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Josep M.Duart, Elena Trepule

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Editors:
Josep M. Duart
Elena Trepule

Editorial co-ordination:
Gabija Kvieskaite
Carlos Madrid

EDEN DLE Secretariat
Roosikrantsi 2, 10119, Tallinn, Republic of Estonia
E-mail: secretariat@eden-europe.eu
https://eden-europe.eu/

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PERSONALIZED VIRTUAL REALITY EXPERIENCE WITHIN MUSEUM EDUCATION CONTEXT: THE INCLUSIVE MEMORY WEB APP

Antonella Poce, University of Modena and Reggio Emilia,Italy

Maria Rosaria Re, University Roma Tre, Italy

Carlo De Medio, University Roma Tre, Italy

Mara Valente, University Roma Tre, Italy

Abstract

It is a fact that museum needs are changing, and the arrangement of visitor experiences in both physical and virtual settings today centres around the idea of personalization. The present paper aims at presenting the results of a personalized virtual reality museum education experience. We realize an inclusive and personalized virtual environment realized through the integration of different technologies with the Frame-VR application for the Tito Rossini permanent collection at the Department of Educational Sciences of Roma TRE. Following a lecture, 183 students participated in the remote experience, which consisted of an initial questionnaire, a virtual tour, and a final questionnaire. Significant correlations between the visitors' artistic preferences and personality traits were discovered, establishing the indicators for a user model. In addition, the system was also positively evaluated from the point of view of usefulness and usability by the participants through direct feedback.

Keywords:

Museum Education, Virtual Reality, Personalization, Webapp, Inclusion.

Introduction

The current world situation with the ongoing Covid-19 pandemic has highlighted the great importance of the use of technology in the field of education (Ting et al., 2020). In particular, technology-enhanced learning environments have been increasingly widespread, especially thanks their ability to develop transversal key competences through collaborative learning experiences, in formal and non-formal education contexts (Marion Gruber 2015). As stated by Pavolova (2015) and Pozzi (2015), these systems succeed in optimizing and supporting learning processes by using technology to provide materials, a social platform and digital learning tools even within museum settings. Moreover, museum education, as non-formal education context, can play a pivotal role in the acquisition of specific knowledge and promotion of 4C skills (Critical Thinking, Communication, Collaboration, Creativity) (Trilling & Fadel, 2015; Poce, 2018) in a life-long learning view, thus trying to achieve the learning objectives (in terms of knowledge, skills and attitudes) that were not reached due to the closure of schools and universities during the spread of the pandemic (Azevedo et al., 2020). Furthermore, the European Commission has been highlighting informal education for many years, recognizing the impact that cultural heritage can have in education supported by modern technologies (European Commission, 2000, p. 7). A fundamental role in the field of technology-enhanced learning environments within museum education context is played by Augmented Reality (AR) and Virtual Reality (VR) technologies. Many research has shown the efficacy of the use of AR and VR within museum education context to increase professional and soft skills within visitors (Qian & Clarck, 2016), together with social and cultural inclusion development (Grau, Coonless & Ruhse, 2017). In the last 6 years, many AR and VR applications have been realized in this direction (Cellan-Johns, 2016), and in terms of personalized user experience (Limongelli, 2015). In the museum education fields, personalization is often linked with the problem of using user data to create the concept of personas, i.e. models that represent aggregates of target users with common characteristics (Miaskiewicz & Kozar, 2011). These personas can be deduced through two approaches: implicit, indirect visitor feedback (camera footage or eye-tracking) (Antoniou & Lepouras, 2010); explicit direct feedback from the visitor normally through questionnaires; questions can be direct ones about museum interests (e.g. favorite works) or indirect ones aimed at improving visitor engagement (Antoniou et al., 2016). Within this field, important results have

been achieved in previous research of the authors (Poce et al, 2019), where, through the Inclusive Memory Web App, the central theme of personalization is dealt with by using direct feedback obtained by questionnaires and indirect feedback obtained by sensors within the exhibitions. Thanks to the Inclusive Memory Web App, users were anonymously tracked and their time spent in visiting the museum and seeing the artworks automatically calculated in order to define specific personas useful for the construction of personalised learning paths. The Inclusive Memory Web App developed is based on five works from the permanent collection of Tito Rossini at the Department of Education of the University of Roma Tre. The exhibition was not equipped with technological supports but only with traditional labels. Initially, the research group developed QR codes with a recorded story and a piece of music associated with each work. The positive results of this first pilot phase are reported in (Poce & Re, 2020). Due to the Covid-19 pandemic, the Inclusive Memory Web App was transformed into a collaborative experience within in a virtual environment by reproducing the 5 artworks and providing them with the following supports: description of the artworks, acted narration, musical soundtrack. The environment used for the experience described in the present paper is "Frame-VR", a platform where virtual rooms can host multiple visitors represented by meta-style avatars and make available an audio-video chat to stimulate collaboration between virtual users.

Methodology

The realized second experience here described was carried out as mentioned above within a virtual environment. The objective was to maximize visitor involvement and develop personas to represent the users. The research questions were:

- How do visitors evaluate a living exhibition accessible through digital tools?
- Is it possible to identify relationships between users' artistic preferences and their personality traits in order to create personas and personalize the experience?

To answer these questions, the research team developed a Web App to profile visitors consisting of three basic modules: an initial questionnaire to be administered before the experience, a virtual room where it is possible to carry out a collaborative visit with other users and an end-of-activity questionnaire. The first questionnaire aimed to profile users through an implicit approach in order to identify personas using items from a similar project developed at the Acropolis Museum in Athens (Antoniou et al., 2016) but with the addition of items related to the dimensions of extroversion and introversion taken from the Big five questionnaire (McCrae & Costa, 2004), 12 items on a Likert scale. Afterwards, the users enjoyed the virtual exhibition followed by a museum educator who conducted a guided tour; this figure is fundamental when working with technological supports in order not to distort the results due to technological gap problems. The second questionnaire was developed to assess the usability and usefulness of the tool developed beyond the preferences of the paintings and mediation tools. The data collection of the questionnaires took place through google forms integrated within the virtual environment to make the process transparent to the visitors. 183 (average age=26 F=157 M=25) university students from University of Modena and Reggio Emilia, attending the courses in "Research Methodology in Education" and "Design and evaluation in educational and training contexts" participated in this second experience. During an introductory lecture, the Frame-Vr virtual environment was presented. In addition, the teacher presented the digitalized artworks and the linked mediation tools. The experience was conducted as a guided tour where the visitors simultaneously enjoyed the recordings of the stories and associated songs to the artworks and a collaborative audio- video chat was set for supporting interaction and dialogue between participants. At the end of the visit, the participants filled in an evaluation questionnaire on the exhibition and the technological tools used. The anonymously collected data were analysed to find the correlations through the IBM's SPSS software.

Results of the User experience

The group of participants consisted of 133 students (72.7%), 42 working students (23%) and 8 students/professionals experienced in the arts and culture sector. 72% had a high school diploma, 37.2a university degree and 8.7% a postgraduate degree. Only 25 participants had heard of the artist and his works. The first research question investigates how visitors rated the virtual experience; participants were almost unanimous in their opinion of the emotion the experience aroused in them, 82% curiosity, 9% surprise and only 9% sadness and boredom.

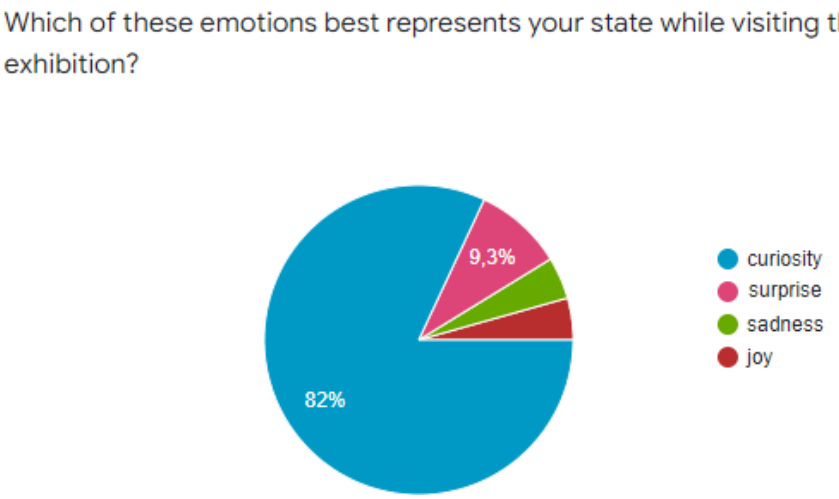

Figure 7. Feelings promoted

However, 92.9% would recommend the experience to others. In contrast to the first pilot phase, which took place in presence, the digital tools within the virtual environment were very successful as shownin the graph: especially the soundtrack, which in presence was described as a disturbance within the app, was evaluated positively, also in combination with the narrative. Compared to the first pilot phase carriedout with 15 participants (Poce et al., 2019), where low levels of extroversion corresponded with a preference for the multimodal exhibition, this second experience here described shows a weak correlation between high levels of extroversion and exhibition preference (R=0.62 P=0,06).

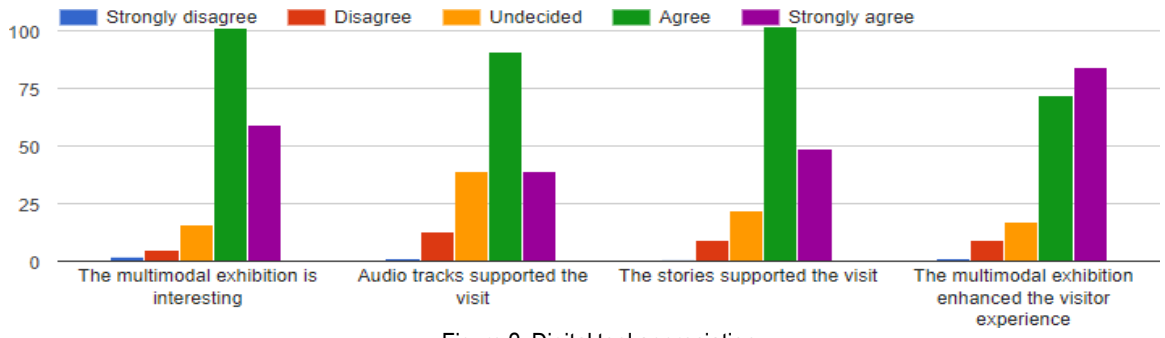

Figure 2. Digital tool appreciation

Results on correlations between personality traits and preferences

The second question explores the relationships between user artistic preferences, extroversion / introversion dimensions, and experiences styles within the exhibition. In the first pilot phase, a correlation emerged between extroversion and realistic art preference, but as shown in the contingency table, in the virtual experience this correlation is no longer true.

	Barely extrovert	Moderately extrovert	Very extrovert
Abstract Parthenon	17	37	23
Realistic Parthenon	9	25	41
Romantic Parthenon	14	34	11
Realistic Monnalisa	12	53	51
Monnalisa Marcel Duchamp	10	26	16
Abstract Monnalisa	18	17	8

Table 8. Contingency table kind of art X extroversion

There is a slightly positive correlation (R=0.75 p=0.004) between levels of extroversion and the preference on the use of storytelling for the artwork mediation. Furthermore, a weak relationship (R=0.67 p=0.046) emerges between average levels of extroversion and the preference for a human museum educator.

	Barely extrovert	Moderately extrovert	Very extrovert
Without supports	8	20	5
Painting + soundtrack + narration	4	15	32
Painting + narration	16	8	33
Museum Educator	12	53	5

Table 2. Contingency table digital tool appreciation X extroversion

As in the pilot phase, it emerged as shown by the contingency table that the works “The hour of revelation” is the preferred setting for the largest number of extroverted participants, and this brings us positive results to demonstrate how personality traits can be used to generate personalized paths that optimize visitor satisfaction.

	Barely extrovert	Moderately extrovert	Very extrovert
Painting “The hour of revelation”	10	34	20
Painting “The moon on the terrace”	3	17	31
Painting “The red bow”	4	23	9
Painting “In the morning”	8	11	7

Table 3. Contingency table best work X extroversion

Discussion

It is a fact that by now all museums around the world are integrating modern technological tools targeted for each user category to increase the visitor pool and optimize their experience by providing customized tours. Building on the pilot experience presented in Poce et al, 2019, the Inclusive Memory Web App was implemented through the "Frame-VRr" application to overcome some of the limitations of the in-presence experience organized in the previous work (use of digital media and inclusion limits) and other limitations imposed by the recent Covid-19 pandemic such as the limit of social distance. Moreover, unlike classical museums where the collection of works is physically arranged within the spaces, the virtual environment allows each user to create a different path based on his or her user model and needs, creating a highly inclusive environment. The correlations found in the extroverted groups with realistic art (in both the Monalisa and Parthenon tests) and multimodal tools showed how it is possible through the analysis of personality traits to propose personalized art styles and routes. The data analysis shows a general appreciation for mediation tools, in particular for narratives, associated with works of art and the song chosen to accompany them. This countertrend to that found in the pilot phase could be explained by the lower average age of the visitors, who fall into a group of users more familiar and comfortable with this type of experience. In contrast to this result, it emerges that low levels of extroversion are indicators of a preference for abstract art. In our opinion, this experimentation has shown how this type of approach can improve the heritage experience.

The methodologies presented and the personas generated from these data can be used to generate personalized museum tours supported by digital materials. In addition, as part of the Inclusive Memory project presented, a system was also developed to anonymously calculate data on the time spent by users in front of individual works of art and the total visiting time from museum surveillance cameras or ad hoc installed cameras. These results can be implemented within the virtual experience by developing software that connects to Frame-VR and, upon explicit consent, captures this data from the visitor's device and sends it to the application.

In the future, through this type of profiling, we aim to produce, taking advantage of the ongoing process of digitization of museum works, customized remote experiences by building virtual tours with works from all over the world as needed. By exploiting information on visit times and artistic preferences after a short questionnaire, the system could produce a virtual room with a pool of works chosen according to one's profile. This is in no way intended to

drive visitors away from the museum, but rather to bring people who find it difficult to enjoy the heritage closer to the environment and encourage them to visit the museum in person in the future.

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