



Article

Revealing Unknown Aspects: Sparking Curiosity and Engagement with a Tourist Destination through a 360-Degree Virtual Tour

Dimitra Petousi ¹, Akrivi Katifori ^{1,*}, Maria Boile ¹, Lori Kougioumtzian ¹, Christos Lougiakis ², Maria Roussou ² and Yannis Ioannidis ^{1,2}

¹ Athena Research & Innovation Center in Information Communication & Knowledge Technologies, 151 25 Marousi, Greece

² Department of Informatics and Telecommunications, National and Kapodistrian University of Athens, 157 72 Athens, Greece

* Correspondence: vivi@di.uoa.gr

Abstract: Over the past decades, 360-degree virtual tours have been used to provide the public access to accurate representations of cultural heritage sites and museums. The COVID-19 pandemic has contributed to a rise in the popularity of virtual tours as a means of engaging with locations remotely and has raised an interesting question: How could we use such experiences to bring the public closer to locations that are otherwise unreachable in real life or not considered to be tourist destinations? In this study, we examine the effectiveness of promoting engagement with a city through the virtual presentation of unknown and possibly also inaccessible points of interest through a 360-degree panoramic virtual tour. The evaluation of the experience with 31 users through an online questionnaire confirms its potential to spark curiosity, promote engagement, foster reflection, and motivate users to explore the location and its attractions at their leisure, thus enabling them to experience it from their personal point of view. The outcomes highlight the need for further research to explore this potential and identify best practices for virtual experience design.

Keywords: 360-degree virtual tours; user engagement; user curiosity; heritage tourism



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1. Introduction

The effective promotion of a city as a tourist destination is based on a deep understanding of its points of interest (POIs), historical, cultural, or otherwise, that guide the design of an appropriate promotional strategy. Relevant high-quality digital content can help convey an attractive image and highlight the POIs, convincing potential visitors of the diverse and engaging possibilities for their visit. Particularly in the case of cultural tourism, after the onset of the COVID-19 pandemic and the consequent restrictions to on-site visits, most museums and cultural heritage sites turned to the digital medium. This urgent need to support alternative ways of interaction with the content and to become inclusive to visitors with impeded access to the heritage site foregrounded the need to re-evaluate and invest in new approaches for digital content and experiences [1].

During the pandemic, virtual tours based on 360-degree panoramic photos were brought into the spotlight and adopted by many sites and institutions [1]. Virtual tours of cities are defined as a “simulation of an existing location composed of a sequence of videos, images, photographic-based media or panoramas that have an unbroken view” [2]. Offering immersion that places the visitors “inside” the destination’s image, virtual tours enable users to interact with the place, thus being considered to have potential, especially for heritage sites and heritage tourism.

The term ‘heritage’ has been used to denote a great number of phenomena of various different natures, such as cultural, archaeological, historical, religious, artistic, scientific,

military, natural, and scenic [3]. In general, the broader use of the concept is focused on tangible or intangible monuments and relics inherited from past generations, maintained in the present, and bestowed for future generations' benefit [4–6]. Heritage tourism is a form of special interest tourism that caters to the desire of tourists to learn about and understand the history and people's lifestyles at a destination. It essentially caters to "cultural motivations" expressed through the movements of travelers, such as by visiting monuments, studying local culture, experiencing local customs, cultural tours, traveling to festivals and other cultural events, etc. Heritage tourism presents tangible and intangible cultural assets to tourists [7].

The interdependent relationship between cultural heritage and tourism is well-documented in the literature [3,4,6,8,9]. Attracting tourists to heritage destinations is closely related to cultural revival in society and tourism [10]. In this sense, "heritage tourism exploits both tangible and intangible cultural assets, such as the physical embodiment of cultural values in the form of historic buildings, monuments, archaeological sites and cultural artefacts, as well as cultural traditions in the form of folklore, arts and crafts, local ways of life, social customs and cultural celebrations, all of which become the 'manifestations of heritage'" [10–12]. The relationship among destination communication, emotional engagement, and rational engagement is widely reported in tourism literature as a central component of effective tourism. Nevertheless, how could one promote engagement with a city or other location not considered a tourist destination? Engagement goes beyond involvement and commitment and comprises a proactive relationship between a tourist and the object or place of interest [13]. Compared to mega-events that need state funding, tourism based on or established on genuine events linked to the authenticity and unique aspects of the place can help preserve and emphasize local characteristics while promoting tourism progress, which is needed for lesser-known destinations [14].

A necessary condition for understanding a place's cultural heritage and significance is having in-depth knowledge of its history. We argue that the virtual representation of its POIs contributes significantly to exploring and understanding its heritage. A 360-degree virtual tour seems suitable for promoting a place, especially for its unknown and/or inaccessible locations and historical aspects.

In this work, we aim to examine how we could promote place attachment and tourist engagement with a location not considered a popular tourist destination. We explore this through a virtual tour experience targeted at the lesser-known history of the place. In other words, we have designed a virtual tour for a city that is not a widely known tourist attraction to explore how presenting its unknown aspects can spark curiosity and engagement. Visitors can experience the place at their own pace and from their perspective through the virtual tour, creating a personal and memorable experience.

Moving away from the common focus on antiquity, we attempt to promote unknown aspects of the city's history and POIs that are not well-known or considered touristic destinations. We also explore the role of pre-existing familiarity of the visitors with the city and the part promoting curiosity. Finally, we look into how presenting a different, unknown view or perspective of the city can elicit user interest, curiosity, engagement, and the desire to delve deeper into its history.

Section 2 presents the background on promoting unknown or inaccessible POIs, the role of curiosity as a motivation for heritage tourism, and existing 360-degree panoramic virtual tours. We then focus on the experience that was used in this study (Section 3), followed by the study methodology (Section 4) and results (Section 5). Section 6 discusses the results of the study and the limitations of the experience, and Section 7 concludes the paper.

2. Background

2.1. Curiosity as a Motivation for Heritage Tourism

Travel is most closely associated with tourism and relevant motivations, such as curiosity, discovery, and adventure. Traveling is considered a method for learning about the

place of interest; while exploring it, the specific location acquires personal meaning for the visitor. Although numerous studies have investigated factors and impact on tourism and tourist behavior, very few have analyzed motivations. Especially in the case of tourist behavior, studies have rarely analyzed the relationship between the level of the visitor's inner motivation to travel and the tendency to visit a place of heritage significance. Among the numerous motivations or other reasons behind the individual interest in traveling, curiosity and the curiosity-knowledge gap are undoubtedly considered possibilities. The literature on curiosity and travel is somewhat limited. However, from a historical and anthropological perspective, there have been works investigating the relationship between curiosity and travel since prehistoric times, to Marco Polo's travels, to today's travel tourism, the travel industry, etc. [15–17]. Pastermark [17] suggests that curiosity is a strong motivation for traveling. Xu et al. [18] have explored tourists' motivations through a gamified approach and identified six basic motivating factors: curiosity, exploring the destination, socialization, fun and fantasy experience, challenge, and achievement. Curiosity is differentiated into two types, where individual differences in the potential for curiosity experiences suggest a trait formulation, while individual differences in curiosity experiences suggest a state formulation [19]. Curiosity emerged as the most popular factor, especially regarding the activities available for users in that destination. A recent study focused on the causal relationship between curiosity as motivation, destination attributes, tourists' attitudes, and loyalty toward a specific destination [20]. The study found that curiosity represents the starting point of the potential tourist's decision-making process. Curiosity directly and strongly influences visitor attitude towards a destination, the individual's response to the holistic destination attributes, and the willingness to recommend or revisit other places.

One of the areas of play literature that appears to have the most direct applicability to pleasure travel is that associated with 'novelty', 'curiosity', and 'exploration'. Crompton [21], Bello and Etzel [22], and Lee and Crompton [23] have all noted the importance of novelty, while Mayo and Jarvis [24] recognized the significance of exploration as a motivation for pleasure travel. For example, Crompton [21] found that when investigating motives, "two primary cultural motives were expressed. They were novelty and education". Lee and Crompton [23] further suggested that, in seeking novelty, pleasure travelers exhibited "exploratory behaviour", which could be seen as "an overt expression of curiosity that is aroused by an environment perceived to be novel".

2.2. Promoting a Destination for Heritage Tourism

The level of tourism interest and engagement in a specific place depends, apart from curiosity and other relevant motivations of the visitors, on a combination of both physical and human geography that comes together, making certain locations more attractive than others. Therefore, according to Cook et al., it may be curiosity or a combination of natural and developed features and attractions of the location that meet visitor wants, needs, and expectations [25].

Hillier [26] describes the term settlement, "whether urban or suburban, as consisting of three interacting sets, the material complex, its people, and the intangible networks of relationships and actions". Creating a strong and legible place-identity based on a thorough, pluralistic, inclusive understanding of the place's cultural heritage is important in the promotion of its specific features and the attraction of visitors according to Tsakiri et al. [27]. They state that: "Place identity is neither a management tool nor an exportable product but the (tangible and intangible) expression of the collective memory and sense of continuity shared by members of a community" [27].

Several practices have been identified regarding the promotion of a place in the context of heritage tourism. These usually include mapping and representation by visual and other means to encourage exploration, curiosity, and understanding of the unknown aspects of an urban environment or cultural landscape to the extent that it highlights emotional and experiential consonances [27].

Traveling is closely associated with narration and, therefore, storytelling, as traveling acquires a starting phase, high points, troubles, and finally, a resolution [28]. Visiting a place may be important for the tourism industry and for the dissemination of cultural heritage. However, many places of cultural and archaeological significance remain physically inaccessible. In this case, a conventional approach to tourism development might not be sufficient, thus creating the need for a more experience-centered approach that draws upon “creative tourism”. According to Sharma [29], the major emphasis of this framework is on a “holistic tourism development approach which uses four pillars of sustainability (social, cultural, ecological and economic) together to create projects that work with, as well as within, an environment and lead to the growth of strong, integrated, healthy communities in every sense”. It creates an interactive connection between the people and the environment, which emphasizes the regional history and culture. Commonly, inaccessible places often become accessible through the means of technology.

2.3. Engaging with a Destination through 360-Degree Panoramic Virtual Tours

Virtual tours can be considered a possible action “that can improve the tourist attractiveness of a city, especially in the case of interesting unknown or inaccessible aspects” [10] as well as a common practice to address inaccessibility. Virtual tourism can be interpreted as “a digital presentation of the actual tourist attraction, where geometric properties of three-dimensional space are communicated to virtual tourists (also called tele-tourists) in such a way that they can provide immersion and telepresence from tourist objects that seem to be real” [30].

In the past decades, and especially after the outbreak of the COVID-19 pandemic, tourist attractions, archaeological sites, and museums all over the world have reached for new methods and technologies to promote the engagement of users from the comfort of their homes, creating a new, more sustainable direction for tourism as a sector: virtual tourism [31–33]. Platforms for virtual tours and experiences can bring cultural heritage closer to the public, utilizing the practical advantages of online technology and the virtual representation of space.

In their most basic form, virtual tours for cultural heritage and tourism are implemented with low-end technologies such as web applications or tailored to smart devices (mobile phones, tablets) to deliver content that enhances the virtual visitor engagement. These tours usually include photographs of the places, along with carefully curated and selected content about historical (information about figures, events, artifacts) or other types of information about the place (geographical, natural history, etc.) as well as other helpful material such as maps and guides. 360-degree panoramic tours are a type of low-cost virtual tour.

From a technical standpoint, according to studies, tours that use 360-degree panoramas can be an inexpensive and efficient solution for creating engaging virtual experiences with a sense of presence, without requiring special technical skills or expertise [34]. Since user engagement is unavoidably intertwined with users’ emotional investment in the experience, we also looked at studies exploring the emotional effect of 360-degree environments on users. A comparison by Higuera-Trujillo et al. [35] of 360-degree panorama photography, plain photography, and virtual reality environments showed that users tend to have better psychological reactions to immersive virtual environments developed using 360-degree panoramas, since they feel that they create the most realistic experience out of all compared methods. Additionally, a study by Chirico and Gaggioli [36] suggested that such virtual environments are capable of causing emotional responses that closely resemble the ones observed in users who experience the environment in real-life. Several studies have attempted to assess the physiological and psychological impact of immersive 360-degree video tours specifically, producing a wide range of results. One study by Wagler and Hanus [37] indicated that 360-degree video tours are capable of generating results equal to real-world experiences in regards to spatial presence and the emotional engagement of users. Other studies report that experiences with higher levels of immersion make users

respond better physiologically in terms of telepresence [38]; their psychological response and emotional engagement, however, do not seem to be necessarily related to the level of immersion as long as the experience carries a strong, well-developed narrative [38–40].

One aspect of virtual tourism is the creation of experiences designed around cities, catered to offering access to popular, high-profile tourist hotspots and more secluded, unreachable locations. For example, virtual tours of Rome [41], Italy, and Austin [42], Texas, offer access to the corresponding cities' most popular spots. The virtual tour of the Forbidden City of China [43] gives us a preview of the palace complex in the center of the Imperial city of China. In terms of content, users can access information in the form of text or audio as well as a gallery of related media for each panorama they visit. Other tours, such as the virtual walk across the city of Krakow [44], Poland, attempt to offer a complete overview of the city, providing access to multiple smaller tours of towns, neighborhoods, universities, museums, buildings, parks, and other tourist attractions. Sub-tours might include informational videos related to the site the user is currently viewing. These tours are not guided, as the user can explore the available viewpoints and hotspots at their own pace and in the order they want. They also do not have a particular narrative.

However, apart from these more "traditional" types of virtual tours, we can also find tours that present the locations of interest more unconventionally. One example is the virtual trekking experience of Khumbu [45], Nepal, where users can take a self-guided tour of the Everest region, exploring villages they would probably never have the opportunity to visit in real life. In terms of content, there is a stylized animated map with the available points of interest for every village, each of which leads to a panorama. Even though the tour is not guided, there is narrative-based audio for most panoramas, where a villager gives information about the location from their point of view. Another example is the Virtual Angkor project [46,47]. This uses 360-degree videos of 3D animated models recreating the Cambodian metropolis of Angkor around 1300 CE. The structure of this experience differs from experiences examined so far in that there are no informational hotspots reachable from within the 360-degree panoramas. There are, however, thematic sections that provide information and media related to different aspects of ancient Angkor.

3. Experience Design

3.1. The Use Case of the City of Eleusis

Eleusis is a small city of about 25,000 inhabitants located 18 km northwest of Athens, Greece. Its history dates back to several centuries BCE, and in ancient times it had a strong participation in Greece's political and religious life. Its recent history is also diverse, including its recent industrial past. Having become a point of fusion between different cultures and the center of controversy concerning its complex environmental issues, Eleusis has a lot to offer a visitor interested in the distant and recent past.

Eleusis is a city where the effects of development on the environment are very prominent. The environmental pollution caused by the factories in the area has even affected the important archaeological site in the center of the city. Eleusis has a rich history, being a sacred city where the Eleusinian Mysteries took place every year during the Greek and Roman antiquity and initiations were held for the cult of Demeter and Persephone. This rich history and important site have been overshadowed by the industrial character of the city and the environmental destruction of the past decades, with a significant impact on tourism [48]. From the 1960s to the 1980s, the natural environment of Eleusis suffered major degradation. This resulted, on the one hand, in the population becoming particularly involved in matters regarding the environment. On the other hand, the city has been stigmatized as an industrial zone with little to offer a potential visitor. In recent years and while the city is gradually coping with the aftermath of intense and thoughtless industrialization, there has been an attempt to improve conditions for the citizens of Eleusis, overcome the established bias, and develop the city as a touristic destination to promote its rich heritage.

The research project Pros-Eleusis (Personalized ROuteS in Eleusis: <https://proseleusis.com/>, accessed on 20 November 2022) has explored ways to engage visitors with Eleusis

both on-site and remote. It focused on the design and implementation of software tools, content, and methodologies to facilitate the exploration of the numerous points of interest (POIs) in a city where the past and the present meet, attempting to provide a path toward a sustainable future for the area. The creation of a 360-degree panoramic virtual tour has been among the project outcomes. The virtual tour aims to engage the visitor with the city and the mostly unknown part of its modern history, namely, the environmental history. It attempts to present this history while highlighting unknown or inaccessible POIs of the city related to its environmental issues.

In this study, we use this virtual tour as our case study to explore the effectiveness of promoting engagement with a city through the virtual presentation of unknown and inaccessible points of interest.

3.2. Interface and Technology of the Web App

The virtual tour experience is designed to utilize 360-degree panorama photography for the representation of the different POIs in the city. These may be selected either from the map available on the bottom left of the screen in Figure 1a or directly from within the panorama the user is currently located in, by clicking on the corresponding arrow indicators in Figure 1b. Information hotspots can be found on each 360-degree panorama image (Figure 1b) and accessed by clicking on the corresponding “i” icons, which offers detailed information as well as a focused image view of each hotspot. Information regarding the selected hotspot is provided via the digital storytelling window located on the bottom right of the screen. Regarding the user experience, the application’s interface is designed to offer maximum flexibility during the virtual tour. Users can explore the available POIs at their own pace and choose to view as many as they wish and in the order they like. The digital storytelling window works parallel to the user’s navigation, giving users the freedom to control the progress of the storytelling.

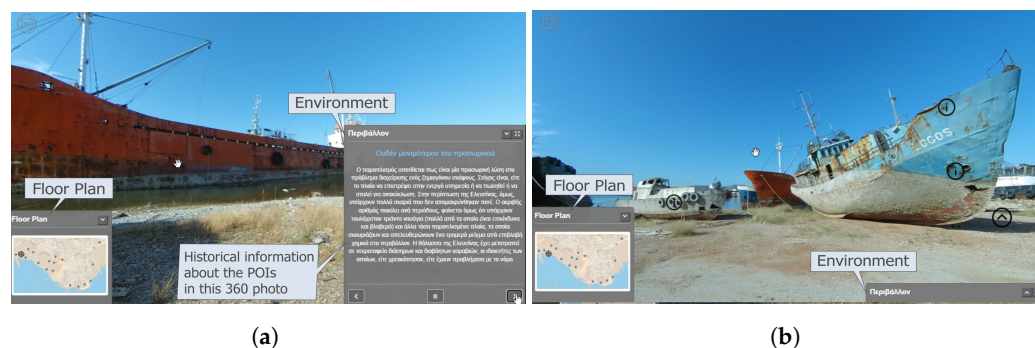


Figure 1. 360-degree virtual tour. (a) The map and narration window are visible; (b) The “i” icons can be used to view content relevant to the image’s details, whereas the arrow moves towards another POI.

From a technical standpoint, the application is a client-side web application based on the model–view–controller (MVC) architectural pattern. It is a single-page app, developed with widely used web technologies such as HTML, CSS, JavaScript, AngularJS, jQuery, Bootstrap, as well as other plugins and extensions. Apache CouchDB, an open-source document-oriented NoSQL database, is used for the storage, processing, and retrieval of data. REST API is used for the communication between the application and the database.

3.3. Narrative Content

The content of the experience encompasses the social, cultural, and economic life of Eleusis in relation to the possibilities and limitations imposed by the industrial development, landscape, and nature. The central objective of the content narrative is to communicate the impact of the industrial development of the area in the environment of Eleusis and the lives of its people. The content contains information about several POIs closely related to the subject of industrial development and environmental changes.

Throughout the narrative, the virtual tour takes visitors to routes that intertwine with the environmental battles fought between the urban fabric, the industrialization of the area, and the natural landscape.

The tour starts with an introductory text at the Monument of Fallen Soldiers of Eleusis, located at one of the city's central historical squares. Then users are given a list of 14 monuments and locations to visit at their own pace and sequence; they can skip at any time and end the experience. Users can choose which locations to visit and what type of information they will listen to. The experience surrounding the environmental issues of Eleusis covers an intricate network of POIs, including both old and active industrial sites, mines, and natural landmarks, telling the story of a region shaped by the forces of industrial progress, its residents, as well as nature.

The approximate experience duration is 40 min if the user visits all POIs and listens to the full content of each POI.

4. Evaluation Methodology

For the evaluation of the virtual tour of the city of Eleusis, we organized a user study with invited participants who provided their feedback in an online questionnaire. In this section, we present the process, questionnaire, and participant profile.

4.1. Process

We circulated an invitation to the authors' personal and professional contacts via social media, in which we briefly presented the virtual tour application, the project and study objectives, and the process the participants would have to follow. More specifically, those interested in participating would have to: (a) follow the experience, explore different POIs, and listen to the relevant content as they wished, skipping parts if they felt they were not interesting enough; (b) stop the experience when they wished; and (c) record how much time they spent with the experience and then fill in the online questionnaire. It was clarified to the users that the study was anonymous, and they were asked to complete an online consent form.

Questionnaire

The questionnaire consists of open- and closed-ended questions grouped in two main parts, (a) participant profile and (b) captivation, as well as affective engagement and reflection questions.

The first part, which records the participant's profile, contains 18 questions, including:

- Demographics (age, gender);
- Interest in history and archaeology. We decided to record this information to examine if it affects in any way the general user experience and time spent with the virtual tour;
- Connection with the city of Eleusis. As above, pre-existing interest in the city may be a factor in engagement and the general user experience, so it was included in our analysis.

The second part consists of 20 questions designed to record general user experience aspects, captivation, and engagement with the concept and content of the experience as well as affective aspects, reflection, and perspective-taking in relation to the broader topics presented with emphasis on the crucial environmental issues of the city. For the purpose of our analysis, these questions are divided into three main categories, curiosity, engagement, and reflection, as also shown in Table 1. The participants were asked to record the time spent with the experience in the questionnaire, comment on any issues they encountered, and offer suggestions for improvements in the relevant open-ended questions.

Table 1. Summary of results (average and standard deviation) for the questionnaire statements on visitor engagement. The statements were Likert-scale from completely disagree (1) to completely agree (5).

	Statement	Average and Standard Deviation
Reflection	S1. The experience made me reflect on issues I would normally not think about.	AV = 3.6, SD = 1.2%
Reflection	S2. The experience changed my view of the city of Eleusis.	AV = 3.3, SD = 1.2%
Engagement	S3. The experience made me observe more closely the points of interest.	AV = 3.7, SD = 1.2%
Reflection	S4. I learnt about the city of Eleusis, something that I would like to remember.	AV = 4.2, SD = 0.9%
Curiosity	S5. The experience inspired me to want to learn more about Eleusis.	AV = 3.9, SD = 1.1%
Engagement	S6. I enjoyed the experience.	AV = 3.4, SD = 1.2%
Engagement	S7. I had the sense that time passed quickly.	AV = 2.9, SD = 1.0%
Engagement	S8. The content of the experience was related to issues that are relevant to me.	AV = 3.7, SD = 1.0%
Engagement	S9. I would like to talk to others about this experience.	AV = 3.3, SD = 1.3%
Curiosity	S10. I felt curious about the topics presented in the experience.	AV = 3.7, SD = 1.1%

For the construction of the questionnaire, we drew on the methodology applied in previous studies to create an evaluation instrument that would help us explore our research questions about the behavior and attitudes of our participants in relation to the virtual tour. For the reflection and engagement aspects, we adapted questionnaires used to measure historical empathy, mainly the one used in [49,50]. Historical empathy [51] is a model focusing on facilitating a cognitive process leading to affective engagement with history. It starts with critical reflection on historical facts (historical contextualization), then moves to a deeper understanding of different perspectives of the people of the past (perspective taking) and, ultimately, establishes an affective connection with these people, prompting users to understand them as individuals with their own emotions, values, and worldview [52]. For curiosity, we relied upon the state-trait curiosity inventory [19] to select and adapt questions that would help us record the state curiosity level induced by the tour. The complete questionnaire can be found at <https://osf.io/n2bxh>, accessed on 22 March 2023.

4.2. Participants

Thirty-one users participated in the study, eighteen of whom were women, twelve were men, and one preferred not to disclose. In terms of age distribution, the majority of the participants were between 26 and 55 years old (Table 2).

Table 2. The age distribution of the study participants.

Age Group	Number of Participants	Percentage of Participants
<25	2	6%
26–35	8	26%
36–45	11	35%
46–55	8	26%
56–65	2	6%
>65	0	0%

4.2.1. Cultural Site Visiting Habits

Most of the study participants reported that visiting a cultural site is something they do “often” (52%) or “sometimes” (42%), with only 2 reporting “rarely”. 84% of the participants visit museums or other cultural sites while traveling, and 82% do so also around their location of residence. In terms of the aspects that are interesting to them when visiting a new place, as shown in Table 3, the history of its people is of interest to 94% of the participants, followed by the natural environment (74%) and the local cuisine (65%).

Table 3. Aspects of interest when visiting a new location.

	Number of Participants	Percentage of Participants
The history of its people	29	94%
The natural environment	23	74%
The local cuisine	20	65%
Other: The urban environment	2	6%
Other: Archaeological remains and the history of the place	2	6%

Seventeen participants (55%) reported that they visit cultural sites online somewhat regularly (23% “often” and 32% “sometimes”). Another 32% “rarely” visit online, whereas 13% never do. The reasons for visiting online are shown in Table 4. Interestingly, none of the users said they visit this type of online resource to prepare for the visit. They visit primarily because they are interested in the topic or cannot access the site for a physical visit. Two participants mentioned professional reasons, with one specifying that they would like to regularly see the technology progress in this sector.

Table 4. Reasons for visiting a virtual museum or cultural site.

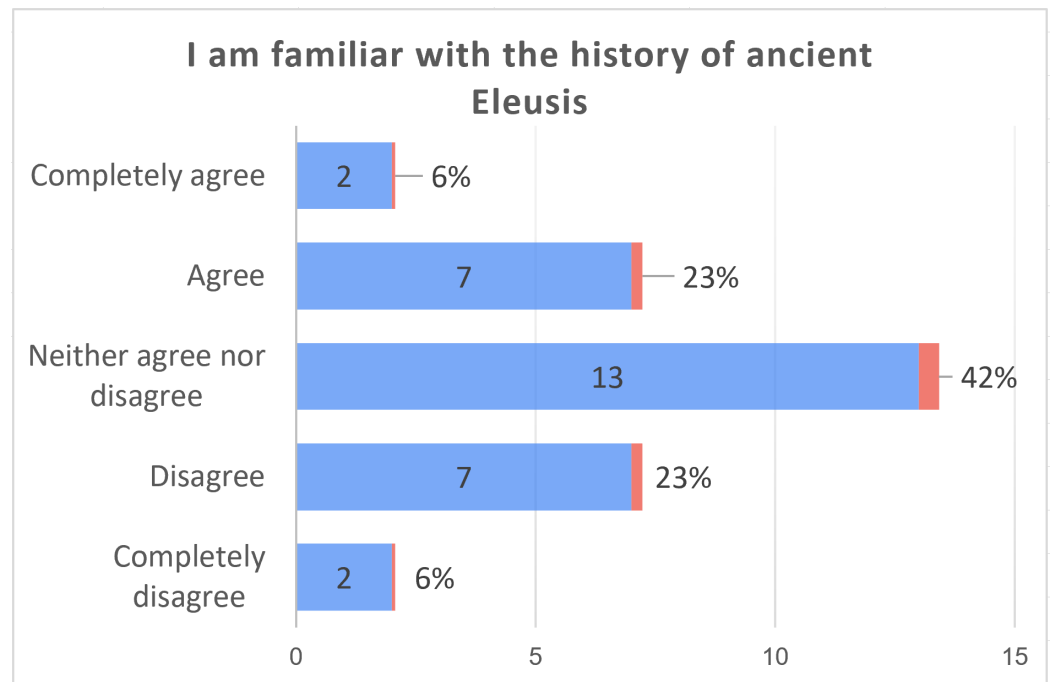
	Number of Participants	Percentage of Participants
Because I am interested in the topic	13	42%
To prepare for the physical visit	0	0%
Because a physical visit is not possible	10	32%
All of the above	12	39%
(Other) Because it is relevant to my work	2	6%

4.2.2. Connection with the City of Eleusis

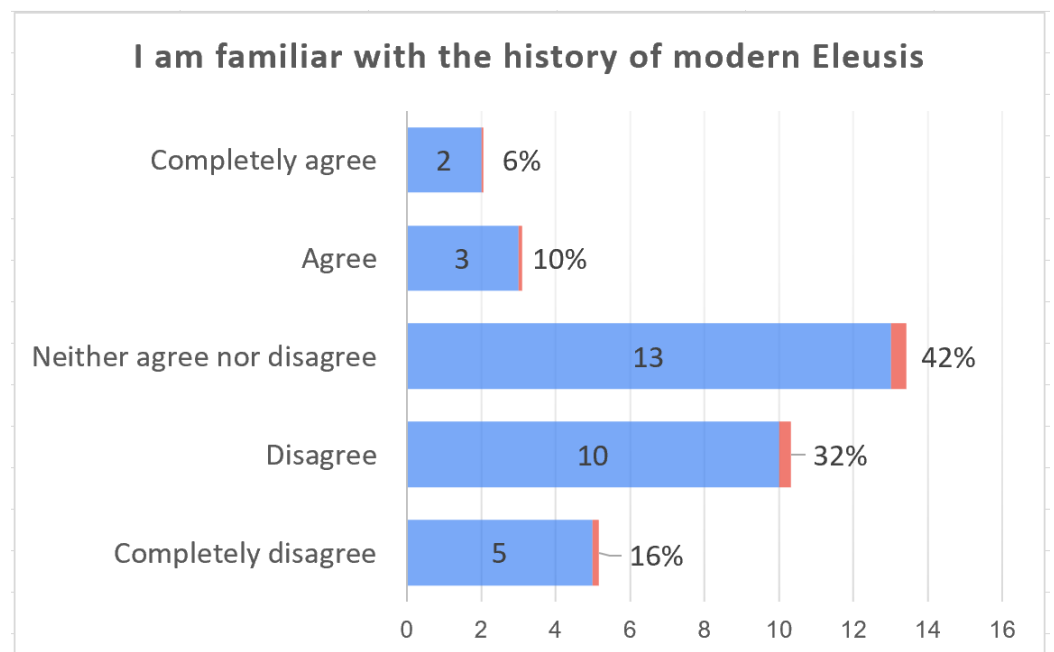
In terms of their connection to the city of Eleusis, we note a variety of responses. Except for one participant who has never visited Eleusis, the rest have visited it “once” (32%), “a few times” (26%), “several times” (26%), and “every day” (13%). As also shown in Figure 2, most participants reported a medium degree of familiarity with the history of Eleusis, with some being slightly more knowledgeable about its ancient history. More specifically, in the three relevant statements, the average score (AV) and standard deviation (SD) in a Likert scale from 1 (completely disagree) to 5 (completely agree) was:

- “I am familiar with the history of ancient Eleusis”: AV = 3, SD = 1;
- “I am familiar with the history of modern Eleusis”: AV = 2.5, SD = 0.9;
- “I am familiar with the issues the citizens of Eleusis face”: AV = 2.7, SD = 1.1 (Figure 3).

Eleusis is more well-known for its ancient history and less for its recent history.



(a) Familiarity with the ancient history of the city.



(b) Familiarity with the modern history of the city.

Figure 2. Responses concerning the participants' familiarity with the ancient and the modern history of the city of Eleusis.

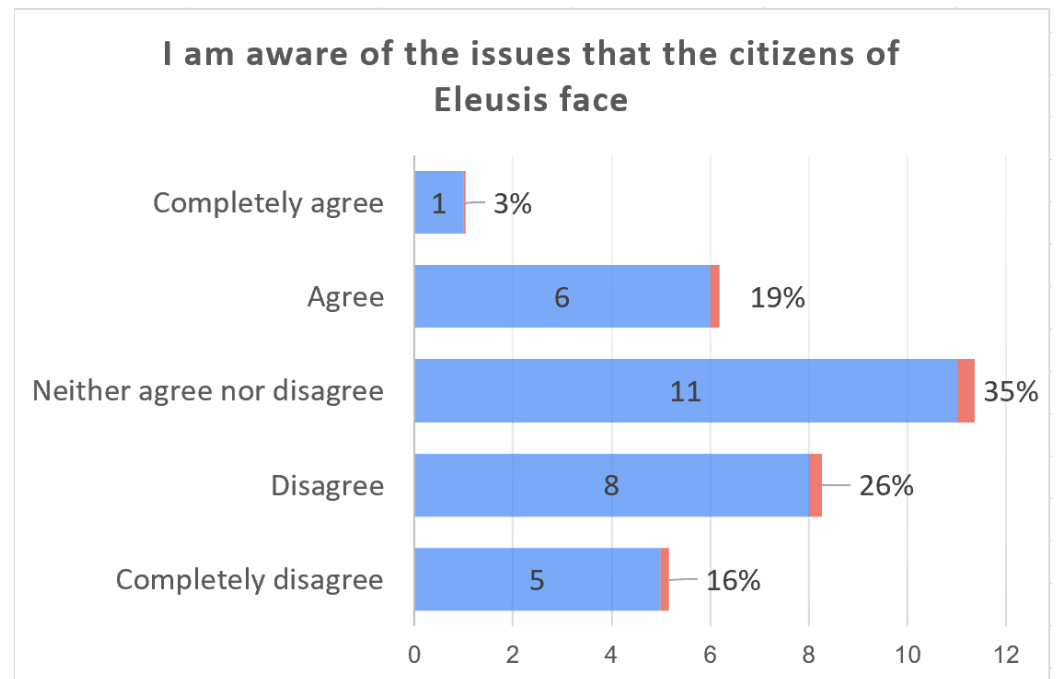


Figure 3. Responses in relation to the participants' familiarity with the current issues of the city.

5. Analysis and Results

The analysis of the results included both quantitative and qualitative results. For the quantitative results of the questionnaire, the average score and standard deviation for the Likert-scale statements have been calculated and are available in Table 1. Appropriate statistical tests were performed to examine the effect of certain aspects of the participants' profile with user engagement, as presented in the remainder of this section.

5.1. Curiosity

Our results suggest that the experience motivated curiosity about Eleusis. Users felt "curious about the topics presented in the experience" (S10 in Table 1) and inspired to learn more (S5 in Table 1), as also shown in Figure 4.

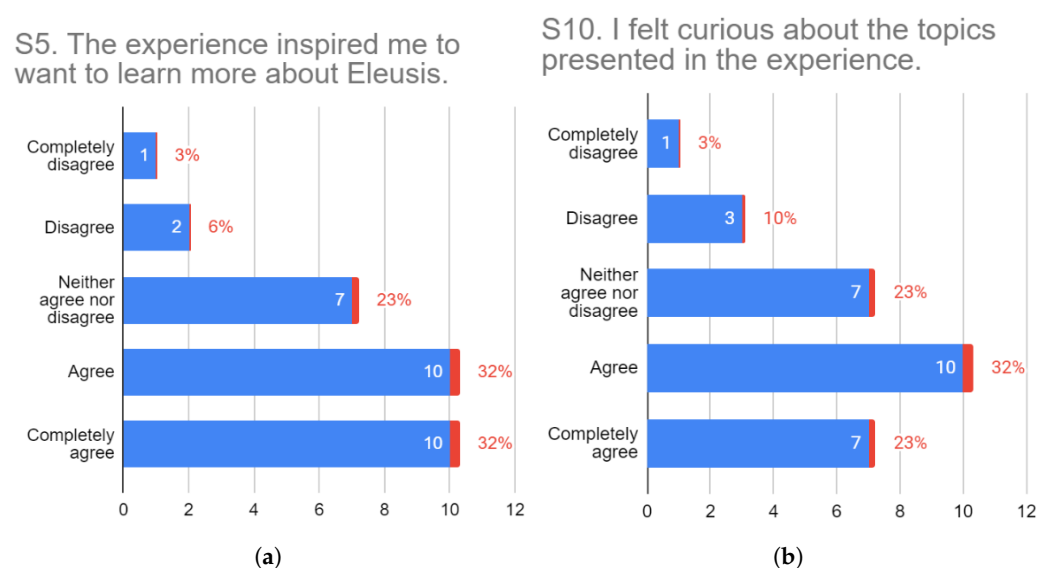


Figure 4. Questionnaire statements related to curiosity. (a) Results for Statement 5 of curiosity questionnaire; (b) Results for Statement 10 of curiosity questionnaire.

Curiosity was also one of the strongest feelings evoked by the experience, as stated by 61% of the participants (Figure 5).

During the experience I felt...

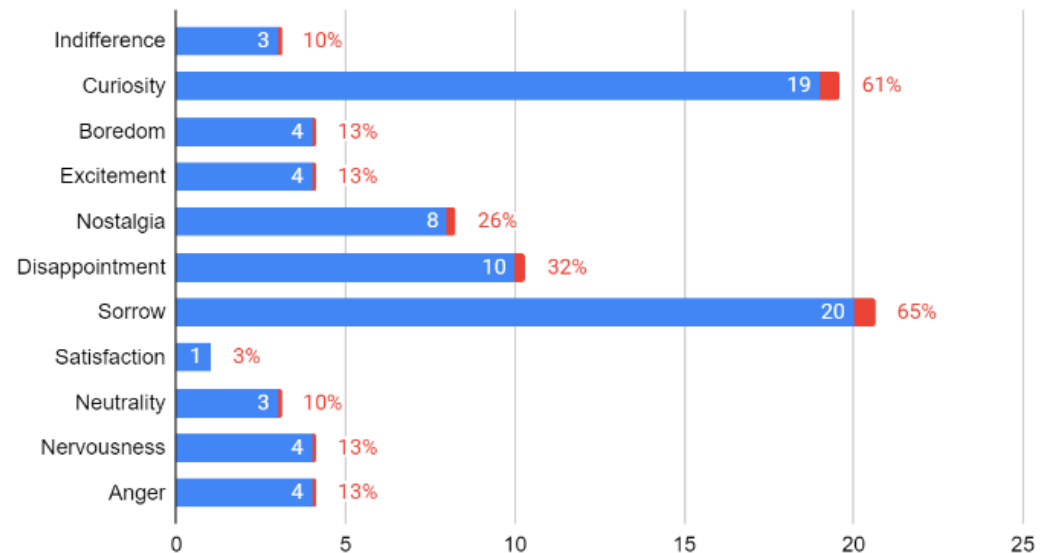


Figure 5. Feelings evoked by the experience as reported by the participants.

Results from the open questions also supported curiosity as a motivator for engagement with the content, as a user stated, “I chose not to follow the map linearly, but chose any point of interest that piqued my curiosity, at random”. This seems to point to curiosity as the underlying reason for interest in specific locations and learning more about the subject.

5.2. Engagement

Approximately half of the users (15) stated that they completed the experience in the sense that they passed by all the POIs on the map. The remaining 16 mentioned that they did not, giving different reasons:

- They did not have enough time to complete (4);
- They found the narrator’s voice tiring or annoying (3);
- The narration was too long (7);
- There was not enough visual content at each POI (3);
- Connection of the narrative content to the POI (2).

Figure 6 presents the experience duration as self-reported by the participants. Considering that the approximate duration to listen to the content of each POI entirely is about 40 min, 6 users (19%) seemed to have stayed in the virtual tour longer, possibly to explore the panoramic views more after the end of the narration. Most participants (46%) spent 20–40 min with the experience. Only 2 (6%) spent under 10 min. The questionnaire statement “S7. I had the sense that time passed quickly”, with an average AV = 2.9 (Figure 6), on the whole, reflects the sense that the experience was too long for some users.

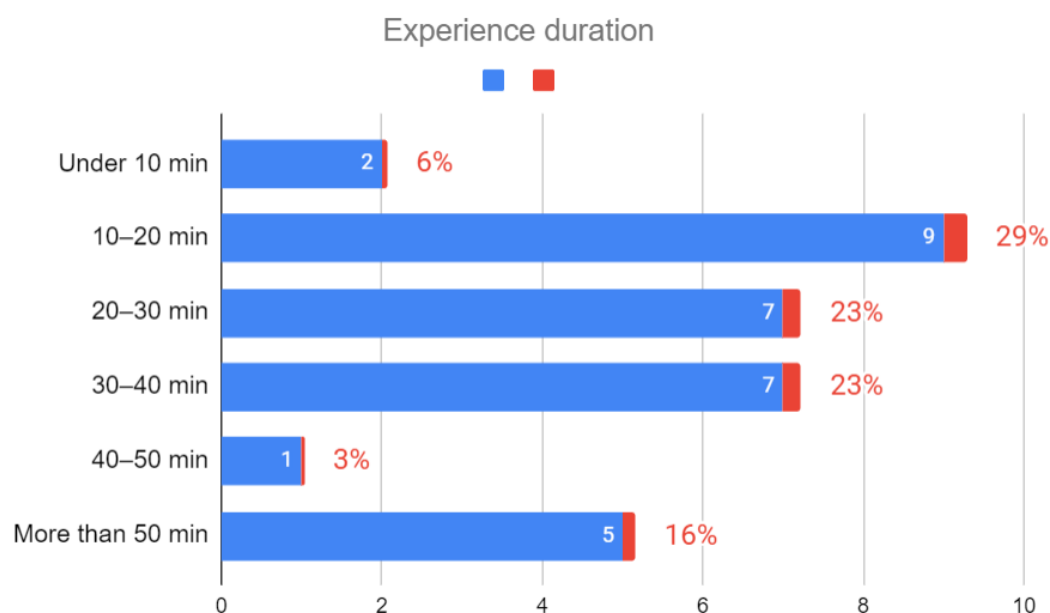


Figure 6. Experience duration as reported by each participant.

Even though half the users did not complete the virtual tour by visiting all the POIs, taking into account the significant length of the experience and amount of audio content, the fact that the majority did dedicate significant time to exploring is indicative of engagement.

The questionnaire results, as presented in Table 1, provide insight into the participants' outlook on the experience. As shown in Figure 7, 48% of the users enjoyed the experience (48%), 23% were neutral, and 21% did not enjoy it (Figure 7c). However, only 2% did not consider the experience relevant to them (Figure 7d). The narrative content of the experience, referring to challenging social and environmental issues of the recent past, resulted in some participants having feelings of sorrow (65%), disappointment (32%), or anger (13%) (Figure 5). Some participants reported, as already mentioned, curiosity (61%), satisfaction and excitement (14%), or nostalgia (26%). Negative or positive emotions indicate an affective connection with the experience, which strongly indicates that it was engaging for them. Smaller percentages of the participants reported indifference (10%), boredom (13%), or neutrality (10%). According to the responses to statement S3, 58% of the users felt that the experience made them observe the POIs more closely, and 26% were neutral (Figure 7a).

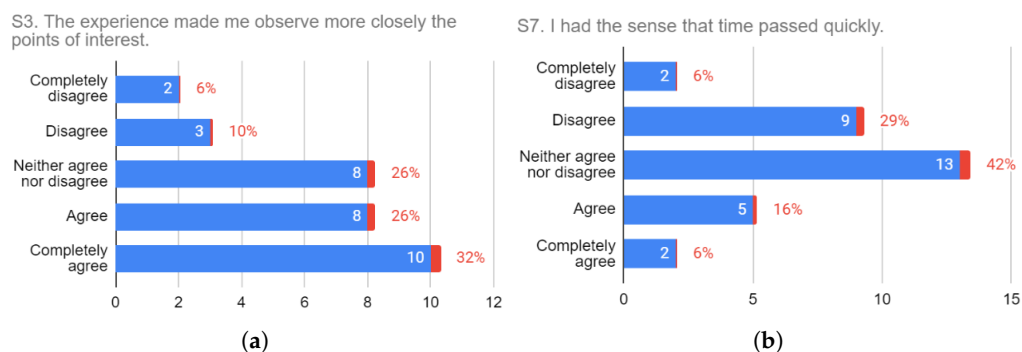


Figure 7. Cont.

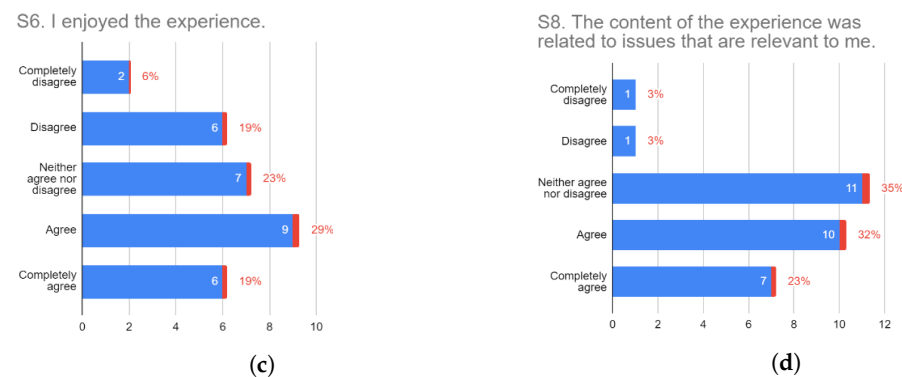


Figure 7. Selected questionnaire statements related to participant engagement. (a) Results for Statement 3 of questionnaire; (b) Results for Statement 7 of questionnaire; (c) Results for Statement 6 of questionnaire; (d) Results for Statement 8 of questionnaire.

5.3. Reflection

As already discussed in the previous section, the experience content focusing on the recent history of Eleusis and tackling complex environmental and social issues had an emotional impact on the participants. 65% reported feelings of sorrow, 32% disappointment, and 13% anger (Figure 5). Disappointment and sorrow were among the most prominent reported feelings, along with curiosity. This affective reaction indicates a more profound reflection on the presented issues. The questionnaire statement S1 confirms this. Figure 8a shows that more than 50% of the participants felt that the experience made them reflect on issues they did not usually think about, whereas 29% were neutral and 15% were negative. Similarly, many users felt that the experience changed their view of the city of Eleusis (45%) (Figure 8b), and the vast majority (81%) felt that they learned something memorable about the city (Figure 8c).

These indications of reflection resulting from the experience are also confirmed by the analysis of the open question results. Users were able to reflect on issues regarding environmental destruction by heavy industry. “The industrial history of the city led to environmental destruction, which had a negative impact on the quality of life of the citizens”.

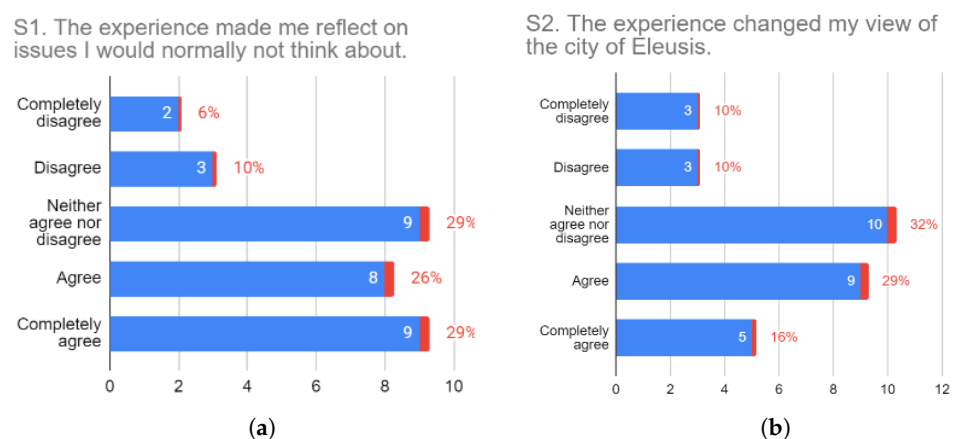


Figure 8. Cont.

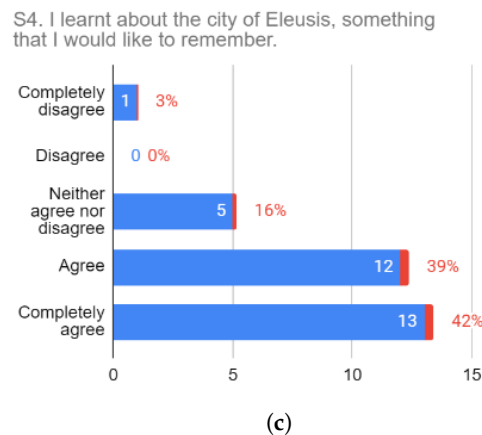


Figure 8. Questionnaire statements related to participant reflection. (a) Results for Statement 1 of questionnaire; (b) Results for Statement 2 of questionnaire; (c) Results for Statement 4 of questionnaire.

This type of mental engagement with the content in the form of perspective-taking and reflection on issues that the participants may not have considered in the past is a strong indication that the participants will remember the city, will form a deeper connection with it, and most probably will seek to visit and explore it further.

5.4. The Effect of Curiosity on Engagement

As part of the analysis process, we examined possible correlations between the participants' self-reported curiosity about the tour content with engagement. To this end, we performed the following tests:

- Kruskal–Wallis non-parametric tests to examine whether there was a difference in the score for engagement-related statements between those participants who reported feeling curiosity during the experience vs. those who did not (see Figure 5). These tests revealed no significant difference between the groups regarding self-reported engagement and reflection.
- Pearson correlation tests to examine the effect of the Curiosity-related statements S5 and S10 on the Reflection and Engagement-related statements of the questionnaire.

As shown in Table 5, those that felt that the experience inspired them to learn more about Eleusis (S5) reported higher scores in all the other statements related to engagement and reflection. However, this is not the case for the statement, "I felt curious about the topics presented in the experience".

Users experiencing curiosity were more eager to learn about the city of Eleusis and expressed emotional connection. Curiosity-oriented users were more likely to engage with the content and extend their experience. This seems to be similar to the type of curiosity demonstrated in travel. As also discussed in Section 5.3, learning about the unknown aspects of Eleusis seemed to expand users' levels of curiosity, which can result in greater motivation to engage with the content and explore information that would result in intrinsic rewards, such as memory of the place and reflection.

Table 5. Pearson correlation tests between curiosity-related statements and those related to engagement and reflection. The table presents the significant results.

		Pearson Coefficient (Z) and Asymptotic Significance (p)
S5. The experience inspired me to want to learn more about Eleusis.	S1. The experience made me reflect on issues I would normally not think about.	$Z = 0.429, p = 0.016\%$
	S2. The experience changed my view of the city of Eleusis.	$Z = 0.406, p = 0.024\%$
	S3. The experience made me observe more closely the points of interest.	$Z = 0.561, p = 0.001\%$
	S4. I learnt about the city of Eleusis, something that I would like to remember.	$Z = 0.562, p = 0.001\%$
	S6. I enjoyed the experience.	$Z = 0.459, p = 0.009\%$
	S7. I had the sense that time passed quickly.	$Z = 0.556, p = 0.001\%$
	S8. The content of the experience was related to issues that are relevant to me.	$Z = 0.456, p = 0.011\%$
	S9. I would like to talk to others about this experience.	$Z = 0.468, p = 0.008\%$
	S4. I learnt about the city of Eleusis, something that I would like to remember.	$Z = 0.457, p = 0.015\%$
S10. I felt curious about the topics presented in the experience.		

5.5. The Effect of Familiarity with the City on Engagement

In this study, we attempted to examine the effect of pre-existing familiarity of the users on user experience and engagement. The participant profile recorded the user's familiarity with the history of ancient Eleusis, modern Eleusis, and the city's current issues in separate Likert-type statements with scores 1 to 5 (see Section 4.2.2). For the analysis, we performed Pearson correlation tests between these three statements and the questionnaire statements related to user engagement. We also used Kruskal–Wallis non-parametric tests to examine if familiarity with the city has any effect on the experience duration, whether the users completed the experience, or whether they reported feeling curiosity during the experience. The previous tests did not reveal any effect of familiarity on any of the four examined aspects. The only exception was the following four questionnaire statements, the scores for which are correlated with specific aspects of familiarity as follows:

- “S1. The experience made me reflect on issues I would normally not think about” is correlated with “familiarity with ancient Eleusis”, with asymptotic significance $p = 0.004$ and Pearson coefficient $Z = 0.499$.
- “S4. I learnt about the city of Eleusis, something that I would like to remember” is correlated with “familiarity with ancient Eleusis”, with $p < 0.05$ and $Z = 0.392$.
- “S9. I would like to talk to others about this experience” is correlated with “familiarity with ancient Eleusis”, with $p < 0.05$ and $Z = 0.359$.
- “S8. The content of the experience was relevant to issues that are relevant to me” is correlated with “familiarity with Eleusis issues”, with $p = 0.017$ and $Z = 0.432$.

Users were more familiar with ancient history than with modern history, which is typical, since monuments of antiquity are promoted more. Familiarity with the place, however, seemed to play little to no effect on the engagement with the experience. This could be due to the familiarity principle affecting decisions and preferences. Since participants were familiar with Eleusis as an urban city, their attention was more focused on historical information.

6. Discussion

Considering the evaluation methodology and results presented in Sections 4 and 5, respectively, this section discusses some of the most prevalent tendencies observed among participants and some of the most common comments submitted during the evaluation.

According to Table 4, 32% of participants seem to take virtual tours of cultural sites and museums due to not being able to pay them a physical visit. This percentage suggests that a significant number of users are looking for an experience resembling the real one as closely as possible, which, according to previous research [35,36], 360-degree panoramas are capable of doing by offering a photorealistic representation of the site.

As reported in Section 5.2 and Figure 5, the majority of users seem to have developed negative or positive emotions while taking the virtual tour. Even though the experience did not offer high levels of immersion, the narrative content of the experience was able to promote the participants' affective connection with the city and get them to engage with its social and environmental issues, a fact which is also supported by previous research [38–40]. Curiosity seemed to play a crucial role as an intrinsic motivation that led to the spontaneous exploration of the points of interest and the seeking of information, with 61% of participants reporting to feel curious about the topics introduced during the experience (Figure 5). To get information, users engaged in exploratory behaviors that resulted in acquiring such information. Regarding user engagement, user feedback suggests that the experience was quite effective in sparking participants' curiosity in the city. It was a motivational factor in encouraging them to explore the content offered in the virtual tour thoroughly. The participants' familiarity with the city did not seem to affect user engagement significantly. It did, however, appear to influence the set of hotspots users chose to interact with based on their content being related to either contemporary Eleusis or historical Eleusis.

Even though the experience performed well in terms of user engagement, several suggestions for improvements were made by users, especially regarding the informational content's structure and design. Considering participants' reports about the informational text and audio at each POI being quite long and disconnected from their accompanying visuals, it is necessary to focus on designing the tour's content more carefully. More specifically, when it comes to variety, adding a larger photo gallery at each POI and enriching and restructuring the textual information into more detailed sections would provide users with a wider set of options, making the experience more versatile. Regarding the tour's design, there is room for improvement at a conceptual level as well. Designing and incorporating linking mechanisms that connect POIs, locations, and the narrative could drastically improve the user experience, adding a clearer intent and purpose to the user's exploration. Moreover, since users follow the tour virtually on their personal computers, access to content sources and related material can be offered via links to external web pages. Anyone who wants to dive deeper into a topic or get to know different aspects of the location better can do so in a separate tab. These are only a few ideas we can implement to enhance users' interaction with the available content, thus making the overall experience more engaging.

Limitations

This study used only one 360-degree virtual tour context for the survey: the city of Eleusis. Further testing of other use cases is needed, as results and outcomes may differ in different contexts. Different people may have different interests in different 360-degree virtual tour contexts. The experience content itself, as well as the content production, may have affected the outcomes. As an example, several users commented negatively on the narrator's voice. Additionally, the lack of observations while users viewed the tour experience did not allow us to analyze user reactions and behavior. Data collection through observation of the users during the experience can greatly contribute to a more comprehensive and in-depth understanding of how they might have perceived the virtual tour.

7. Conclusions and Future Work

In conclusion, in this paper, we presented our approach to promoting user engagement and stimulating users' interest in locations that are typically not popular tourist destinations, using a virtual tour that utilizes 360-degree panoramas and a non-guided narrative. Despite

being around for decades in multiple contexts and formats, virtual tours are yet to be considered a good alternative to the real cultural heritage and tourist sites they represent. However, in the aftermath of the global pandemic of COVID-19, most cultural heritage sites and tourist attractions have already acquired some type of online virtual tour. These were regarded as a cost-effective and convenient solution to offer potential visitors access to the site while the actual sites remained closed. In the case of our virtual experience, the evaluation results indicate that, despite its weaknesses, it was able to spark curiosity among users and activate their inner motivation to explore the city of Eleusis and its unknown aspects. With the implementation of a few improvements, we are confident that our proposed tour approach combining 360-degree photography with a narrative shows true potential to create beautiful and engaging experiences capable of captivating users who might be up for an “adventure” from the comfort of their homes.

The outcomes of the study presented in this work are promising for the use of virtual tours combining 360-degree panoramas and narratives to promote visitor engagement. There is a need to further explore the potential of this genre through more studies to identify design elements and best practices when designing content. The interactivity of the 360-degree photographs as well as the flexibility to combine other multimedia elements, including 2D photos, videos, or audio as part of hotspots, supports versatility in design and the possibility of experimenting with different approaches that maximize the potential of the medium. Sociality may be an additional factor to intensify the engagement with the experience. Cultural visits are mostly social experiences, as tourists rarely visit a destination alone [53,54]. Supporting group visits for virtual tours of this type and adding user-to-user interaction in the experience design is, consequently, another promising direction of research. Virtual tours based on 360-degree panoramas are a cost-effective medium, the potential of which has not yet been fully explored, and we hope our work will become an incentive for additional future studies on this topic.

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