Virtual Reality Games in Cultural Heritage

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The use of Virtual Reality (VR) games in cultural heritage has been growing. VR Games have increasingly found their way into museums and exhibitions, highlighting the increasing cultural value associated with games and the institutionalization of game culture. VR appears to be a very promising technology in facilitating experiences in the field. It offers significant results concerning the types of technologies used, the types of games used, as well as the different types of experiences for the user. Usage of VR games in the cultural heritage area is associated with multiple learning gains, increased visit motivation, and dynamic engagement.

VR games   culture games   heritage games   cultural heritage   virtual heritage

1. Introduction

The emergence of Virtual Reality (VR) has posed significant challenges for scientists who started investigating the way VR changes social dynamics [1] as well as social attitudes [2]. Especially during the pandemic, cultural heritage, culture, and tourism had to find new ways to engage the public, since travelling was largely restricted. Thus, the potential of virtual tourism was explored, showing multiple positive effects in promoting sites, allowing the recovery of tourist destinations after the pandemic, and supporting engagement with cultural content for remote audiences. [3]. In addition, virtual applications also allowed interactions with intangible cultural heritage [4]. When VR is combined with storytelling, e.g., 360 video storytelling, cultural content becomes engaging and significant increases in immersion and levels of presence are observed [5]. Finally, research has shown that VR places specific demands on human cognition, and in order to be engaging and provide a smooth experience, its design needs to respect human cognitive requirements [6].

In recent years, games in cultural heritage have been considered a good way to increase engagement with cultural content; thus, serious games and game-based learning is on the rise. Although challenges remain in their development, there are significant results showing advantages of their use [7][8]. Moreover, the combination of VR and games in cultural heritage also produced very promising results, especially for specific age groups, regardless of their domain knowledge of cultural heritage [9], making such games important tools for cultural experiences. Therefore, games and gamification processes in cultural heritage can not only increase engagement but also reflection and interpretation, and numerous studies seem to support this finding [10].

2. Virtual Reality Games in Cultural Heritage

2.1. Learning Experiences with Games in Cultural Heritage

Digital games or video games are games that integrate digital technology [11]. In videogames users play through audiovisual platforms with contents on the basis of a story created from historical or fantasy themes. The concept of digital games as represented in literature [11], Ref. [12] focuses on game itself, narrative (story), interactivity, and play. Games designed for educational objectives (serious games), look as an effective tool to learn cultural content in an engaging way. In order to transform static content into a serious game in Cultural Heritage, gamification techniques are used. Gamification is the process of introducing game strategies and components into some scenarios and situations that are not a game [13].

Additionally, there is a wide variety of cultural material since there is the tangible Cultural Heritage, which includes historic places and buildings, monuments, records, works of art, machineries, and other artifacts that are thought to be valuable enough to be preserved for the future. There is also the natural Cultural Heritage environment which incorporates components related to geology, paleontology, and morphology as well as landscapes, flora, and wildlife. Games can cover all the aforementioned material and therefore are an essential and integrated part of modern Cultural Heritage that can support teaching and learning for as a modern tool by integrating art, storytelling and digital technology [8][14].

2.2. VR as a Medium in Cultural Heritage

One of the main characteristics of VR is that headsets completely take over users' vision to give the impression that they are somewhere else. For games, VR supersedes the surroundings, taking the user to other places where physical presence is no longer important. These features provide numerous possibilities for VR games in cultural heritage, as the player is free to travel to different locations (real or fictional) across time and space and have experiences from different historical or even future eras. Dealing with VR, one inevitably deals with immersion, the feeling of being a part of the virtual environment. Although immersion is present in other mediums too, such as books and films, VR immersion is not only mental but could be also physical. In this case, the feeling of being physically present in the virtual world is strong, of course depending on the quality of the VR environment and its design [15].

However, the effective reconstruction of the virtual world for cultural heritage VR games is a challenge. Significant historical knowledge is needed in order to reconstruct past worlds in ways that are meaningful for the player and to allow her to play and explore history. Details on the appearance of monuments, objects, people, landscapes, etc., are very important in creating the right interaction conditions for the game [16]. In this sense, AR games for cultural heritage might be easier to implement than VR ones, as AR uses a real world setting while VR needs to reconstruct entire worlds. In addition, AR might only need a smartphone for its use, whereas VR needs a headset device.

VR in cultural heritage is often combined with storytelling such that the effects of both VR and storytelling are maximized. In this setting, the person is using multiple modalities to access information, as she experiences the place where the story is evolving in the virtual world [17]. For example, iMareCulture explored ways storytelling, VR games, and underwater archaeology could be combined, as players could explore cities long lost under the sea (while playing in VR) [18].

Moreover, VR applications for cultural heritage can take many forms. Apart from games and reconstructions of different spaces, VR can be used in different and even unexpected forms of culture such as poetry [19], and researchers appear to be testing the medium and exploring its full potential. VR can also be used for testing research hypotheses, like assisting archaeological research. For example, VR and 3D models were used to explore architectural history and features of buildings that no longer exist [20].

For the development of virtual worlds and games for Cultural Heritage, different techniques are used. In the case of the historic Klodzko Fortress in Poland's Lower Silesia, terrestrial laser scanning was used to capture the real world. The scans were later used in a game engine to create virtual interactions [21]. The use of game engines for the implementation of virtual cultural experiences and VR culture games is popular with different researchers, since they provide a solution in reducing the production cost of VR applications and also in helping to overcome different technical issues [22].

Gamification of VR experiences is a topic of research that has been particularly increased with the growth of VR technology, such as, low-cost HMDs and high field-of-view. In [23], researchers compared different human–computer interaction methodologies for real-time VR simulation of both tangible and intangible digital heritage sites and the creation of dedicated, immersive, gamified curation experiences. Moreover, various interaction methods, such as sensor-based, device-based, tangible, collaborative, multimodal, and hybrid interaction methods, have also been employed by immersive reality technologies to enable interaction with the virtual environments. Previous studies compare the existing VR technologies and interaction methods against their potential to enhance cultural learning in Virtual Heritage applications [24]. The guidelines for the utilization of immersive technologies and interaction methods that can assist professionals in cultural heritage to predetermine their relevance to attain the intended objectives of an applications: *"(1) establish a contextual relationship between users, virtual content, and cultural context, (2) allow collaboration between users, and (3) enable engagement with the cultural context in the virtual environments and the virtual environment itself"* [24].

Finally, new methods of interacting with VR games are developed. Researchers investigated psychological responses to playing videogames using a VR HMD [25] and also investigated how cybersickness impacts the sense of presence one feels in the virtual environment, as well as how cybersickness affects enjoyment. It reports that better technology does not affect the frequency or severity of cybersickness for players; but sensory conflict has a significant impact on how sick users become.

2.3. Learning Experiences with VR Games

It is nowadays widely accepted that games can significantly boost learning in cultural heritage, since they increase engagement and motivation [26]. Studies of VR games have focused on different features that can make them more learning effective for different audiences, such as different genders [26]. VR can turn passive visitors into active learners. VR does not remove importance from the real objects but it can improve the understanding of them, since it allows users to manipulate objects and be actively involved [27]. The importance of games and gamification in cultural heritage is further explored by [10], where current trends are analyzed.

Learning is not only an individual activity but also a social one. In fact, learning benefits are maximized when people interact in a social setting and cultural heritage sites are important cultural and also social spaces. A recent study showed that people using VR from home could interact with others physically present at the museum that used AR, and together they could play and co-explore cultural content. The important findings were used to inform the Mixed Reality Museum Co-Visit Theory that fosters collaboration in cultural heritage setting and amplifies learning outcomes [28]. Similarly, Dolezal et al. [29] created collaborative educational applications in immersive virtual environments that allowed people geography (explanation of "people geography"?).

Efforts have been made to make the development of educational VR games for cultural heritage more effective. In particular, Game Engine Platforms are used to create Virtual Learning Environments as a response to the increased need for VR games and experiences due to the COVID-19 pandemic and restriction of physical visits [30].

2.4. Positive and Negative Impacts of VR Games

VR games and cultural heritage settings are in the process of converging, and their interaction can be mutually beneficial. VR games not only give players a glimpse of the past, but allow them to manipulate the virtual word, be active in it, interact with cultural content and other players and actively involve perception and imagination (S13). As presented above, the use of VR games in cultural heritage are associated with multiple learning gains, increased visit motivation, and dynamic engagement. The ability of VR to increase immersion allows people to experience culture with multiple senses and not only to hear or read about it.

Multiple types of technologies can be used depending on the venues needs and multiple types of games and interactions can be implemented, covering the needs of diverse audiences. These applications allow people to experience culture alone or in groups, and also provide opportunities for personalized content and experiences, depending on users' needs, personalities, and interests. VR games seem to increase enjoyment and thus provide a more holistic experience that not only focuses on learning but also addresses other needs of cultural visitors, such as having fun, being active, and making meaningful interactions with cultural content and other visitors. Finally, VR games can allow researchers and museum staff to collect valuable visitor feedback.

2.5. VR Games to Support Cultural Heritage

Concerning interaction in VR gaming environments, it is important that players have meaningful choices. The game structure and rules should allow players to have an effect on events and influence the game outcomes. Players need to clearly understand how their actions change the outcomes and believe they have some control over the game. It is also important to find a balance between too much or too little ambiguity. The game should have surprise elements but not to the point where the player believes that she has no control. This implies that the elements of the game work in combination to create a cultural heritage environment that is appropriately challenging, but which players still perceive as fair and equitable, balancing fun and learning. Sometimes finding

the right balance between a game that is too hard or too easy to play is difficult. In addition, such games need to find a balance between gaming elements and cultural content that respects historical and cultural data.

VR games in the field of cultural heritage can be used to increase its sustainability. When used within a specific sustainability strategy, the games can have maximum effect [31]. UX methodologies are now mature enough to be used in cultural technologies and VR games in order to provide smooth visitor experiences and to allow useful evaluation of visitor experiences [32]. In addition, the field of games in cultural heritage is expanding, with new types of games emerging, like cinematographic videogames [33]. It is important to see where VR games stand compared to other types of games for cultural heritage and explore what is cost effective, maximizes visit effects, increases learning and engagement, etc. Moreover, it is also important to consider the physical aspects of VR games, such as the equipment used, as well as where they will be played (e.g., at the museum, at people's homes) ([34], p. 8). Finally, it is crucial to consider organizational issues around the use of VR games in cultural heritage, such as possible organization resistance issues, acceptance levels, as well as the mode of use (i.e., whether people will isolate the individual in the virtual world or people will support virtual social interactions). As previous study reports, the spectatorship experience for VR games differs strongly from its non-VR precursor [35]. The immersive full-body interaction is a crucial part of the player experience. Bystanders and viewers prefer the first-person version, which allows them to better focus on in-game actions and experience greater involvement [35].

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