experience ($M_{\text{VR display group}} = 5.85 > M_{\text{Photographic display group}} = 5.19$, $t = -4.135$, $p < 0.001$) and intention to use VR ($M_{\text{VR display group}} = 5.90 > M_{\text{Photographic display group}} = 5.52$, $t = -2.361$, $p < 0.05$) in VR group were significantly higher than those in photographic display group. This showed that the experimental materials had stimulating effects on the subjects. All materials passed the pre–test and could be used in

the main experiment.

Main experiment. Experiment 3 was to verify whether familiarity with VR had a significant moderating effect on the influence of display methods on the intention to use VR. A two–display methods (Photographic vs. VR display) × two-familiarity with VR (high vs. low) two–factor intergroup design was performed.

The recruitment information was published through the Credamo platform (Credamo.com) and randomly recruited subjects. Before the questionnaire, we explained the purpose of the experiment and briefly introduced the painting *Water Lilies* to the subjects. Next, participants were asked to imagine they were visiting a museum and would randomly see the photographic (or VR) version of *Water Lilies*. In the VR group, we also wrote specific operation instructions so the subjects could get a more real VR experience. In this part, we set a minimum viewing time to ensure that the experimental manipulation of the subjects was effective. The participants were then asked how familiar they were with VR technology and completed questionnaires about flow experience, intention to use VR, and demographic characteristics. A total of 208 complete questionnaires ($n_{\text{Photographic display group}} = 94$ vs. $n_{\text{VR display group}} = 114$) were collected after removing 52 invalid questionnaires (with incomplete answers, all answers the same), with a response rate of 80.0% (Table 9).

Insert Table 9 here.

First, Cronbach's α statistic was employed to test the reliability of scales. The Cronbach's α coefficients for flow experience and intention to use VR were greater than 0.6, indicating that the scales had acceptable reliability (Taber, 2018) and could be used in the experiment

(Table 10).

Insert Table 10 here.

Second, the PROCESS plug-in Model 8 of SPSS software, was used, and the Bootstrap method was used to determine whether familiarity with VR played a moderating role on the main and mediating effects. The sample size was 5,000 with a 95% confidence interval. The statistical results are shown in Table 11.

Insert Table 11 here.

As can be seen from the test results in Table 9, familiarity with VR generally had a moderating effect on the mediating effect of flow experience but not the main effect.

(1) Moderating effect of familiarity with VR on the main effect. The interaction effect between familiarity with VR and display methods was not significant at the 5% level (β = –0.1706, $p > 0.05$) (Table 9), and the moderating effect was insignificant; H_5 was not supported.

(2) Moderating effect of familiarity with VR on flow experience's mediating effect. According to Zaman and Aktan's (2021) interpretation of the test results of moderated mediation models, whether the mediation process is moderated, the test results are used to reflect when the mediation effect is strong and when it is weak. According to the test results of moderated mediating effects (Table 9), the moderating effect interval of the moderated mediation was [–0.2532, –0.0001], excluding 0, indicating a significant moderated mediating effect, and the effect value was –0.1209. In the low score group, the moderating effect interval of participants on the mediating effect of flow experience was [0.1523, 0.5389], excluding 0, indicating a significant moderating effect, and the effect value was 0.3294. In

the high score group, the moderating effect interval on the mediating effect of flow experience was [–0.0330, 0.2157], including 0, indicating that the moderating effect was insignificant. Familiarity with VR effectively moderates the relationship between display methods and intention to use VR through flow experience (Figure 7). That is, compared with those with high familiarity with VR; it is easier for tourists with low familiarity with VR to achieve a balance of skills and challenges (Jackson & Marsh, 1996), which leads to a higher level of flow experience and, ultimately, a stronger intention to use VR. Hypothesis H_6 is supported. Figure 8 reports the coefficients and the significance of each path in the model.

Insert Figure 7 and Figure 8 here.

Conclusions and implications

Conclusions

Integrated previous research results, flow theory and S-O-R framework, this research developed and tested the theoretical framework for the relationship between display methods (Stimulus), flow experience (Organism), and intention to use VR (Response). Specifically, experiment 1 explored the effect of the museum exhibit display methods on the intention to use VR; experiment 2 verified the mediating effect of flow experience, and experiment 3 found the moderating effect of familiarity with VR on flow experience's mediating effect. Through three experiments, the following conclusions were drawn.

First, the display methods for museum exhibits significantly affects intention to use VR. Compared with the traditional photographic displays, people had stronger intention to use VR after experiencing the VR version of *The Starry Night*. The VR video generated more novel

and vivid experiences, generating positive attitudes toward VR and reflected by the intention to use VR. This conclusion suggests that product developers should pay attention to display methods when designing new products. The display methods (such as VR, AR, and MR) create more varied tourism experiences that arouse curiosity about these new presentation forms and generate use or purchase intentions.

Second, museum exhibit display methods affect the intention to use VR through flow experience. Compared with the photographic group, visitors in the VR group are more likely to enter the state of personal skills equal to the required challenges, namely, flow experience, and further generate a stronger willingness to use VR. This conclusion verifies the preliminary judgment of the first conclusion and explains a psychological level. The level of flow experience measures perception and involvement with different display methods. The VR display is richer and has a more profound sense of engagement, with stronger intention to use VR, which is consistent with the S-O-R framework. Therefore, product developers should pay attention to the product's flow experience attributes, which directly affect intention to use the technology, and ultimately affect acceptance and admiration for the tourism product. By incorporating the variable of flow experience into the research model, this research produces a more in-depth and comprehensive analysis of the psychology of intention to use VR.

Third, familiarity with VR plays a moderating role in the flow experience's mediating effect between museum exhibit display methods and intention to use VR. Those with low familiarity with VR experienced a more significant impact on intention to use VR through flow experience than people with high familiarity with VR. According to Jackson and Marsh's (1996) research on flow state scale, compared with those with high familiarity with

VR, it is easier for tourists with low familiarity with VR to achieve a balance of skills and challenges, which leads to a higher level of flow experience and, ultimately, a stronger intention to use VR. This finding may inspire tourism practitioners to promote products with such emerging technologies to people unfamiliar with the new technologies to achieve greater visitor satisfaction.

Theoretical contribution

This research examined behavior and intentions from different theoretical perspectives and has the following three theoretical contributions.

First, the focus on museum exhibit display methods expands the research on intention to use VR in museums. Earlier studies were more based on the technology acceptance model proposed by Davis et al. (1989), which believed that perceived value factors such as perceived usefulness and perceived usability were the critical factors in determining whether tourists would use VR technology. In recent years, more and more scholars have paid attention to interpersonal travel constraints (Schiopu et al., 2022), interactivity (Yung et al., 2021), perceived substitutability of VR (Schiopu et al., 2022), atmosphere and emotion (Cheng & Huang, 2022), hedonic motivation (Kim & Hall, 2019) and other external environmental and psychological factors on the intention to use VR. Through the summary of the literature, it can be found that most of the existing studies have explored the influence of technology and tourists' perceptions on their technological intention, and few have explored the influence of display methods on their technological intention from the perspective of exhibits. This research studied the impact of the display method on visitors' VR usage,

providing a new perspective for researchers to understand the real needs of tourists, which can promote the improvement and upgrading of technology–based museum tourism products.

Second, by applying flow theory and the S-O-R framework, this study enriches the theoretical perspective of technology acceptance research in museum tourism. The existing research on museum technology acceptance is mainly from the technology acceptance model (TAM) (Manis & Choi, 2018), virtual reality hardware acceptance model (VR–HAM) (Manis & Choi, 2018), Unified Theory of Acceptance and Use of Technology (UTAUT) model (Ronaghi & Forouharfar, 2020), hedonic motivation system adoption model (Kim & Hall, 2019), pleasure–arousal–dominance model (Cheng & Huang, 2022) based on TAM's extended model theory perspective, but there is a lack of explanation for this behavior from psychological theories such as flow theory and S-O-R framework. This research explored visitors' VR usage behavior based on these two psychological theories. The VR display method was found to promote stronger intention to use VR by bringing users a higher flow experience. This conclusion provides a more comprehensive and systematic understanding of the formation of use intention from the psychological level. Besides, this research extends the application of S-O-R theory in museum tourism, which can provide academics with useful insights for theory verification of the SOR paradigm.

Third, this research considers familiarity with VR to verify this variable's influence on technology acceptance processes. The variable of technological familiarity is mainly used in the field of new technology applications, such as the influence of the public's familiarity with the popularization of Internet technology on their acceptance of new technology (Kang & Gretzel, 2012), the influence of customers' usage and familiarity with technology on their

choice of products based on new technology (Mastrogiuseppe et al., 2022). However, in the field of museum tourism, the role of this variable has received less attention, and the conclusion of this research adds to this point, indicating that visitors' familiarity with new technologies such as VR does affect their VR usage behavior. This conclusion reflects the formation process of intention to use VR more comprehensively, expands the research on intention to use VR, and enriches the research content on technology acceptance processes in museum tourism.

Practical implications

The conclusions have significance for museum managers in developing tourism products and applying and promoting new technologies represented by VR.

First, museum managers should actively embrace and apply new technologies such as VR. In this study, we found that VR gave visitors a higher flow experience when visiting famous paintings in museums and, thus, a stronger willingness to use VR. Museums that introduce VR before their competitors may also promote brands as market leaders or innovators, generating interest in markets they may not be able to reach, such as Millennials (Beck et al., 2019; Yung et al., 2021). Specifically, museums can apply this technology to display and promote various exhibits (such as paintings, sculptures, cultural relics, and architecture) so that people can get to know them more realistically without leaving their homes (Guttentag, 2010). For example, Cho et al. (2002) suggested embedding the VR of the tourist destination into the official website, which they thought was a good way of publicity; Guttentag (2010) further demonstrated that visiting a museum website embedded in VR can

increase one's interest in visiting a real museum. Of course, managers should not blindly display all exhibits and attractions with VR but select display methods according to the characteristics of individual exhibits (Bozzelli et al., 2019).

Second, museum managers should pay attention to the flow experience attribute of VR products, which can help tourists get a better travel experience and use VR technology more in the future. Moreover, existing studies have also shown that experiencing flow can enhance tourists' confidence and loyalty to the online shopping (Bilgihan, 2016). Specifically, technicians can enhance the flow component of VR in museum tourism content through diverse media (e.g., a computer screen, radio, smartphone, TV, or virtual reality device) so that users can obtain a higher flow experience (Kim & Hall, 2019). Besides, Zhang and Rahman (2022) argued that visitors would be satisfied and loyal to the service providers through flow which produces cognition bonds between visitors and the service providers and strengthen recreation enjoyments. The experience of tourists is an aspect that museums cannot ignore when developing the product.

Third, how familiar visitors are with VR technology is a factor that cannot be ignored in marketing and promoting VR technology-based products. The interaction between display methods and familiarity with VR indirectly affects visitors' intention to use VR through flow experience. When visitors' familiarity with VR is low, the VR display method positively affects intention to use VR through flow experience. According to existing research, Kim and Ko (2019) believe that media users who lack interest and skill in the information contained in certain media content are less likely to experience streaming states, so providing VR to less engaged or new sports audiences may be an effective strategy to increase their sports media

consumption and loyalty. Similarly, in museum tourism, marketers need to be more aggressive in promoting VR-based museum tourism products when targeting people who are less familiar with VR technology, as they are more likely to experience a higher level of flow while experiencing VR, which in turn motivates them to visit the museum (An et al., 2021). For example, this can be achieved by setting rewards for visitors who have already experienced VR products to invite new people to experience them. That is, the generally high ratings from this group for VR can generate more substantial word-of-mouth recommendations.

Research limitations and future research directions

This research has the following limitations. First, this analysis explored the effect of display methods (Photographic vs. VR display) of paintings on intention to use VR. The display method can be subdivided in the future, capturing more direct and detailed factors affecting usage intentions. Other experimental materials (such as sculpture and ancient architecture) should be added to explore more generalizability. Multiple factors influence the intention to use VR. This research was only conducted from the perspective of display methods and flow experience. Researchers should study the effect of other related influencing factors to explain attitudes and behaviors more comprehensively. Second, only online experimental research was conducted due to the inconvenience of conducting offline laboratory research during the COVID-19 pandemic. On the one hand, we carried out the online experiment by means of text and video manipulation. We could improve the experiment's effectiveness by setting the minimum duration and screening the questionnaire later. On the other hand, we could only

guarantee providing the same experimental environment for some subjects to exclude the influence of other factors. In the future, recruiting subjects for personal experience in a real museum scene can be considered. After that, in addition to the direct report of their own experience through a questionnaire survey, they can also directly obtain the data of the subjects through more diversified means, such as staff observation, interview, and mobile eye tracking, to improve the reliability of the experiment and external validity. Third, a naked-eye VR video was used in this experiment. Although it has advantages such as convenience, low cost, and easy implementation (with the help of mobile phones and computers) compared with traditional VR devices, traditional VR can also provide users with rich sensory experience and interactive experience with the help of a gamepad, glasses, and other devices. In the future, the museum tourism experience with traditional VR devices can be considered to verify the conclusions of this paper and conduct more extensive research.

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