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REVIEW ARTICLE

Evaluation of Virtual Reality Cultural Heritage Experience at Guilin Museum, China: A Conceptual Paper

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ABSTRACT

Integrating Virtual Reality (VR) technology into cultural heritage presents unprecedented opportunities for enhancing museum experiences, specifically through immersive and interactive digital presentations (Theodoropoulos & Antoniou, 2022). Although virtual reality technology has the potential to enhance the experience of cultural heritage, according to previous research, it is not difficult to find that existing museum VR applications often lack an immersive experience, and many experiencers' immersion is interrupted during the experience, highlighting the urgent need for a VR application evaluation framework. In addition, most of the research is from the technology perspective, ignoring the users' experience needs. Therefore, the purpose of this conceptual paper is to present a conceptual framework that theoretically justifies the creation of a virtual reality evaluation. This conceptual paper begins by reviewing relevant research on VR in the cultural heritage field and methods and scales for measuring immersion. It suggests the possibility of utilizing grounded theory to uncover potential factors. Subsequently, this conceptual paper summarizes previous research and theoretical gaps. A conceptual framework for establishing a robust evaluation of virtual reality applications is proposed as a two-stage mixed research method (Exploratory Sequential Mixed Method Design) (Berman, 2017). This concept paper illustrates the details and rationalization of the conceptual framework so that it can be further investigated theoretically or empirically in the future. This concept paper contributes to developing an evaluation of VR cultural heritage applications. At the same time, it theoretically enhances the understanding of digital presentation and preservation of cultural heritage.

Contribution/Originality: The paper contributes the first logical analysis of VR evaluation frameworks for immersive experiences in cultural heritage museums, offering valuable insights for researchers, museum designers, and technology developers to advance digital heritage preservation and presentation.

1. Introduction

Virtual reality (VR) technology has brought new vitality to cultural heritage. It enhances the experience, accessibility, and engagement of cultural artifacts, and previous research has consistently highlighted VR's ability to create immersive cultural experiences (Lee et al., 2020). However, traditional ways of interacting with cultural heritage often face challenges. For example, this limits the depth of visitors' interaction with heritage objects due to their fragility or preservation needs (Slater, 2004). In addition, traditional museum exhibits and static interpretations struggle to attract younger audiences who are more accustomed to dynamic and interactive digital content (Khundam, 2020). In this regard, how to let the cultural heritage be passed on is very worthy of study.

VR technology can help improve these constraints, especially in public facilities such as museums, where it can deepen people's understanding and engagement with cultural heritage (Pavlidis et al., 2007). This has received much attention in academia, with previous research showing that some VR applications can provide access to otherwise inaccessible or damaged buildings and participate in historical events (Ferdani et al., 2020; Cecotti, 2022). For example, VR can recreate historic sites and rare artifacts, helping future generations to appreciate and preserve cultural heritage (Zara, 2004). For example, the VR exhibition at the Academy of Athens allows users to explore ancient Athenian architecture and artwork in a virtual space, creating memorable cultural experiences (Clini et al., 2023). Furthermore, researchers have found that the immersive nature of VR improves learning efficiency and engagement (Jung et al., 2020). This immersive experience can refer to the flow theory, where individuals can achieve deep concentration and high enjoyment when faced with challenging but achievable tasks (Csikszentmihalyi, 1975). These studies contribute to understanding how VR and cultural heritage can be further integrated.

With the advent of immersive technologies, such as virtual reality (VR) and augmented reality (AR), museums and designers around the globe have begun to incorporate these innovations into cultural displays (Wang et al., 2019). This shift has provided new opportunities for exploring and experiencing historical artifacts, mainly through VR, which presents expansive possibilities for digitalizing cultural heritage (Noev et al., 2019). As museums strive to captivate visitors and enrich educational experiences, they continuously seek innovative methods (Fussell & Truong, 2022).

Guilin, located in the Guangxi Zhuang Autonomous Region of China, is renowned for its spectacular karst topography and rich cultural heritage. The Guilin Museum is a repository of this diverse heritage, housing an extensive collection of artifacts, including ceramics, bronzes, and ethnic textiles. These cultural relics not only showcase the artistic and historical depths of the region but also highlight its significance as a historical trade and transportation hub (Li et al., 2019). By reflecting the region’s rich history and ethnic diversity, the museum plays a pivotal role in preserving and promoting Guangxi's cultural legacy (Wang et al., 2017). Therefore, better integrating

modern technologies such as Virtual Reality (VR) into the Guilin Museum experience is an issue worth studying.

It is easy to see through previous research that VR technology still faces significant challenges in cultural heritage applications today. Virtual museum tours, serious gaming, and virtual travel applications are popular forms of VR, but they each offer different experiences that may complicate the harmonization of evaluation criteria (Cecotti, 2022). Existing literature suggests that while VR has the potential to create engaging and immersive experiences that enhance the appreciation of cultural heritage, the quality and consistency of these applications vary widely (Theodoropoulos & Antoniou, 2022). Improving the quality and content of VR applications is crucial, as existing experiences often fall short in user immersion and overall satisfaction. Moreover, many studies have been conducted primarily from a technical perspective, often ignoring the critical user experience elements required for meaningfulness. In addition, the lack of standardized assessment frameworks for effectively evaluating virtual experiences has led to varying levels of user satisfaction (Carrozzino & Bergamasco, 2010; Economou & Tost, 2011).

Addressing these challenges, an evaluation based on VR applications is essential to measure the effectiveness and quality of virtual museum applications. Therefore, this conceptual paper aims to present a conceptual framework that theoretically justifies the creation of a virtual reality evaluation and to detail the elements of the conceptual framework. This research will significantly contribute to VR technologies' theoretical and practical field in cultural heritage preservation and presentation (Jung et al., 2017; Cecotti, 2022). Also, the benefits of this research include increasing visitor engagement, enriching educational tools, and guiding the creation of VR applications.

1.1. Significance of the Research

The significance of this study lies in integrating virtual reality technology with cultural heritage, which not only facilitates the preservation and dissemination of cultural heritage, making it more accessible to the public but also reduces damage to historical artifacts (Khundam, 2020). It also enhances public attention to cultural heritage and strengthens people's understanding of local culture (Slater, 2004). Moreover, the evaluation method proposed in this conceptual paper is worth exploring in depth, as it ensures the rationality of the research process and the scientific validity of the research outcomes. The future research results will assist educational institutions and museums in selecting appropriate VR immersive learning software and guide developers in creating products that meet user needs (Wang et al., 2019). Additionally, it can provide a reference for application development in other museums or cultural sites (Fussell & Truong, 2022).

1.2. Research Objective

To develop a conceptual framework for evaluating virtual reality (VR) applications in cultural heritage museums that enhances immersive and interactive experiences by addressing both technological aspects and users' experiential needs, thereby bridging existing theoretical gaps and guiding future empirical validation.

2. Method

A Critical Literature Review is a structured process of analyzing and evaluating existing research to identify gaps, highlight key themes, and understand current trends. Unlike a simple summary, this method critically examines previous studies to provide deeper insights into the topic. For this study, the review focuses on how virtual reality (VR) enhances cultural heritage experiences, considering factors like visual quality, interactivity, sensory integration, and storytelling (Frasca & Ryan, 2002; Tabakova & Pelaheichenko, 2023; Slater, 2004).

3. Findings

Virtual Reality (VR) can bring innovation and change to the cultural heritage sector. For example, virtual reality (VR) offers innovative ways to attract tourists and enhance the dissemination of cultural knowledge (Tsita et al., 2023). The immersive experiences facilitated by VR allow users to explore historical environments, artifacts, and narratives in a manner that traditional media cannot replicate (Skola et al., 2020). Virtual reality technology provides a sense of immersion, placing the individual in a virtual space with the artifacts on display. This is particularly important as it allows for virtual exploration, especially of sites inaccessible due to geographic or time constraints, and enhances educational value by allowing active participation (Notarangelo et al., 2023). In the process, the user becomes an active learner. According to relevant studies, it has been proven that such interactions can enhance interest and engagement (Klippel et al., 2019).

3.1. Identification of Key Influencing Factors

Several factors influence the quality and effectiveness of a virtual reality immersive experience. Technical attributes such as display quality, latency, and interactivity are crucial for crafting immersive experiences. High-resolution displays with accurate color rendering and minimal pixelation significantly enhance visual realism, improving user immersion (Slater, 2004). Ensuring low latency in a virtual reality system is critical to maintaining an immersive experience by reducing the delay between the user's physical actions and the corresponding system response, thus maintaining a sense of presence (Meehan et al., 2002). Additionally, the level of interactivity, which includes features like gesture recognition, tracked hand controllers, and haptic feedback devices, plays a pivotal role in enhancing users' perceived control and engagement within the virtual environment (Mine, 1997).

User characteristics, including prior VR experience, cognitive load capacity, and emotional readiness, play a pivotal role in shaping immersive experiences. Users already familiar with VR technology often adapt more quickly and experience higher levels of presence, benefiting from an established cognitive framework for interacting within virtual environments (Bowman & McMahan, 2007). These experienced users can seamlessly transport their learned interaction patterns into new VR contexts, enhancing engagement and enjoyment. On the other hand, beginners might need time to adjust and learn how to interact effectively within these environments.

Narrative and thematic coherence are vital components in deepening cognitive and emotional immersion. Users are more likely to invest in and remain engaged with well-structured storylines and thematic content, particularly in cultural heritage contexts

where storytelling plays a foundational role (Frasca & Ryan, 2002). Storytelling is a fundamental aspect of cultural transmission, especially in cultures with rich oral traditions, such as in various Asian contexts where historical events, legends, and myths are conveyed through narrative (Podara et al., 2021). Research indicates that users experience deeper emotional connections and meaningful learning experiences when content is presented through compelling stories. This storytelling approach facilitates emotional connections, is crucial for immersive learning, and sparks a genuine interest in cultural heritage (Tabakova & Pelaheichenko, 2023).

High-quality visuals are foundational for immersion, crafting a believable environment that, when coupled with auditory cues like the rustling of leaves or distant footsteps, works in concert to deepen the sense of presence. Research has shown that coordinating visual and auditory stimuli can evoke more robust emotional responses, critical to maintaining virtual reality immersion (Kim & Lee, 2022). It has also been suggested that introducing other senses, such as smell, can significantly enrich the VR experience. For example, scents that match the virtual environment can evoke specific emotions or memories, thus enhancing engagement and connection (Archer et al., 2022). Moreover, balancing sensory inputs is essential to ensure users are not overwhelmed by too many stimuli, which can lead to confusion or disorientation (Ranasinghe et al., 2018). This ability to optimize sensory engagement is also essential in virtual reality, allowing users to interact with virtual environments through various senses (e.g., feeling textures or smelling smells), thus enhancing the overall immersive experience (Melo et al., 2020).

It is easy to see from previous studies that many factors play a crucial role, especially when it comes to cultural heritage. However, gaps and challenges still need to be overcome to enhance the immersive experience of integrating virtual reality with cultural heritage (Zhang et al., 2020). As VR technology continues to evolve, some scholars have suggested that some underlying factors may have yet to be explored (Han et al., 2020). It is also clear that one VR app cannot cover every aspect; for example, high hardware costs and design issues in learning activities prevent wider adoption (Jensen & Konradsen, 2017). Immersive experience applications for museums will only be experienced once by many users, so it is vital to find the key influences. At the same time, it is not hard to find some studies that mention the lack of interactivity and compelling narratives in many VR apps, with homogenized content, lack of detail, and insufficient interactivity reducing user interest and engagement (Cecotti, 2022; Mortara et al., 2014). This concept paper will propose ways to find the key factors influencing the virtual reality experience. This will help to maximize the role of virtual reality in the preservation and presentation of cultural heritage.

3.2. An Immersive Evaluation for Evaluating VR Cultural Heritage Applications

Virtual reality technology can be attractive to young people. Therefore, it can help cultural transmission (Ching et al., 2019). Although many studies have enhanced how students receive knowledge through virtual environments and VR software, including graphics rendering, interaction, and modeling, VR cannot wholly replace traditional education (Hamilton et al., 2020). Similar open learning environments like museums are particularly well suited to work with VR technology; for example, one study found that the sense of presence in immersive virtual reality was strongly correlated with students' motivation, interest, and enjoyment of learning (Makransky et al., 2020).

For evaluating VR immersive experiences, the Technology Acceptance Model (TAM) is considered the most popular model for determining essential factors of user feedback and subjective experiences (Zhang et al., 2022). Many scholars have explored users' acceptance and attitudes toward VR in education. Most studies use TAM to investigate learners' intentions to use VR (Fussell & Truong, 2022; Podara et al., 2021). Questionnaires are commonly used to collect quantitative user feedback data. Other studies employ mixed methods, combining focus group discussions and user behavior observation to assess immersion levels. For instance, Somrak et al. (2021) tested the user experience of virtual reality through the User Experience Questionnaire (UEQ) (Somrak et al., 2021). Cecotti (2022) argues that VR applications for cultural heritage can be grouped by content, such as art galleries and museums, and evaluated through workload, usability, process, and potential VR symptom surveys (Cecotti, 2022). For VR cultural heritage experiences, existing measurement scales are primarily derived from frameworks such as Salzman et al. (1999) presence model, Csikszentmihalyi's (1975) flow theory, and Witmer and Singer's (1998) presence questionnaire. These theories serve as important references.

3.3. Grounded Theory in VR Research

Grounded theory, as a robust qualitative research methodology, aims to delve deeply into the complex structures of phenomena and is particularly adept at identifying potentially influential factors. This method focuses on the experiences of participants, thus providing insights that are contextually rich and relevant (Charmaz, 2006; Thornberg et al., 2013). Grounded theory has demonstrated its methodological adaptability and capability to reveal complex social vectors across various fields. For example, in education, researchers have combined participatory action research principles with elements of grounded theory to uncover underlying factors influencing educational practices, exposing complex social dynamics such as stakeholder interactions and educational needs (Canlas & Karpudewan, 2020). Sales research has played a crucial role in new and emerging areas by identifying underlying factors affecting sales behavior, helping to fill knowledge gaps, and broadening the understanding of market dynamics (Johnson, 2014).

In the rapidly evolving virtual reality (VR) field, grounded theory is increasingly used to explore factors influencing immersive experiences. It offers a practical qualitative approach to understanding complex phenomena within immersive environments (Ammann et al., 2020). Researchers have utilized grounded theory to analyze user experiences in VR training programs, such as those for emergency responders or medical professionals. This analysis identified key themes related to realism, engagement, and emotional responses, which help optimize training protocols and enhance user satisfaction (Gere et al., 2021). Additionally, in treatment settings for anxiety and phobias, grounded theory has been used to study users' emotional responses to various VR scenarios. Researchers have identified core concepts like presence and emotional immersion that significantly affect therapeutic outcomes, leading to the design of better interventions (Stelick et al., 2018). Furthermore, grounded theory has also been important in exploring social interactions within VR environments, such as multiplayer games or virtual meetings, uncovering identity, communication styles, and social presence themes. This research provides valuable insights into how virtual interactions differ from real-life interactions, enriching the understanding of VR's impact on social behavior (Kong et al., 2020).

3.4. AHP Method to Identify the Key Factor

Among the established methods for determining the relative weights of evaluation criteria, the Analytic Hierarchy Process (AHP) is notable for its effectiveness. Developed by Thomas Saaty in the 1970s, AHP assists decision-makers in organizing and analyzing complex decisions involving multiple criteria (Saaty, 2008). AHP is a structured decision-making methodology particularly suited for complex scenarios requiring multiple criteria evaluation. Its essence lies in breaking down decision-making into a hierarchy consisting of the main goal, criteria, sub-criteria, and alternatives. The process begins with constructing this hierarchy, which involves clearly defining the decision goal, identifying relevant criteria and sub-criteria, and listing potential alternatives to create a detailed map of the decision space. Subsequently, pairwise comparisons are performed using a nine-point scale, allowing decision-makers to evaluate the relative importance of criteria, with scores ranging from 1 (equal importance) to 9 (extremely different importance). The weights of these criteria are then calculated using the eigenvector method, which quantifies the relative importance of each criterion (Saaty, 2008).

After evaluating the criteria, alternatives are assessed through similar pairwise comparisons against each criterion to determine their standings based on the established criteria. Finally, the weighted scores of the alternatives are aggregated, enabling decision-makers to rank them and make a well-informed recommendation (Saaty, 2008; Vaidya & Kumar, 2006). In the context of VR, AHP can be applied to understand the weights of indicators affecting immersive experiences, thereby identifying the most critical indicators. This allows for targeted enhancement of the museum immersive experience with limited resources, thus enhancing the overall VR experience for the user.

This study will review relevant literature and select grounded theory as the research method for exploring potential factors. Grounded theory is well-suited to addressing the complexities of combining virtual reality with cultural heritage. By integrating it with the Analytical Hierarchy Process (AHP), key indicators can be identified, thereby improving VR applications in this field. The following conceptual framework aims to provide a comprehensive overview of research methodologies for future studies, offering insights into optimizing the integration of VR technology with cultural heritage presentation.

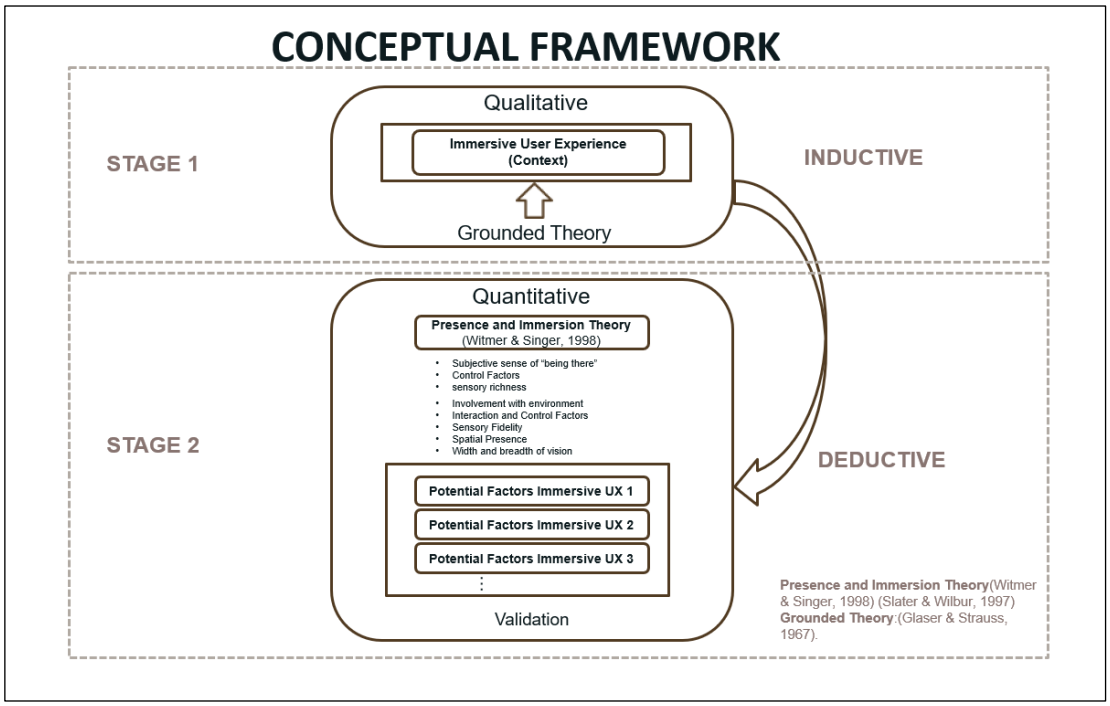
3.5. Proposed Conceptual Framework

The conceptual framework proposed in this conceptual paper is illustrated in Figure 1. This conceptual framework describes the process of establishing an evaluation of immersive experiences within the virtual reality (VR) cultural heritage environment of the Guilin Museum, clearly defining the relationship between the two stages. These two stages integrate qualitative and quantitative research, reflecting the design concept of mixed methods research. The framework employs inductive and deductive reasoning to comprehensively analyze various aspects of the immersive experience and scientifically validate the research results. The following sections will provide a detailed introduction to each stage.

The initial stage of the research is centered around qualitative methods, essential for uncovering the potential indicators. Grounded Theory (Wagner et al., 1968) is employed

as the guiding framework to explore and identify potential factors that influence immersive experiences in virtual reality (VR). This approach allows for the emergence of concepts directly from the data, without the constraints of preconceived notions. Later on, the researchers plan to design in-depth and face-to-face interviews with a group of 15 VR-related volunteers. The selection of volunteers is planned to be based on purposive sampling and snowball sampling, ensuring that they can provide insightful feedback on their experiences and perceptions. The face-to-face format ensures a personal detailed expression, as well as the ability to probe deeper into individual experiences.

Figure 1: Conceptual Framework Developed for This Study from the Researchers



Sources: Witmer and Singer (1998), Slater and Wilbur (1997), Glaser et al. (1968)

The data gathered from these interviews will be analyzed using inductive thematic analysis (Boyatzis, 1998), a method well-suited for discovering patterns and insights in qualitative data. Inductive analysis focuses on building theories from the ground up, as opposed to testing predefined hypotheses. This process allows for the identification of recurring themes and concepts that are critical in shaping the immersive experience. Following this, the researcher plans to rigorously code the content of the interviews. This process will result in an initial set of assessment indicators. These indicators will serve as the foundation for future stages of the research, which may involve quantitative testing or further qualitative exploration to validate and refine the identified themes.

In the second stage, the study transitions to quantitative analysis, starting with applying the Analytic Hierarchy Process (AHP) (Saaty, 2008). AHP assigns weights to the critical factors identified during the qualitative research phase, facilitating a structured evaluation framework. Following the weight assignments, a comprehensive questionnaire survey is conducted to gather extensive data on users' immersive experiences within the VR environments. Designed based on qualitative findings and Presence and Immersion Theory (Witmer & Singer, 1998), the questionnaire assesses dimensions such as presence, control, sensory richness, and interaction. The collected

data undergoes Exploratory Factor Analysis (EFA) (Fabrigar & Wegener, 2012) and Predictive Accuracy Evaluation using SmartPLS 4 software (Cheah et al., 2023) to verify the reliability and validity of the proposed evaluation model.

Exploratory Factor Analysis (EFA) identifies latent structures in observed variables, simplifying data and enhancing interpretability (Fabrigar & Wegener, 2012). Its main goal is to uncover factors affecting immersive experiences. Predictive Accuracy Evaluation uses SmartPLS for analyzing complex relationships via Partial Least Squares Structural Equation Modeling, utilizing Explanatory and Predictive Power (R^2 and Q^2) values to assess model accuracy and relevance (Cheah et al., 2023). This method ensures a robust empirical foundation, facilitating the development of VR cultural heritage applications that are both theoretically sound and practically effective.

4. Conclusion

This study explores the challenges and shortcomings of Virtual Reality (VR) technology in preserving and disseminating cultural heritage. A literature review reveals that the characteristics of VR technology, such as immersion and interactivity (Archer et al., 2022), are crucial for enhancing audience engagement, as they effectively attract younger audiences accustomed to dynamic digital content (Kim & Lee, 2022). Additionally, establishing a VR application evaluation framework is vital for protecting cultural heritage and information dissemination, as it can improve user experiences by providing immersive interactions to foster a deeper understanding of cultural contexts.

This conceptual paper proposes a framework to explore and validate the potential factors influencing immersive cultural heritage experiences in museums, detailing and rationalizing the framework's components. Future research can further investigate this framework through theoretical and empirical studies. The outcomes of this research will benefit policymakers and cultural heritage professionals by helping them effectively leverage VR technology to enhance cultural dissemination. Additionally, the framework aims to provide valuable references for VR application developers, promoting the widespread adoption of VR technology to preserve cultural heritage.

Ethics Approval and Consent to Participate

Not applicable.

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Conflict of Interest

The authors declare no conflict of interest.

References

Ammann, J., Stucki, M., & Siegrist, M. (2020). True colours: Advantages and challenges of virtual reality in a sensory science experiment on the influence of colour on flavour identification. *Food Quality and Preference, 86*, Article 103998. https://doi.org/10.1016/j.foodqual.2020.103998

Archer, N. S., Bluff, A., Eddy, A., Nikhil, C. K., Hazell, N., Frank, D., & Johnston, A. (2022). Odour enhances the sense of presence in a virtual reality environment. *PLoS ONE, 17*(3), Article e0265039. https://doi.org/10.1371/journal.pone.0265039

Berman, E. (2017). An exploratory sequential mixed methods approach to understanding researchers' data management practices at UVM: Integrated findings to develop research data services. *Journal of eScience Librarianship, 6*(1), Article e1104. https://doi.org/10.7191/jeslib.2017.1104

Bowman, D. A., & McMahan, R. P. (2007). Virtual reality: How much immersion is enough? *Computer, 40*(7), 36–43. https://doi.org/10.1109/mc.2007.257

Boyatzis, R. E. (1998). *Transforming qualitative information: Thematic analysis and code development*. Sage Publications, Inc.

Canlas, I. P., & Karpudewan, M. (2020). Blending the principles of participatory action research approach and elements of grounded theory in a disaster risk reduction education case study. *International Journal of Qualitative Methods, 19*. https://doi.org/10.1177/1609406920958964

Carrozzino, M., & Bergamasco, M. (2010). Beyond virtual museums: Experiencing immersive virtual reality in real museums. *Journal of Cultural Heritage, 11*(4), 452–458. https://doi.org/10.1016/j.culher.2010.04.001

Cecotti, H. (2022). Cultural heritage in fully immersive virtual reality. *Virtual Worlds, 1*(1), 82–102. https://doi.org/10.3390/virtualworlds1010006

Charmaz, K. (2006). *Constructing grounded theory : a practical guide through qualitative analysis*. SAGE Publications, Ltd.

Cheah, J., Magno, F., & Cassia, F. (2023). Reviewing the SmartPLS 4 software: The latest features and enhancements. *Journal of Marketing Analytics, 12*(1), 97–107. https://doi.org/10.1057/s41270-023-00266-y

Cheah, J., Magno, F., & Cassia, F. (2023). Reviewing the SmartPLS 4 software: the latest features and enhancements. *Journal of Marketing Analytics, 12*(1), 97–107. https://doi.org/10.1057/s41270-023-00266-y

Ching, E., Li, Y., Cai, S., & Leow, F.-T. (2019). The effects of VR environments on the acceptance, experience, and expectations of cultural heritage learning. *Journal on Computing and Cultural Heritage, 13*, Article 13. https://doi.org/10.1145/3352933

Clini, P., Angeloni, R., D'Alessio, M., & Quarchioni, R. (2023). Enhancing onsite and online museum experience through digital reconstruction and reproduction: The Raphael and Angelo Colocci temporary exhibition. *SCIRES-IT - SCIentific RESearch and Information Technology, 13*(2), Article 2. https://doi.org/10.2423/i22394303v13n2p71

Csikszentmihalyi, M. (1975). *Beyond boredom and anxiety*. Jossey-Bass.

Economou, M., & Tost, L. P. (2011). *Evaluating the Use of Virtual Reality and Multimedia Applications for Presenting the Past*. IGI Global Scientific Publishing.

Fabrigar, L. R., Wegener, D. T., MacCallum, R. C., & Strahan, E. J. (1999). Evaluating the use of exploratory factor analysis in psychological research. *Psychological Methods, 4*(3), 272–299. https://doi.org/10.1037/1082-989x.4.3.272

Ferdani, D., Fanini, B., Piccioli, M. C., Carboni, F., & Vigliarolo, P. (2020). 3D reconstruction and validation of historical background for immersive VR

applications and games: The case study of the Forum of Augustus in Rome. *Journal of Cultural Heritage, 43*, 129–143. https://doi.org/10.1016/j.culher.2019.12.004

Frasca, G., & Ryan, M. (2002). Narrative as Virtual Reality: Immersion and interactivity in literature and electronic media. *South Atlantic Review, 67*(1), 153. https://doi.org/10.2307/3201597

Fussell, S. G., & Truong, D. (2022). Using virtual reality for dynamic learning: An extended technology acceptance model. *Virtual Reality, 26*, 249–267. https://doi.org/10.1007/s10055-021-00554-x

Gere, A., Zulkarnain, A. H. B., Szakal, D., Feher, O., & Kokai, Z. (2021). Virtual reality applications in food science. *Progress in Agricultural Engineering Sciences, 17*(1), 3–14. https://doi.org/10.1556/446.2021.00015

Hamilton, D., McKechnie, J., Edgerton, E., & Wilson, C. (2020). Immersive virtual reality as a pedagogical tool in education: A systematic literature review of quantitative learning outcomes and experimental design. *Journal of Computers in Education, 8*(1), 1–32. https://doi.org/10.1007/s40692-020-00169-2

Han, S., An, M., Han, J. J., & Lee, J. (2020). Telepresence, time distortion, and consumer traits of virtual reality shopping. *Journal of Business Research, 118*, 311–320. https://doi.org/10.1016/j.jbusres.2020.06.056

Jensen, L., & Konradsen, F. (2017). A review of the use of virtual reality head-mounted displays in education and training. *Education and Information Technologies, 23*(4), 1515–1529. https://doi.org/10.1007/s10639-017-9676-0

Johnson, J. S. (2014). Qualitative sales research: An exposition of grounded theory. *Journal of Personal Selling and Sales Management, 35*(3), 262–273. https://doi.org/10.1080/08853134.2014.954581

Jung, K., Nguyen, V. T., Piscarac, D., & Yoo, S. C. (2020). Meet the virtual Jeju Dol Harubang: The mixed VR/AR application for cultural immersion in Korea's main heritage. *ISPRS International Journal of Geo-Information, 9*(6), Article 367. https://doi.org/10.3390/ijgi9060367

Jung, T., & Dieck, M. C. T. (2017). *Augmented reality and virtual reality*. Progress in IS.

Khundam, C. (2020). Storytelling platform for interactive digital content in virtual museum. *ECTI Transactions on Computer and Information Technology (ECTI-CIT), 15*(1), 34–49. https://doi.org/10.37936/ecti-cit.2021151.239948

Kim, H., & Lee, I. (2022). Studying the effects of congruence of auditory and visual stimuli on virtual reality experiences. *IEEE Transactions on Visualization and Computer Graphics, 28*(5), 2080–2090. https://doi.org/10.1109/tvcg.2022.3150514

Klippel, A., Zhao, J., Jackson, K. L., La Femina, P., Stubbs, C., Wetzel, R., Blair, J., Wallgrun, J. O., & Oprean, D. (2019). Transforming earth science education through immersive experiences: Delivering on a long-held promise. *Journal of Educational Computing Research, 57*(7), 1745–1771. https://doi.org/10.1177/0735633119854025

Kong, Y., Sharma, C., Kanala, M., Thakur, M., Li, L., Xu, D., & Torrico, D. (2020). Virtual reality and immersive environments on sensory perception of chocolate products: A preliminary study. *Foods, 9*(4), Article 515. https://doi.org/10.3390/foods9040515

Lee, E. A., Wong, K. W., & Fung, C. C. (2010). How does desktop virtual reality enhance learning outcomes? A structural equation modeling approach. *Computers & Education, 55*(4), 1424–1442. https://doi.org/10.1016/j.compedu.2010.06.006

Li, J., Krishnamurthy, S., Roders, A. P., & Van Wesemael, P. (2019). Community participation in cultural heritage management: A systematic literature review comparing Chinese and international practices. *Cities, 96*, 102476. https://doi.org/10.1016/j.cities.2019.102476

Makransky, G., Andreasen, N. K., Baceviciute, S., & Mayer, R. (2020). Immersive virtual reality increases liking but not learning with a science simulation and generative learning strategies promote learning in immersive virtual reality. *Journal of Educational Psychology, 113*(4), 719–735. https://doi.org/10.1037/edu0000473

Meehan, M., Insko, B., Whitton, M., & Brooks, F. P. (2002). Physiological measures of presence in stressful virtual environments. *ACM Transactions on Graphics, 21*(3), 645–652. https://doi.org/10.1145/566654.566630

Melo, M., Goncalves, G., Monteiro, P., Coelho, H., Vasconcelos-Raposo, J., & Bessa, M. (2020). Do multisensory stimuli benefit the virtual reality experience? A systematic review. *IEEE Transactions on Visualization and Computer Graphics, 28*(2), 1428–1442. https://doi.org/10.1109/tvcg.2020.3010088

Mine, M. R. (1997). *Exploiting Proprioception in Virtual-Environment Interaction*. University of North Carolina at Chapel HillChapel Hill, NCUnited States. https://dl.acm.org/citation.cfm?id=287388

Mortara, M., Catalano, C. E., Bellotti, F., Fiucci, G., Houry-Panchetti, M., & Petridis, P. (2013). Learning cultural heritage by serious games. *Journal of Cultural Heritage, 15*(3), 318–325. https://doi.org/10.1016/j.culher.2013.04.004

Noev, N., Bogdanova, G., Todorov, T., & Sabev, N. (2019). Innovative approach to the presentation of cultural heritage in the game module of Serious Game for Blinded People. *Digital Presentation and Preservation of Cultural and Scientific Heritage, 9*, 213–218. https://doi.org/10.55630/dipp.2019.9.18

Notarangelo, N. M., Manfredi, G., & Gilio, G. (2023). A collaborative virtual walkthrough of Matera's Sassi using photogrammetric reconstruction and hand gesture navigation. *Journal of Imaging, 9*(4), Article 88. https://doi.org/10.3390/jimaging9040088

Pavlidis, G., Koutsoudis, A., Arnaoutoglou, F., Tsioukas, V., & Chamzas, C. (2007). Methods for 3D digitization of cultural heritage. *Journal of Cultural Heritage, 8*(1), 93–98. https://doi.org/10.1016/j.culher.2006.10.007

Podara, A., Giomelakis, D., Nicolaou, C., Matsiola, M., & Kotsakis, R. (2021). Digital storytelling in cultural heritage: Audience engagement in the interactive documentary *New Life*. *Sustainability, 13*(3), Article 1193. https://doi.org/10.3390/su13031193

Ranasinghe, N., Jain, P., Nguyen, T., Koh, R., Tolley, D., Karwita, S., Lin, L., Yan, L., Shamaiah, K., Tung, C., Yen, C., & Do, E. (2018). Season traveller: Multisensory narration for enhancing the virtual reality experience. *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems*.

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International Journal of Services Sciences, 1*(1), 83. https://doi.org/10.1504/ijssci.2008.017590

Salzman, M. C., Dede, C., Loftin, R. B., & Chen, J. (1999). A model for understanding how virtual reality aids complex conceptual learning. *PRESENCE: Virtual and Augmented Reality, 8*(3), 293–316. https://doi.org/10.1162/105474699566242

Skola, F., Rizvic, S., Cozza, M., Barbieri, L., Bruno, F., Skarlatos, D., & Liarokapis, F. (2020). Virtual reality with 360-video storytelling in cultural heritage: Study of presence, engagement, and immersion. *Sensors, 20*(20), Article 5851. https://doi.org/10.3390/s20205851

Slater, M. (2004). How colorful was your day? Why questionnaires cannot assess presence in virtual environments. *PRESENCE: Virtual and Augmented Reality, 13*(4), 484–493. https://doi.org/10.1162/1054746041944849

Slater, M., & Wilbur, S. (1997). A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments. *Presence:*

Teleoperators and Virtual Environments, 6(6), 603–616. https://doi.org/10.1162/pres.1997.6.6.603

Somrak, A., Pogacnik, M., & Guna, J. (2021). Suitability and comparison of questionnaires assessing virtual reality-induced symptoms and effects and user experience in virtual environments. *Sensors, 21*(4), Article 1185. https://doi.org/10.3390/s21041185

Stelick, A., Penano, A., Riak, A., & Dando, R. (2018). Dynamic context sensory testing: A proof of concept study bringing virtual reality to the sensory booth. *Journal of Food Science, 83*(8), 2047–2051. https://doi.org/10.1111/1750-3841.14275

Tabakova, H., & Pelaheichenko, M. (2023). Storytelling as a means of activating students' cognitive activity in the modern educational space. *Scientific Papers of Berdiansk State Pedagogical University Series Pedagogical Sciences, 1*(1), 165–172.

Theodoropoulos, A., & Antoniou, A. (2022). VR games in cultural heritage: A systematic review of the emerging fields of virtual reality and culture games. *Applied Sciences, 12*(17), Article 8476. https://doi.org/10.3390/app12178476

Thornberg, R., Halldin, K., Bolmsjo, N., & Petersson, A. (2011). Victimising of school bullying: A grounded theory. *Research Papers in Education, 28*(3), 309–329. https://doi.org/10.1080/02671522.2011.641999

Tsita, C., Satratzemi, M., Pedefoudas, A., Georgiadis, C., Zampeti, M., Papavergou, E., Tsiara, S., Sismanidou, E., Kyriakidis, P., Kehagias, D., & Tzovaras, D. (2023). A virtual reality museum to reinforce the interpretation of contemporary art and increase the educational value of user experience. *Heritage, 6*(5), 4134–4172. https://doi.org/10.3390/heritage6050218

Vaidya, O. S., & Kumar, S. (2006). Analytic hierarchy process: An overview of applications. *European Journal of Operational Research, 169*(1), 1–29. https://doi.org/10.1016/j.ejor.2004.04.028

Wagner, H. R., Glaser, B. G., & Strauss, A. L. (1968). The discovery of grounded theory: Strategies for qualitative research. *Social Forces, 46*(4), 555. https://doi.org/10.2307/2575405

Wang, J., Cheng, G. H., Chen, T., & Leung, K. (2019). Team creativity/innovation in culturally diverse teams: A meta-analysis. *Journal of Organizational Behavior, 40*(6), 693–708. https://doi.org/10.1002/job.2362

Wang, X., et al. (2017). *Guilin cultural relics: Historical insights and museum curation*. Beijing Publishing House.

Witmer, B. G., & Singer, M. J. (1998). Measuring presence in virtual environments: A presence questionnaire. *Presence: Teleoperators & Virtual Environments, 7*(3), 225–240. https://doi.org/10.1162/105474698565686

Yan, L. (2021). Construction of the professional quality evaluation system of environmental impact assessment engineers based on YAAHP software. *E3S Web of Conferences, 259*, Article 05002. https://doi.org/10.1051/e3sconf/202125905002

Zara, J. (2004). Virtual reality and cultural heritage on the web. In *Proceedings of the 8th International Symposium on Virtual Reality, Archaeology and Cultural Heritage* (pp. 101–112). https://doi.org/10.11176/edu3781278

Zhang, M., Shu, L., Luo, X., Yuan, M., & Zheng, X. (2022). Virtual reality technology in construction safety training: Extended technology acceptance model. *Automation in Construction, 135*, Article 104113. https://doi.org/10.1016/j.autcon.2021.104113

Zhang, Y., Liu, H., Kang, S., & Al-Hussein, M. (2020). Virtual reality applications for the built environment: Research trends and opportunities. *Automation in Construction, 118*, Article 103311. https://doi.org/10.1016/j.autcon.2020.103311