ARtales: AR Mobile Application Using Transformative Learning Through Aesthetic Experience – First Evaluation

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Abstract: Nowadays, the noteworthy growth of digital tools for museums and art spaces enhances and redefines the museum experience. The creation of digital applications that provide meaningful experiences in the art space is a real challenge. Transformative learning theories focus on educational processes that aim for the development of critical thinking while some of them involve the aesthetic experience as a medium that can be exploited. ARtales is an augmented reality mobile application for the National Gallery of Athens visitors which utilizes transformative learning methods through aesthetic experience in an attempt to offer a more substantial and innovating experience in the gallery. More specifically, users asked to discover hidden symbols, uncover hidden objects and live AR experiences related to different subjects/scenarios in the outdoor spaces of the gallery or in their personal place, in order to develop their critical thinking and revisit the artworks in a playful and substantial way. The application also uses a points-based reward system in the direction of gamification. This study refers to the first use and evaluation of the ARtales application by a number of postgraduate students in order to draw conclusions related to the development of the critical thinking and the transformation of the views and perceptions of the participants, the assimilation of the offered information as well as the acquaintance with the artworks. For this purpose, questionnaire-based evaluation and free conversation with the participants was carried out as well. According to the results derived, the first use showed positive acceptance and response. Last but not least, the study gives suggestions for future work and exploitation as well as future pilot implementation which is of major importance in order for the ARtales app to become feasible for a widespread use in the near future.

Keywords: Augmented reality, Transformative learning, Aesthetic experience, Mobile learning, Museum experience, Game-based learning

1. Introduction

In recent years, museums and art spaces are increasingly seen as learning environments (Jeffery-Clay, 1998). Furthermore, the use of new technologies and particularly mobile devices in the modern museum has contributed to the redefinition of museum experience by "creating new experiences and enhancing familiar ones in unprecedented ways" (Bradburne, 2008). Especially, Augmented Reality (AR) emerges an important tool for reshaping digital experiences and "has a significant positive effect on motivation to learn" (Gopalan et al., 2017).

Transformative learning is a theoretical approach of education which has been applied in many different frameworks. "Between 2005 and 2017, fertile ground for research studies about transformative learning and the arts within the field of adult education yielded" (Blackburn Miller, 2020) recognizing the transformative power of art and its contribution to empowering and engaging participants (Bentz, and O'Brien, 2019).

The ARtales app is an AR application for the National Gallery of Athens created as an attempt to combine elements from transformative learning methods with aesthetic experience in a digital tool and provide innovating learning experiences in the gallery, aiming to the development of critical thinking apart from the acquaintance with the artworks. This study concerns the first use and evaluation of the ARtales app by a number of postgraduate students. In this paper, after a brief review of relevant literature and a short description of the ARtales app, the evaluation method and the findings of the whole process are described in detail. Finally, conclusions are documented and suggestions for future exploitation in order for the ARtales app to become feasible for a widespread use in the near future are given as well.

2. Literature review

2.1 Transformative Learning and Aesthetic Experience

Transformative learning is defined as the "process by which we transform problematic frames of reference (mindsets, habits of mind, meaning perspectives) – sets of assumption and expectation – to make them more inclusive, discriminating, open, reflective and emotionally able to change" (Mezirow, 2009). This process "involves learning to think critically by questioning assumptions and expectations that shape and influence the way we think and do" (Crowther and Sutherland, 2006) which Kegan (2000) refers as "way of knowing". In the

process of transformative learning, the concept of "experience" plays a dominant role, according to Dewey (1938), as it "allows a holistic approach to education, in the sense that it is based on the interaction between the human being and the world" (Hohr, 2012). In addition, critical thinking – which Freire (1970) first refers to - is used as "a tool for self-determination and civic engagement" (Giroux, 2010) which leads to critical awareness while dialogue between instructor and learner is also of great importance in the transformational process (Koulaouzides, 2015).

Aesthetic experience, concerns processes related to seeing, perceiving, understanding and appreciating a work of art, as well as the pleasure and satisfaction that accompany these processes (Dewey, 1934), (Vessel et al., 2013). These processes involve a variety of emotional responses and other (often knowledge-based) emotions (Vessel et al., 2013). Furthermore, artworks can "facilitate thinking through the critical observation in a way that allows individuals to approach them in their own way and discover their own meaning and according to thinkers of Palo Alto, this function is due to the fact that contact with artworks is related to the function of the right hemisphere of the brain" (Kokkos, 2010). As follows from the above, art can be a useful tool for the reinforcement of the transformative process (Cranton, 2006), (Raikou and Karalis, 2011). Dewey (1934), Greene (1980) and Gardner (1973) refer to the contribution of aesthetic experience to the development of students' imagination and generally to the learning process.

Aesthetic experience has been utilized in a number of approaches within the framework of transformative learning. Freire was the first who integrated artworks and especially sketches by the Brazilian painter Francisco Brennand in transformative learning process in order to support participants to redefine their views (Freire, 1968). Different types of artworks are used in different approaches, such as artworks of high aesthetic value as well as works of mass culture without emphasizing on their aesthetic value. However, it has been shown that the utilization of artworks of high aesthetic value could enforce critical thinking in a largest degree (Kokkos, 2010). Most of the approaches that utilize aesthetic experience, are based on observation of selected artworks, critical questions, and conversation about the examined subject (Figure 1) and such an approach is the methodology "Transformative learning through aesthetic experience" which was developed by Kokkos (2022).

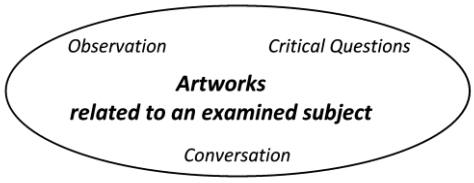


Figure 2: Elements that used in transformative learning methods which utilize aesthetic experience

2.2 Augmented reality

Augmented reality (AR), as a digital technology, enables to "combine real and virtual worlds in real-time, supplementing the real world with computer-generated virtual objects" (Khan et al., 2019) such as text, information, 2D and 3D graphics, sounds and other sensory stimuli. In recent years, the interest in augmented reality (AR) is being increased due to the potential for simulating real-life situations and creating authentic learning tasks (Czerkawski and Berti, 2021). Especially, studies have shown that AR applications can enhance the learning process, learning motivation and effectiveness (Tzima et al., 2019) (Akcayir and Akcayir, 2017). "The increased student motivation may be largely attributed to the elements of curiosity, fantasy, and control (Gopalan et al., 2017) presented using AR technology, as student motivation may be directly influenced using an attractive or stimulating medium or learning material" (Khan et al., 2019).

2.3 Museum Learning and Digital Technologies

"Over the past decade, researchers of learning in non-formal educational environments have focused their attention on museums as environments that construct learning experiences and the way visitors learn in them, playing an active role in the learning process" (Filippoupoliti, 2015). "Museums are increasingly asked to demonstrate not only their cultural, but also their educational and social significance and that is why the means to understand how museum visitors learn becomes ever more important" (Hohenstein and Moussouri, 2017). John Dewey recognizes the powerful educational value of museums (G. E. Hein, 2004) while Hein (1998) refers to museum learning as an active process in which knowledge is actively constructed in visitors' minds.

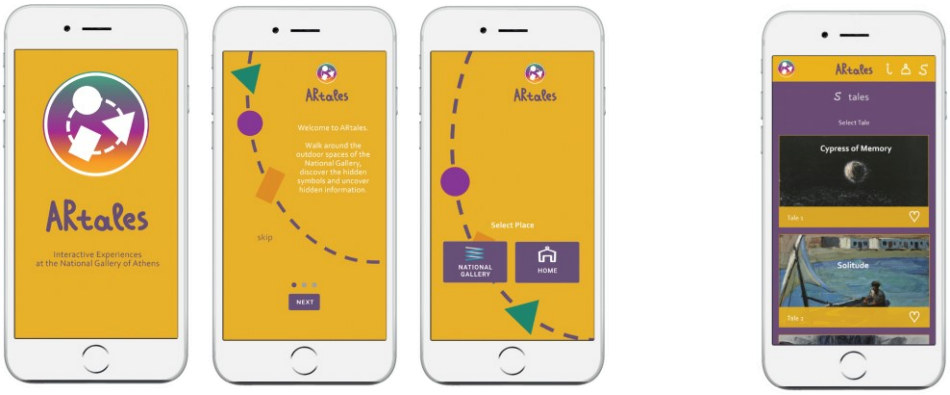
"The use of digital technology in museums and art galleries emerges as a dynamic tool which offers visitors the opportunity to better understand the exhibits and collections that interest them, create their unique personal context to each visit and live a meaningful experience in the museum" (Keene, 1998). Especially, mobile devices enhance the visit and assist visitors on several levels utilizing the advantages of mobile learning. (Wessel and Mayr, 2007). Regarding the utilization of digital technology in the modern museum, a great number of digital applications has been developed all over the world. Although these applications provide users with information of high-learning value, they lack to offer opportunities for dialogue between the user and the museum, for participatory learning and for the users to add their own social meaning to the museum experience (Sexton and Lagoudi, 2021).

2.4 The National Gallery of Athens

The National Gallery of Athens in Greece was founded in 1900 and encompasses in its collections more than 20,000 works of painting (National Gallery, 2022a), sculpture, engraving and other forms of art and is the treasury of the latest Greek artistic creation. It also owns a remarkable collection of Western European paintings. The National Gallery of Athens has developed 4 mobile applications which offer access to rich content, information, and audio-visual material (National Gallery, 2022b). Therefore, although they are useful tools, they do not enable users to interact with the artworks in a more creative and immersive way.

3. The ARtales app

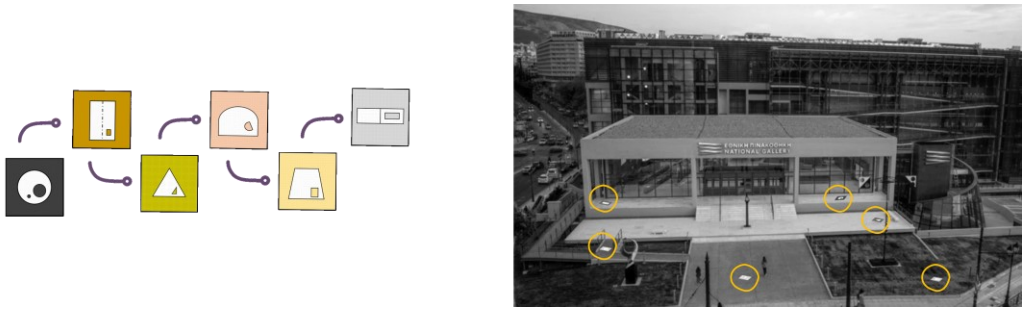
ARtales is an AR mobile application created for the National Gallery of Athens visitors which utilizes transformative learning methods through aesthetic experience (Figure 2(a)). Via the application, visitors can live different AR experiences in the outdoor spaces of the gallery, after their visit to the gallery, while they could use the application at home. Every AR experience is based on a different scenario related to a social or more personal issue such as forest fires, loneliness in everyday life, feelings, memory and lethe (Figure 2(b)). The goal is for the visitors to take part through the application to an original AR experience which will support them to develop their critical thinking and redefine their views about the examined issue beyond the better understanding of the artworks.



(a) (b)

Figure 3: Screens of the ARtales app (a) On boarding/introduction screens (b) Scenario selection

Based on the theories described above (Paragraph 2.1), the AR experiences that are provided incorporate elements from the relevant transformative learning models in conjunction with the interactivity and the possibilities offered by the augmented reality. Especially, every AR experience utilizes a number of paintings from the National Gallery's permanent collection with themes related to the selected issue, which could create a visual scenario that deals with questions related to the sub-topics of the subject matter.



(a) (b)

Figure 4: (a) Map of symbols and (b) their position in the outdoor spaces of the Gallery

During the navigation, users are asked to discover a number of symbols in the outdoor spaces (Figure 3), scan them with the mobile camera and uncover hidden objects each one related to a different artwork and read critical questions about the subject (Figure 4(a)). At the same time, information about the artworks and the examined subject is given in the form of readable text as well as audio material. At the end of the scenario, a summary with important data about the examined subject is provided (Figure 4(b)). The exact same scenarios can also be played by the user at home. In this case, instead of looking for the symbols around, user is called to interact with them through the screen.

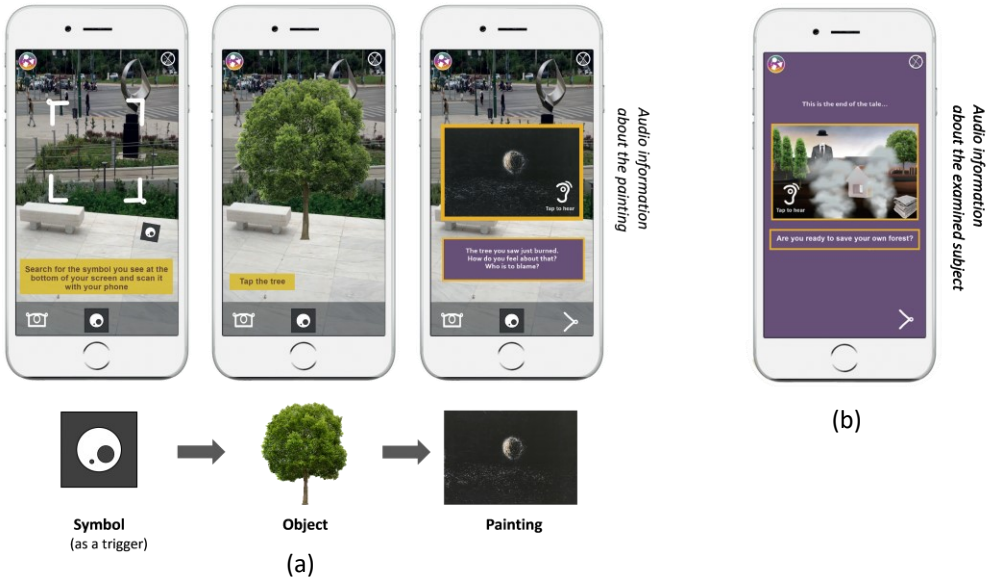


Figure 5: Screens of the AR experience (a) Uncovering a painting (b) Final screen of the scenario

In the direction of gamification, the application uses a points-based system of prizes based on each specific scenario, similarity of the scenarios, the number of scenarios that have been completed and the place (National Gallery or home). The user can obtain more prizes by answering optionally to a number of quizzes while after having collected a certain number of prizes, user is awarded with a real gift such as a book from the National Gallery Shop. The application also provides instruction screens and user profile with user's favourite stories, user's progress as well as awards and badges received.

4. Method

The purpose of this case study was to conduct an initial trial of the application by a small number of users in order to draw conclusions at various levels that will contribute to the future pilot implementation of the ARtales app. Specifically, in this trial users were asked to try out a specific AR scenario. The aim was to investigate the impact of using the application on 3 levels: (1) the contribution of the ARtales app to the assimilation of the information given in relation to the artworks as well as the examined subject, (2) the effectiveness of the utilization of transformative learning elements by examining the development of critical thinking and the transformation of views and perceptions of the participants about the examined topic and (3) the evaluation of the AR experience with respect to the general impression that participants gained. According to the above, a

questionnaire-based evaluation took place using questionnaires of different types before and after the use of the ARtales app by the participants.

4.1 Selected scenario

The scenario selected to be tested by the participants is entitled "Cypress of Memory" (as the title of the painting by Tassos Christakis which is used in this scenario) and concerns the issue of forest fires. The reason for this choice was that forest fires is a worldwide and widely known phenomenon, known to everyone, regardless of cognitive background and interests.

"Forest fires is one of the major environmental disasters that has serious consequences for the ecosystem, services, biodiversity as well as humans" (Wang et al., 2021). "Worldwide, millions of hectares (ha) of forests and other types of vegetation burn every year. Covering nearly one third of the land surface of the globe, forests make a wide range of direct and indirect contributions to human well-being" (Halleux, 2020).

The scenario examines the causes and impacts of forest fires, the reasons that prevent nature from regenerating naturally, reforestation as a restoration practice, ways to prevent forest fires, and volunteering. In particular, the scenario considers the attitude of individuals towards the issue, how conscious they are of the effects of fires in the ecosystem as well as their willingness to help. Six artworks uncovered by the user during the AR navigation are used as a reason to pose questions via the application related to the subtopics mentioned above while information about the artworks - the techniques and the messages - is provided (Table 1). As an example, the information provided for the painting of T. Christakis "Cypress of Memory" is as follows: *"Christakis draws on paper (a wood byproduct) with charcoal – the burnt product of the same material… The solitary burnt-yellow colour intimating fire comes from the actual burning of the paper…"*. At the end of the navigation, a short synopsis with important data about forest fires is given, concluding with a final question which offers motivation for reflection.

Information that provided during the scenario, derived from the WWF (World Wildlife Fund,2022) and National Gallery websites.

Table 1: Symbols, Objects, Paintings and Questions that are used in the AR scenario "Cypress of memory"

Symbol						
Object						
Painting	 *Christakis Tassos* Tree (1947)	 *Bokoros Christos* Cypress of Memory (2002)	 *Tsoclis Kostas* We Are All Responsible (1972)	 *Gaitis Yannis* Composition (1975)	 *Semitekolo Grigoris* Imaginary Landscape (1993)	 *Chouliaras Nikos* The Warm Desert of Life (1996)
Question	The tree you saw just burned. How do you feel about that? Who is to blame?	Why are cypresses important? After a disaster, can they be restored?	How much does forest burning concern us? Although newspapers often report on fire events, we don't care. Why?	We are so focused on our everyday activities that we don't care about the forests. How often do you think of things you can do to protect trees from burning?	Could you live in an area without trees?	Are you ready to live in an unfriendly planet and suffer the consequences of climate change??

4.2 Participants

Participants of the study were 12 postgraduate students (7 men and 5 women) in the field of "Art and Digital Design" of different ages (3 between (20-25), 5 (26-30), 2 (31-40), 2 (>40)) and backgrounds. The criterion of the selection of the participants was their willingness to volunteer, the subject of their studies and easy access to them due to the relevance of the subject of studies and the research interests of the authors. It is noted that the selection of these students due to their familiarity with the subject of digital design was made, taking into account that they could also provide more targeted observations about the design during the discussion, in addition to their contribution to the trial.

4.3 Types of questionnaires

Three types of questionnaires were used for the evaluation which participants were asked to complete, each one of them aimed to examine the impact of the ARtales app in each of the three levels described above. Especially (Table 2), (1) Questionnaire A with 4-point scale questions before and after the accomplishment of the AR scenario, (2) Questionnaire B with closed-type knowledge questions with a unique correct answer and (3) Questionnaire C with the majority of the questions in a 4-point scale, after the AR experience. It is noted that for the evaluation of the development of critical thinking and impact of the AR experience where the aim was to draw qualitative conclusions (trends, assessments) 4-point scale questions were used in the majority of questions.

Table 2: Description of questionnaires that were used for the evaluation

Questionnaires	**Questionnaire A**	**Questionnaire B**	**Questionnaire C**
Examined feature/aspect	development of critical thinking, transformation of views and perceptions	assimilation of the information given in relation to the works of art as well as the examined subject	AR experience with respect to the general impression that participants gained
Types of questions	4-point scale open-ended	knowledge questions with a unique correct answer (multiple choice / matching questions)	4-point scale matching open-ended
Subject of the questions	forest fires, main causes, factors that prevent regeneration, reforestation, actions for the prevention, volunteering	- numerical and geographical data related to forest fires - the artworks, the artistic techniques, the artists, the messages	- user experience and the design of the AR experience - contribution of the AR experience to the understanding of the topic - familiarity with symbols and visual elements
Indicative Questions	"Who is to blame for the forest fires?" , How satisfactory can the burnt area be ¨regenerated¨ by itself? Write 3 factors that prevent ¨regeneration¨, Do you believe that you can help save the forests? Suggest 3 actions.	The highest percentage of burnt areas in Europe are in countries of the (a) Central Europe (b) Mediterranean (c) None of the above, - Which painting do the phrase(s) correspond to? : e.g. (a) The artist uses humorous images to describe an unpleasant reality.	Was the AR experience creative?, Match the symbols with the paintings they uncover, Did the experience help in the assimilation of the information about the works of art?

4.4 Procedure

After visiting the exhibition of the National Gallery's permanent collection, participants were asked to answer questionnaire A and then to use the ARtales app and carry out the AR experience for the selected scenario. At the end of the AR experience, they were asked to answer questionnaire A again and subsequently questionnaires B and C. Finally, free discussion with participants took place. So, the overall procedure conducted, is indicated in Figure 5.

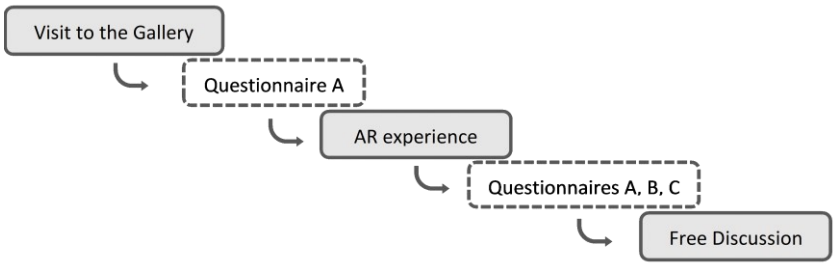


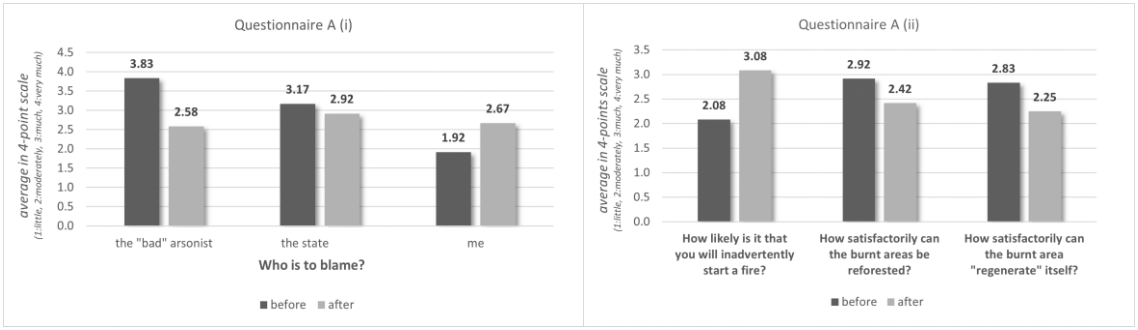
Figure 6: Overall Procedure of the evaluation

5. Findings

Based on the analysis of the answers of the questionnaires as well as on the discussion which followed, findings were extracted related to the impact of the AR experience in each of the three examined levels.

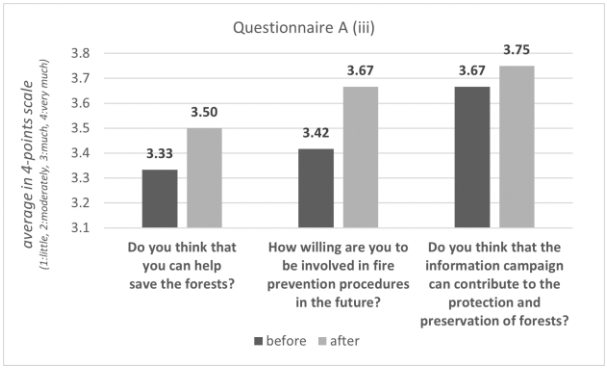
Concerning the development of critical thinking of the participants (Questionnaire A), the comparison of the answers on questionnaire A, before and after the end of the AR scenario, showed that generally participants differentiated and transformed their views, due to the reflection as well as the processing of information provided to them. Generally, after the procedure the participants gave scores to all questions that corresponded to a higher percentage of reality. Especially, in the question "Who is to blame for the fires?" participants rated 3,83 at the beginning of the course and 2,58 at the end for the bad arsonist (Figure 7(a)) recognizing that a large percentage of fires are due to human negligence and not arson. In the question "How satisfactorily can the burnt area "regenerate" itself?" participants rated 2,83 at the beginning of the course and 2,25 at the end (Figure 7(b)),

realizing that several reasons (such as repeated fires, grazing on burnt land, and erosion) impede nature from being restored naturally. Finally, participants, after the AR experience, were more willing to participate in fire prevention activities in the future, recognizing the value of information campaign (Figure 7(c)), while they were able to write down more targeted actions that could be a step in the right direction and realized that it is not such a difficult process to become volunteers and contribute actively.



(a)

(b)



(c)

Figure 7 (a), (b), (c): Answers on questions about transformation of views of the participants (before and after)

Regarding the assimilation of the provided information, the majority of the participants assimilated, to a large extent, the information related to forest fires as well as to the paintings. In particular, in the questions about forest fires, the majority of the participants answered correctly in each individual question (Figure 8), while 75% of them achieved a score of 100%, answering all the questions correctly (Figure 9(a)). At the same time, in a many-to-one matching question about artworks with 12 matches, 58,3% of the participants achieved a score of 100% and 16,7% answered 11 out of 12 questions correctly (Figure 9(b)).

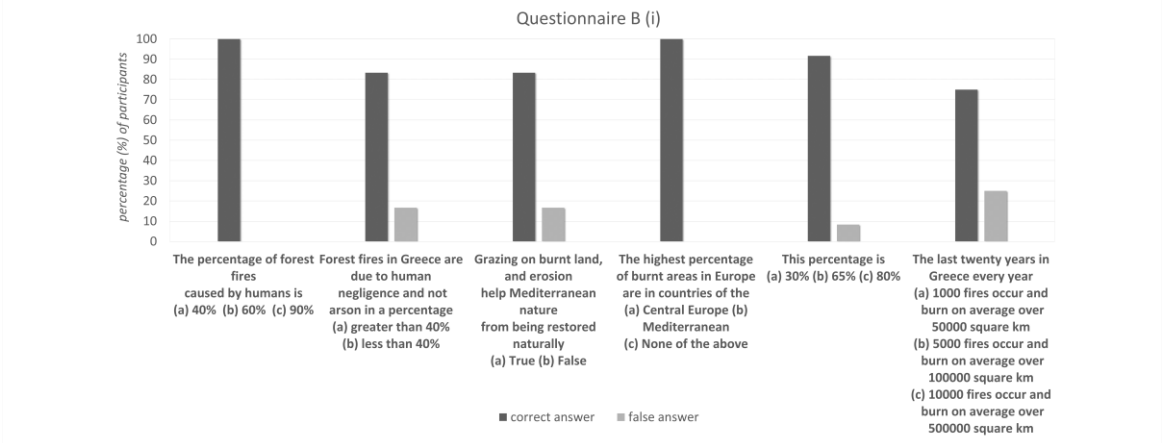
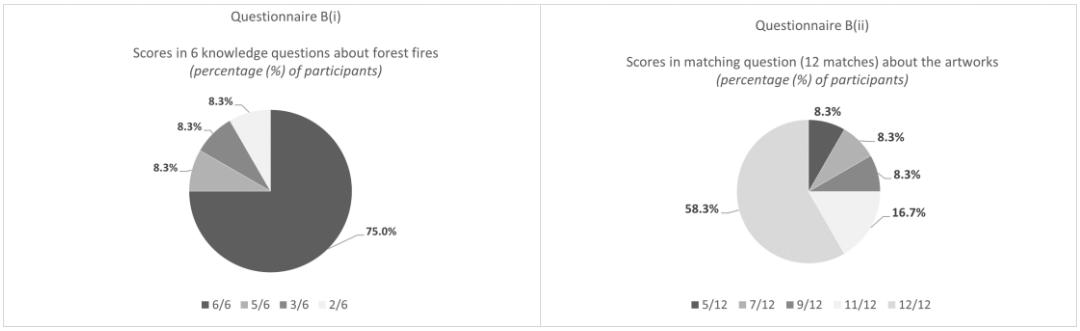


Figure 8 : Answers on knowledge questions about forest fires



(a) (b)

Figure 9: Scores in knowledge questions (a) about forest fires (b) about the artworks

As far as the AR experience is concerned, the participants gained positive impressions and the findings showed that the way that the information was provided by the application through the different points of interest in the outdoor spaces of the gallery, helped them to better acquire the information. Focusing on the results, 81,8% of the participants had the ability to remember the relative artwork connected with a unique symbol (Figure 10) which indicates that the visual relevance of the symbol with the painting it reveals, contributed that the visual information is better imprinted on the mind. 91,7% of the participants characterized the experience as "much" (16,7%) or "very much" (75,0%) easy to use, 100% as "much" or "very much" innovating and 91,7% as "much" or "very much" creative, rating 3 or 4 points in a 4-point scale (Figure 11(a)). Finally, 91,7% of the participants answered that the AR experience helped them ("much" or "very much") to reflect and redefine their views on the issue of forest fires while 83,4% of the participants stated that the AR experience helped the assimilation of information about the artworks (Figure 11(b)).

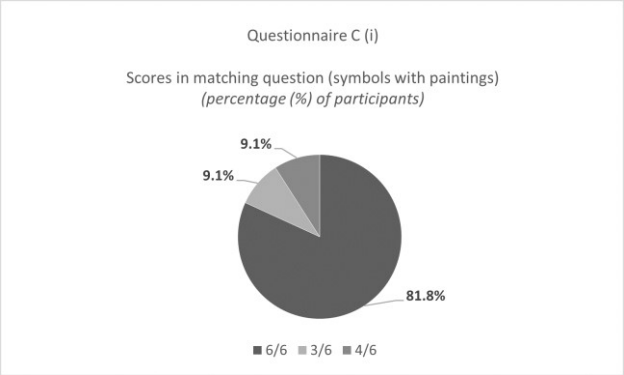
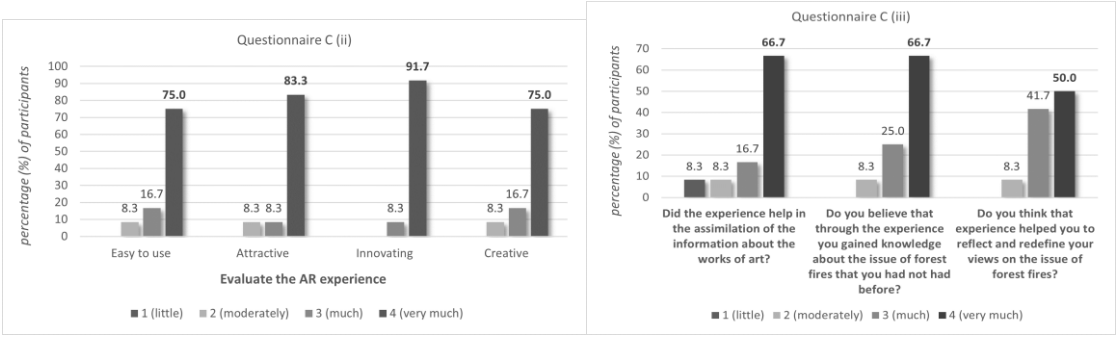


Figure 10: Scores in question of matching the symbols with the paintings



(a) (b)

Figure 11: Answers on questions about the AR experience

Focusing on the free discussion with participants that took place after the completion of the whole process, participants stated that in general the ARtales app "achieved its purpose although it can be improved on some levels". They also pointed out the importance of the use of augmented reality as "an additionally important incentive in increasing motivation". In addition, they focused on the content, noting that the information

provided is very clear and precise. They also noted the perspective of the use of the ARtales app in typical education. At the end, they referred to the application as “a beautiful ending of their visit to the gallery” and “a clever way to assimilate the information about the artworks” which also promoted them to “gain a more in-depth view of the examined subject” and stimulated them for “reflection upon experience”. They were also interested in the rewards system which it gave them “an extra stimulus to return to the gallery space and use the app again”, adding that they “would also use the app at home with pleasure, choosing a different scenario”.

6. Conclusions and future work

This study mainly aimed to examine and evaluate the first use of the ARtales application by a number of university students. From the results derived, the first use showed a positive response. Although this survey was conducted on a small – indicative sample and these results could not be generalized, an optimistic perspective for a widespread use and evaluation in the near future emerged. As the participants were art and digital design students, their comments were particularly important as a starting point for further testing and improvement of the application.

The idea of utilizing elements from transformative learning theories in an AR experience, turned out to be an interesting attempt which in this initial trial seemed to achieve its purpose as shown by the data concerning the transformation of the views of the participants. Furthermore, the use of augmented reality as a digital tool with a positive effect on motivation to learn, proved to be equally important. Apart from the efficient assimilation of the information ascertained by the findings, participants also evaluated positively the AR experience in the questionnaires, while in the discussion which followed, they focused on augmented reality as a means for creating an innovating and substantial learning experience in the museum. In addition, since the ARtales app was designed for an art space, the application's contribution to the assimilation of information related to artworks as well as to a better understanding of them was equally important.

A further study could be the pilot implementation of the application in co-operation with adult educators as well as visual artists or art historians in order to draw more targeted conclusions about the efficiency of the application. During this pilot implementation and with the contribution of adult educators, improvements to AR scenarios and to the questions and information that are provided via the application could be implemented. Visual artists would also support the enrichment and improvement of the content related to the artworks which is important to be communicated through the application. Finally, user testing will enable appropriate modifications in the user experience and user interface as well as the further development of the rewards system. Another study could focus on the utilization of the application in Primary and Secondary education, examining possible modifications in the context and the design by taking into account the profile of the students as digital natives.

In conclusion, the project of utilizing transformative learning methods in a digital tool and the proper incorporation of these elements in the design is a real challenge and therefore further study is of major importance. Despite the limitations of this research, undoubtedly the application gives a new dimension to the museum experience. With the appropriate adaptations and improvements, the ARtales app could be used in other museums and art spaces as well, offering more substantial experiences to the contemporary museum, redefining the way we observe, and approach artworks.

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