Int. J. Bio-Inorg. Hybr. Nanomater., 9(4): 211-220, Winter 2021

Heterogenize Architecture, Modern Nano Architecture, Restorated Buildings and Creating Safe Places Tehran Azad Science and Research University

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Received: 10 August 2020; Accepted: 13 October 2020

ABSTRACT: As a virtual heritage the development of the augmented reality projects that intended to communicate the significant of architectural heritage requires to contribute the subject by discussing the case study which was held in Istanbul. Findings of the evaluation process revels that the architectural heritage is the most important valuable materials for designer. The evaluations process was not embodied with the application and participants benefits and it gave researches feedback and the opportunity to enhance the application for the future.

Keywords: *Argument reality's, Cultural heritage, Evaluation heritage, Heterogenize Architecture, Nano Architecture.*

INTRODUCTION

Champion (2015) proposes that the major aim for virtual heritage should be to "convey the unique significance of the simulated culture, which requires an attempt to understand how the original site was experienced and understood by its original inhabitants" [1]. In terms of virtual reality, and particularly for augmented reality (AR), the verb "to attempt" may have alternate meanings from different perspectives. For the user, it is an attempt to explore the medium, understand the interface and interpret the context; for the expert it is an attempt to convey significance and meaning consistently (within the scope of Nora document), effectively and transparently (regarding the London Carter) [2,3]. For the system developer it is an attempt to bring together software and hardware capabilities with the unique characteristics of Nano technology effect of heritage sites. It is also possible to add administrative, environmental and other contextual viewpoints into these perspectives. The interconnected multitude of these perspectives, caused by the continuous advancement of computational technologies, are changing the shape and understanding of types of virtual realities. While becoming more user friendly and commercially avail-

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able, Platforms and tools (including both software and hardware capabilities) are under constant scrutiny and developers are still in search for a user experience that was described by researchers and pioneers decades ago. This makes it harder to craft an AR application for any purpose. Additionally, although there is literature evaluating AR environments, Regarding Nano Technology materials, they generally focus on AR enabling Nano technologies rather than the human 7 user aspect of the projects and they certainly do not consider the dissemination of information about cultural heritage. The quality of the content and dissemination is important in cultural heritage, therefore, for cultural heritage AR Nano applications, evaluation has an important role. Additionally, continuous evaluations of virtual heritage projects contribute to creating more meaningful experiences that aim to communicate the significance of cultural heritage. Because of the issues above, there is always a danger of previous work (including the ones that are given as an example) becoming outdated or irrelevant. This study aims to clarify how the function of evaluations and the inclusion of evaluation processes as a part of the experience can contribute the virtual heritage Nano applications to better communicate heritage values and be more successful. The case study presented here is part of Ph.D. dissertation by the first.

EVALUATION OF VIRTUAL HERITAGE

The aims of virtual heritage projects

Dünser and Billinghurst (2011), referring to both different modalities and engagement methods concerning different AR environments, as well as the different aims of the AR projects, point out the difficulties of developing a singular evaluation method. Therefore, they suggest an evaluation approach dependent on the questions posed. Undoubtedly, the evaluation of AR applications that aim to communicate heritage requires this approach [4]. While Dünser and Billinghurst (2011) list potential methods of evaluation for AR, Champion (2011) classifies the evaluation methods available for virtual heritage applications as the following: expert testing (including guidelines), content and media comparison studies, physiological testing, task performance, surveys questionnaires and ethnographic evaluation. Champion's classification of evaluation methods of virtual modalities is proposed with heritage aims in mind and therefore includes a more interdisciplinary approach [5].

Another issue which must be addressed to create an evaluation process is the scale or specific aim of the project, which seems to correspond with the Dünser and Billinghurst's "question posed". Considering both the Burra and Ename Charters and the relevant literature, Pujol and Champion (2012) suggest six aims for virtual heritage projects. While the first five of them are similar to charter principles, in their sixth aim they suggest that researches "attempt to carefully evaluate its (the project's) effectiveness with above five aims in order to improve both the project and virtual heritage in general" (pujol & Champion 2012) [6].

Previous Research Examples

The numbers of published research examples that focus on the evaluation of communication of heritage are quite few. The examples discussed below were chosen from this limited group for their selection of virtuality and evaluation methods.

Palenque Project

The Palenque Project is a kind of virtual heritage project developed by Champion, Bishop and Dave (2012) [7]. The project's research question was to understand role of three interaction modes (*instruction, observation and action*) in cultural learning by task performance evaluation and without post-experience questionnaires to compare the findings.

AR-Cathedral

AR-Cathedral is an AR application for the renaissance frescoes inside the gothic vaults of the Cathedral of Valencia; the project evaluation included expert review physiological testing and questionnaires. The goal of the project was to visualize and disseminate the results of terrestrial laser scanning prior to the dismantling of the Baroque vault, which existed from 1682 to 2006 [8]. The AR-Cathedral application can be considered as one of the first examples of a virtual heritage project that included an AR evaluation. In this study, although a system evaluation carried out

the assessments were about the AR enabling aspects (*AR target size and types, ergonomics of the backpack etc.*) rather than the information conveyed. However, feedback about the heritage and suggestions to improve the contents of current application came from interviews with users.

AR@Melaka Project

The AR @ Melaka project, tied to the Melaka heritage site, is a project that aimed to improve the visitor experience in AR environments; its evaluation methods included a task performance (a multiple-choice online test), questionnaires and on-site observations [9]. At the site, researchers prepared a profile, multimedia content, maps and multiple-choice tests for predetermined information points. The profiles of the points included information such as name, function, year of construction, builder, and years of use. There were also multimedia presentations with content containing audio and video about the site. Furthermore, other interest points were indicated in relation to user's current position to facilitate navigation on the map. The multiple-choice test included a link to the online test page, where the prepared questions about the content were located. The mobile AR application, which was created for this study, offered a very limited and one-way communication. AR view contains the tags of monuments that act as the link of an html documents about monuments. Even though users found navigating and accessing data easy, because of the heritage information was not specialized, and limited interaction of the user interface, the question of whether if this is an AR application or not becomes an issue.

EVALUATION: METHOD AND DATA

@ Rkademi project's research question was to ascertain the effects of AR on the user's perspective on both the designed space and heritage content [10]. For this purpose, researchers designed an evaluation that consisted of a questionnaire for participants; an expert review panel also evaluated the experience. The expert review panel was composed of scholars who were

Table 1. Participants' responses to specific age, education and occupation groups.

1a.	Age	No	(%)
	Under 17	0	0
	17-25	8	21.1
	25-35	12	31.6
	36-50	14	36.8
	50+	4	10.5
1b.	Education		
A	High school	7	18.4
A	Graduate	5	13.2
B	Post graduate	10	26.3
C	PhD	16	42.1
1c.	Occupation (multiple answers possible)		
	Graduate student (architecture)	6	15.8
	Graduate student (other)	1	2.6
	Post-graduate student	9	23.7
	Instructor	30	78.9
	Architect/interior arch.	26	68.4
	Conservation specialist	6	15.8
	Urban planner	2	5.3

Table 2. The questionnaire had five sections: demographic information, previous experiences with AR, the evaluation of the experience, the value of the contribution of AR to the experience and thoughts on current conservation issues.

2	Previous virtual experiences	1	2	3	4	5
2e.	Did you have any difficulties viewing AR environment?	0 (%0)	0 (%0)	9 (%23.7)	16 (%42.1)	13 (%34.2)
2f	Would you like to use this kind of application to be informed about your surrounding?	0 (%0)	1 (%2.6)	2 (%5.3)	7 (%18.4)	28 (23.7)
3	User's evaluation of AR experience					
3a.	Are you satisfied with the exhibition?	0 (%0)	0 (%0)	5 (%13.2)	14 (%36.8)	19 (%50)
3c.	Did you read the supplementary information?	1 (%2.6)	7 (%18.4)	6 (15.8)	16 (%42.1)	7 (%18.4)
3d.	Did you listen to the audio narrative?	7 (%18.4)	9 (%23.7)	6 (%15.8)	8 (%21.1)	7 (%18.4)
3e.	Did the experience affect your view of space?	1 (%2.6)	0 (%0)	6 (%15.8)	10 (%26.3)	21 (%55.3)
3f.	Did the exhibition make you want to study or become more informed about this space?	2 (%5.3)	2 (%5.3)	6 (%15.8)	14 (%36.8)	14 (%36.8)
4	Contribution of AR experience to user					
4a.	Were you given enough information?	0 (%0)	1 (%2.6)	5 (%13.2)	15 (%39.5)	17 (%44.7)
4b.	Was the navigation sufficient/easy to follow?	0 (%0)	7 (%18.4)	8 (%21.1)	10 (%26.3)	12 (%31.6)
4c.	Was the exhibition's scope satisfactory?	0 (%0)	1 (%2.6)	2 (%5.3)	22 (%57.9)	13 (%34.2)
4d.	Did you feel a sense of exploration (about the space or the medium)?	0 (%0)	2 (%5.3)	0 (%0)	11 (%28.9)	25 (%65.8)
4f.	Would you like to use this medium for other purposes (informational or other)?	0 (%0)	3 (%7.9)	5 (%13.2)	6 (%15.8)	24 (%63.2)
5	Thoughts on current conservation issues of the heritage					
5a.	Given the entire history of site, do you think it is necessary to conserve past renovations?	1 (%2.6)	0 (%0)	2 (%5.3)	10 (%26.3)	24 (%63.2)
5e.	To what extent did the exhibition affect your opinions while answering the above questions?	1 (%2.6)	7 (%18.4)	7 (%18.4)	13 (%34.2)	10 (%26.3)
5f.	Is this medium useful to you when forming your opinions in a setting?	0 (%0)	1 (%2.6)	3 (%7.9)	8 (%21.1)	26 (%68.4)

conservation specialist and medium experts, and the panel reviewed the application and the experience.

User Evaluation Questionnaire

The questionnaire had five sections: demographic information, previous experiences with AR, the evaluation of the experience, the value of the contribution of AR to the experience and thoughts on current conservation issues. Apart from demographic section, the questionnaire used Likerd scaling -1 (lowest) to 5 (highest)- for qualitative measurements. Sections include also multiple-choice questions and a multiple answer question (5c). The results were organized by

Table 3. Results of Questionnaire Evaluation Previous AR Experience.

2a.	Device ownership (plural mc)	No	(%)
	Mobile phone	35	92.1
	Tablet PC	18	47.4
	Wearable computer	1	2.6
	other	0	0
2b.	Have you previously experienced an AR environment?		
	Yes	9	23.7
	No	29	76.3
2c.	Have you previously experienced an AR-like environment (navigation, spatial browsing, etc.)?		
	Yes	15	23.7
	No	23	60.5
2d.	Which device didi you use for the experience?		
	iOS smartphone	16	42.1
	iOS tablet	1	2.6
	Android smartphone	18	47.4
	Android tablet	0	0
3b.	How many experience points have you visited? (out of 25)		
	Less than 5	2	5.3
	5-10	9	23.7
	10-15	8	21.1
	15-20	11	28.9
	20-25	7	18.4
3g.	Which theme of experience was your favourite or informative from below. (multiple answers possible)		
	Previous states of buildings	24	63.2
	Previous states of the building environment	2	5.3
	Renovation of 1970	5	13.2
	Sketches	5	13.2
	The comparative display of prior 1974 and today	17	44.7
4e.	How often should this exhibit be displayed?		
	Once	1	2.6
	At regular intervals	10	26.3
	Continuous	27	71.1
	Should not be done	0	0
5b.	How would you define this structure?		
	A palace from the 19th. century	4	10.5
	A modernist architectural example	8	21.1
	A waterfront university campus	5	13.2
	All of above	20	52.6
5c.	How would you sort the below statements according to their importance (1 important - 4 unimportant)		Average over 4
	The floors are made of wood		2.2
	The light wells were added in 1970		2.5
	The entrance hall (mimar sinan hall) was elevated in 1970		2.5
	There were designs in the wooden structure		2.7
5d.	What should be the conservation approach of these structures?		
	The building should be preserved in it's initial (palace) state	5	13.2
	The building should be preserved in the state of its 20th -century interventions	13	34.2
	Every aspect of previous states of the building should be considered and conserved	20	52.6

these types rather than the relevant section for easier data representation (Tables 1, 2 & 3). The questionnaire was conducted during the exhibition in the Mimar Sinan Fine Art University (MSFAU) Findikli campus. The questionnaire language was Turkish. Although around 120 visitors received the questionnaire, only 38 were returned, mostly from scholars and instructors [11,12].

Participants' responses to specific age, education and occupation groups were examined together and comparatively. Looking at the demographic results (Table 1), we see that the majority of the participants have at least a graduate level education and are professionally related to the space (*e.g.jobs as architect/ interior architect*). This profile of users was expected, as the exhibition was held in the architecture faculty; therefore, the evaluation questions were prepared with this expectation in mind.

It is possible to group the participants as follow:

12 undergraduate and graduate students (*group A*), 10 PhD candidates (*group B*) and 16 post- PhD scholars (*group C*). The second section aims to find the participants knowledge and prior experiences of the AR and related technologies. The third and fourth sections of the questionnaire were designed to ascertain the participants' perception of the information communicated by the experience. The process of perception is quite relative for every person; trying to understand the level of it can also result in ambiguous conclusions. Therefore, to determine a level of perception it is necessary, at minimum, to ask participants if they listened to narration, read the supporting posters and banners and completed the tour. Their answers to these questions also contributed to our assessment of participants' level of satisfaction and the quality of the overall experiences. The fifth and final section of the questionnaire was about the participants' views on issues of conservation, and it queried whether the scenarios helped them to shape these views. The corresponding answers support the view that all the layers of Nano heritage should be conserved, and the @ Rkademi environment was considered as a valued way to represent the previous architectural states. The questionnaire contained multiple choices, plural multiple-choice and open-ended questions. The multiple-choice questions in section 5 provoked participants to think about the conservation of the heritage and to evaluate the role of the relevant experience [10,11].

@RKADEMI PROJECT

The Cemile and Munire Sultan Palaces seem to occupy a small place when all the cultural history of Istanbul is considered, but they have stood witness too many important political and social developments since they

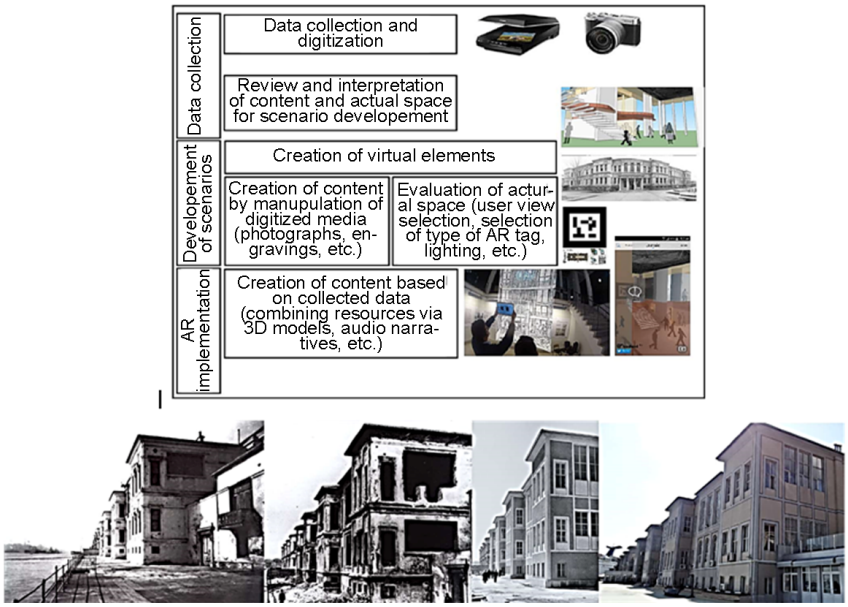

Fig. 1. Creation workflow for @Rkademi project [10].

were built in 1859. As an educational institution, Mimar Sinan Fine Arts University, the oldest art institution in Turkey, has a history of 133 years; it started as Imperial Fine Arts School (*Mekteb-i-Sanayi-I Nefise-I Şahane*), and now includes these two structures. This project was an effort to digitally embed the historical strata of these university buildings by me Ans of AR into the day-to day life of campus. The goal in communicating these historical layers was for users to perceive the intrinsic value of this architectural heritage [11,12].

In order to include these different historical layers, the previous functions of the buildings of the Mimar Sinan Fine Arts University Findikli Campus and the spiritual impacts of these changes were researched in the archives and gathered from previous projects. Using the information, we gathered, we were able represent the significant architectural changes in augmented reality scenarios and turned those into AR experiences within the @Rkademi AR exhibition (Figs. 1, 2). The exhibition took place at MSFAU Findikgil Campus between 17 November and 31 December 2014. This date was chosen for the availability of the space and the relative high user density around these dates. Although total visitation time was dependent on the users' interest and the walking distance between the points of interests, the total duration of visiting the exhibition was thirty minutes. @Rkademi contains data about the buildings in different point of the time, which was gathered from books, university archives and other works about the buildings. The data was classified according to both time and place, and then we created twenty scenarios to cover the life span of the buildings and environment, up to the present day. The data we found also include a social narrative of the Mimar Sinan Fine Arts University Findikli Campus, which was previously named the State Academy of Fine Arts; the social narrative tells another story, of the campus's intangible heritage, which covers more than 120 years of education in fine arts and architecture (Figs. 1, 2). To create the AR environment, the Metaio AR design environment was used (*Metaio Creator, Junaio, Metaio Toolbox, etc.*). Using this AR environment also made it possible for us to develop the experience in both Android and iOS platforms, which was essential for researching a broader audience with a familiar interface. The 3D reconstructions were made in Trimble's a bigger problem than expected. Most significantly, as stated in AR Cathedral Project the properties of light changed through the day, and the changing interior lighting made it difficult to create visual trackable. Therefore, we used a rather conventional method of image tracking, which also served as a hint to the visitor than an AR experience was available (Figs. 1, 2) [10-12].

EVALUATION OF @RKADEMI

Results of Questionnaire Evaluation Previous AR Experience

Although the participants' smart device ownership

Fig. 2. Entrance of Mesfau Findikli Campus, (photographs from before* (below) the renouation and current state (above) (*Courtesy of Mimar Sinan Fine Arts University Photography Studio) [12].

was very high, only 23,7% of the users had previously encountered AR environments. Participants' use of AR and VR-like environment was 39,7%. According to these results, it is possible to say that some of the participants had prior knowledge of, or interest about, the medium. On the other hand, considering the wide use of navigation software on portable platforms and the (*assumed*) spatial interests of the participants, the result was lower than expected. The participants' responses to the question evaluating the usability (*ease of use*) of the application was 4,1 (*out of 5*). This result had a uniform distribution across groups A, B and C. When assessed together, the lack of familiarity with AR experiences that was identified in previous question and the result of this usability question reveal that the application is more useful than the participants expected.

Although the AR environment was new to most of the participants, the replies to question 2f---" Would you like to use this kind of application to be informed about your surroundings?" --- were quite positive (*4,7 out of 5*) This positive attitude might reflect the view point known as "hight-tech Nano perception", but a positive view of AR can also be attribute to the excitement and sense of discovery created by this spatial experience. It is worth nothing that iOS users gave an average rating of 4,3, but the average for Android platform users was 5,0; this was the only question that elicited a different response based on operating platform.

The User's Evaluation of the AR Experience

Sixty percent of the participants indicated that they read the printed material (*posters and brochures*), which, in the context of an AR environment, would normally be considered a high rate, 3, 6, to be low in the context of presenting important historical and heritage information. In parallel to this finding, the responses regarding the usage of audio narratives were similarly low (*3 out 5*) [9].

Another indicator for measuring the level of engagement with and influence of the experience is participants' completion rate of the exhibition scenarios. Although this is a quantitative question, we found that the responses were qualitative and the participants considered this question (3b) as an evaluation of the content, as the results were evenly dispersed between 5 to 25 scenarios. Therefore, the navigation between the points of experience was not adequate (*it was only available on printed media*), and it should have been inserted into the experience as related points.

The Contribution of the AR Experience to the User

The questions in this section were meant to explore the successes and failures of cultural information on performance. The users, who can assume have an opinion about the buildings they are in, were simultaneously given implicit information via both AR environment and the physical buildings. They expressed increased feelings of both exploration and curiosity (*4,3 out of 5*). Parallel to this, the responses to question 3f--- the need to obtain more information about the architectural heritage --- were similarly high (*3,9 out of 5*) [9].

For question 4a, visitors replied that they were given enough information, including the brochures and posters. Responses to question 4b---navigation between exhibition markers--- were considered low (3,7 out of 5), perhaps because printed media was required for navigation.

For the last question in this section, regarding the duration of the @Rkademi experience, the vast majority of users (71%) felt that the exhibit and AR experience should be permanent. Responders felt that this AR environment should be designed as a permanent experience that could constantly be developed and refreshed.

Thoughts on Current Conservation Issues of the Heritage

In parallel with the previous findings, the participants' level of interest with this space and heritage and the responses to the question of how effective the experience is in construction or supporting these views are positive. The assessment shows that the users benefited from this experience, and it helped shape their views regarding conservation. The positive responses to question 4f--- would the participants would like to use AR for other purposes---reinforces this finding [9].

Expert Review

The expert review panel's primary concern was whether the experience, and especially the exhibition

sections, communicated clear and transparent information about the heritage of the site. One area where this came into question was in the models of the current and former state of Mimar Sinan Hall (*the model of its former state was created from old photographs*). In the presentation of the models, to prevent possible tracker misalignment, the interpretation of the present situation was in white, while the digital visual reconstruction of its older state was shown in yellow, with the ceiling plan photo added in black and white. Reviewers pointed out that, in these experiences, the visualization can create a misleading perception of old/new and existing and evidence-based interpretations. It is necessary that in future the methods and display techniques used should be carefully designed to ensure that this distinction is made clear and tp prevent potential interpretation problems [10-12].

Suggestions for Improving the Evaluation:

Interaction should be increased and gamification options should be explored. An interactive and bi-directional infrastructure, which can also support mission performance assessments, would allow for the continuous evaluation of outputs and the development of the AR environment.

Following the evaluation of the user surveys, it was decided that the following questions and methods should be added to clarify certain topics not covered effectively in the evaluation:

1- The extent to which the content is remembered by users; this can be measured by post-experience survey.

2- Plan on follow-up evaluations that can be carried out on subsequent visits of the same participant, and monitor changes in his/her views.

3- The need to sample from the user population from outside architecture and its related fields which accounts for a large part of the participant profile. A more diverse sample would allow for more precise decisions on perceptibility of digital environments and susceptibility to three-dimensional environments.

CONCLUSIONS

The @Rkademi project and evaluation created a communication opportunity for discussion about space, heritage and conservation between participants and experts. Throughout the study, the process evaluation itself helped to clarify the "question posed," to suggest improvements in usability and to communicate the message and values of the heritage. The questionnaire, therefor, can be considered as important not only as an evaluation of the application and the environment but as an opportunity to direct participants' attention to specific parts of the experiences, therefore helping to communicate the significance of the place. In order to construct a better interface for communication, both the questionnaire and the assessments should be carried out simultaneously in the environment and throughout the AR experience.

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