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Elements of Museum Mobile Augmented Reality for Engaging Hearing Impaired Visitors

Esraa Jaffar Baker[1,a)], Juliana Aida Abu Bakar[2,b)] and Abdul Nasir Zulkifli[2,c)]

[1]*School of Multimedia Technology and Communication, Universiti Utara Malaysia, Malaysia,
The University of Mustansiriyah, Iraq*

[2]*Institute of Creative Humanities, Multimedia and Innovation,
Universiti Utara Malaysia, Malaysia*

a)Corresponding author: esiraq@yahoo.com.com
b)liana@uum.edu.my
c)nasirzul@uum.edu.my

Abstract. Nowadays, designers are more concern with the issue of engagement and informal learning at museum and gallery sites. This has made studies to focus more on the use of Mobile Augmented Reality (MAR) at museum and gallery sites. However, most of the MAR applications for museum visitors are largely tailored to normal hearing visitors while the hearing-impaired (HI) visitors are not supported. The hearing impaired (HI) community account for over 5% of the world's populace which is about 360 million people. Thus, this paper explores the design elements of mobile augmented reality for engaging hearing impaired visitors at the museum site. The findings of this paper argues that there are eleven major elements of engagement of MAR needed for the design of an efficient museum MAR app for hearing impaired visitors. These eleven elements include Aesthetics, Curiosity, Usability, Interaction, Motivation, Satisfaction, Self-Efficacy, Perceived Control, Enjoyment, Focused Attention and Interest. This study pointed out that for an efficient and engaged MAR app for the HI community especially HI visitors to museum sites, these eleven elements are critical. This finding will help MAR designers and developers on how to design an efficient and engaged MAR app for the HI community at large and museum HI visitors specifically.

INTRODUCTION

MAR apps have enormous benefits which include mobility, handle, wearability, environment-awareness, multi-modal, flexible usage, visual alerts and reminders which have positive social interaction. Despite the facts that MAR apps have enormous benefits to human beings both socially and industrially, however, there are still few technical limitations of these applications such as outdoor and portability use, depth perception, tracking and calibration, user experience, overload, and over-reliance [1]. Out of these limitations, many studies have focused on users' experience because it is believed to promote MAR social acceptance. This has made researchers such as [2], [3], [4], [5] and [6] to investigate on ways to increase users' engagement and learning in MAR. In these studies, engagement depicts the act of raising users' attractiveness and interest in a pleasing manner in order to get their attention to performing activities at the museums whereas learning refers to the informal learning that can be obtained in the museum environment.

Nevertheless, there is still lack of study that explores MAR users' engagement and learning criteria among the Hearing-Impaired (HI) people, especially among museum HI visitors and tourists. It is unfortunate that the HI tourists are having huge difficulties not only with accessibility issues within the museum but also with the engagement experience [7]. Likewise, it is unfortunate that little is known about how people with hearing losses can have an engaging informed learning experience within the museums. This is because most of the technological solutions and devices provided in most museums are not suitable and appropriate to enhance HI visitors' and

tourists' engagement experience. Therefore, this paper explores the design elements of the mobile augmented reality for engaging hearing impaired visitors at the museum site.

METHODOLOGY

The main aim of this study is to explore the engagement MAR elements that are needed for the design of an efficient museum MAR app for hearing impaired visitors. The study employed the combination of both systematic literature review and expert opinion. This approach was considered suitable based on the objective of the study and as implemented in a similar study by [8]. The systematic literature review was used to identify the elements whereas the expert opinion was used to validate (check the consistency of these elements to the real scenario) the identified elements. There were five phases involved in the study methodology as summarized in Figure 1.
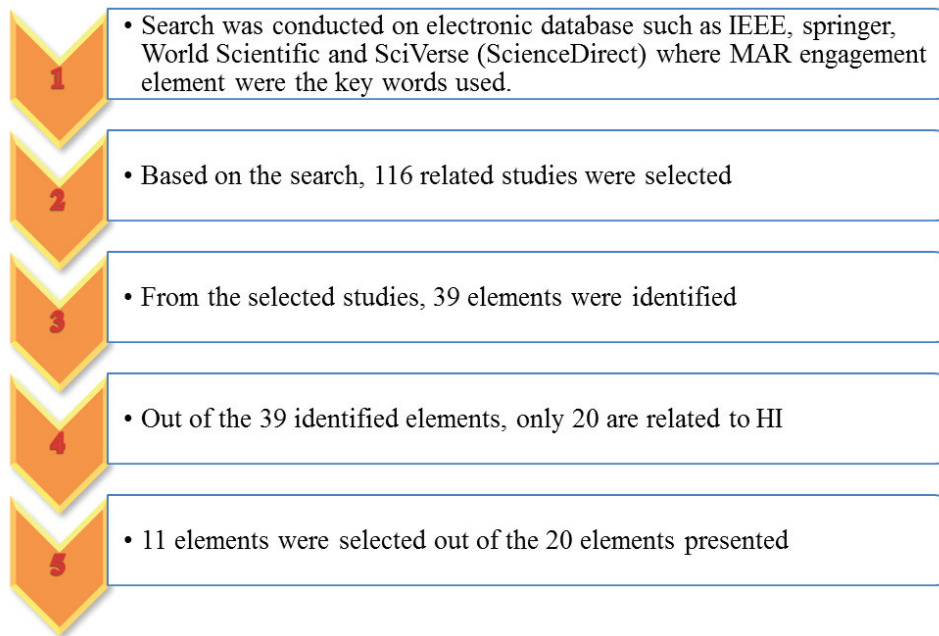

1. • Search was conducted on electronic database such as IEEE, springer, World Scientific and SciVerse (ScienceDirect) where MAR engagement element were the key words used.

2. • Based on the search, 116 related studies were selected

3. • From the selected studies, 39 elements were identified

4. • Out of the 39 identified elements, only 20 are related to HI

5. • 11 elements were selected out of the 20 elements presented

FIGURE 1. Methodology

Based on the study objective, the first phase of this study is to conduct a systematic review from related database on MAR which includes IEEE, SpringerLink, World Scientific and ScienceDirect. The key words used for this review includes mobile augmented reality engagement. These key words were searched combinatorial and interchangeably in order to obtain more specific and refine outcomes. Based on these searches, a total of 116 related studies were selected and reviewed critically where 39 elements were identified. The 39 identified elements were further examined by investigating whether they are relevant to the HI in the light of the HI literature. Only 20 out of the 39 elements were found to be related to the HI people. Then, the 20 elements were presented for expert opinion where the experts were made up of academicians, HI medical personnel, museum management and MAR designer experts and a total of 11 elements were selected. These 11 selected elements are considered as the major engagement MAR elements that are needed for the design of an engaging museum MAR app for the hearing impaired visitors.

THE ELEMENTS OF ENGAGING MUSEUM MAR FOR HI

The findings of this study determined eleven major elements of the MAR required for the design of an engaging museum MAR app for the hearing impaired visitors. These eleven elements include Aesthetics, Curiosity, Usability, Interaction, Motivation, Satisfaction, Self-Efficacy, Perceived Control, Enjoyment, Focused Attention and Interest. These elements are further discussed as follows:

Aesthetics: This is one of the elements identified and it is the element of mixing the nature of beauty, art, and taste and with the creation and appreciation of HI MAR [9]. This element injects the theory of beauty into MAR, so that mobile users can appreciate the expression and representation of the message that the MAR app is conveying as expressed in [10].

Curiosity: This is the element that describes quality about inquisitive thinking which will push users to internal exploration and investigation. This concept promotes informal learning whereas users learn by investigating and exploration. The concept has been implemented in studies such as [11], [12], [13], and [4] where it is discovered that apps that increase user curiosity can successfully engage the users in the learning environment.

Usability: This is the element of flexibility, ease of use and learnability of MAR. As mentioned by [14], ease of use of a system is one of the measuring tools for evaluating MAR apps. Similar concept has been implemented in studies like [15], [13], [10], [9], [16] and [17] where it is maintained that usability promotes users engagement and satisfaction with the MAR.

Interaction: This element depicts the way and manner that users and app connects. This is important because the platform and nature of the app communication will affect user engagement with the app [16]. Thus, ability to connect between users and application is critical to engagement [18].

Motivation: The element of motivation defines the ability for users to be willing and desire to accompany task [18]. Studies such as [4] have shown that users usually get engage with apps that they perceive to inspire or motivate them toward excellent.

Satisfaction: This element implies creating pleasing moments with an app which is usually by users fulfilling their expectations on the app. This concept pinpoints that every users usually have predefine target or aim for exploring an app whereas if this target aim is not met then they will disengage with the app. On the other hand, if the target aim is met then they will become more engaged with the app [19], [11] and [20].

Self-efficacy: This element defines confident in users' belief in their ability to succeed in specific situations or accomplish a task. Based on [21] and [22] studies, any apps that enhance users' self-efficacy will also engage them.

Perceived Control: This is the belief element that users feel that they are in control of the event or situation within an app. It is a state that users have the understanding that they determine the internal situation and event within an app. This state becomes more intense when users belief that they have more control and influence on the app environment and/or bring about desired outcomes. This element has been used in studies such as [12] and [15] where it is noted that users' perceived control on app promotes their engagement.

Enjoyment: It is an element which implies the feeling of being benefiting to the conveying message of app. This element involves users experiencing fun, joy, satisfaction, peace and fulfilment based on their interaction with the apps [23].

Focused Attention: This is the element that portrays attraction of awareness in order to make a communicated message more interesting and fun to users [24]. Many studies such as [10], [24], [4] and [22] implemented this element in their studies and concluded that apps which are able to gain attention of users will successfully engage users.

Interest: The element of interest is the gaining of users' awareness and concern in order to get them involves and participates in predefined action or behaviour. Many studies such as [19], [11] and [4] have argued that users' engagement is succeeded when they are interested in the app message.

These eleven selected elements are considered as the major engagement MAR elements that are needed for the design of an efficient museum MAR app for hearing impaired visitors and they are summarized in Table 1.

TABLE 1: Summary of the Identified Eleven Elements

No	Element	Description	Reference
1	Aesthetics	Visual beauty or the study of natural and pleasing (or aesthetic) computer-based environments	[4]
2	Curiosity	This is when the human mind thirsts for knowledge by investigating an environment, object or situation in search of the knowledge.	[12]
3	Usability	This is the measurement of the suitability and ease of use of the app functionality as perceived by the users. It is the users' emotional experienced when using an app and it defines the users' efforts, feeling and control on the app.	[25] , [10]
4	Interaction	This a form of social relation and connection between users and an app	[26]
5	Motivation	This is a drive toward involvement in order to achieve (fun and enjoy) a target (learning or playing)	[27]
6	Satisfaction	This is the act of being contend and fond with an app	[18]
7	Self-Efficacy	Self-efficacy is one's belief in one's ability to perform a desired outcome while computer self-efficacy is the belief in one's ability to perform a desired outcome using a computer.	[28], [29]
8	Perceived Control	Act of dominating, commanding and regulating others, an activity, or a system.	[12]
9	Enjoyment	The user experiencing fun, joy, satisfaction, peace and fulfilment with the usage of the app.	[30], [31]
10	Focused Attention	The ability to involved and absorbed on a specific task by losing track of time without being distracted	[10]
11	Interest	This is when an object or system attract attention, provoke thought, intrigue and fascinate a user.	[32]

CONCLUSION

This study has been able to depict vital elements that are needed for the design of a museum MAR app for engaging HI visitors. These eleven elements include Aesthetics, Curiosity, Usability, Interaction, Motivation, Satisfaction, Self-Efficacy, Perceived Control, Enjoyment, Focused Attention and Interest. This paper argues that for an efficient and engaged MAR app for the HI community especially HI visitors to the museum sites, these eleven elements are critical. It is crucial for museum MAR designers to consider these elements in their design in order to positively engage the HI community for both informed learning and amusement at the museum sites. Likewise, these elements will ensure that the museum MAR app transcends beyond the use of displaying texts and videos at the museum and gallery sites and also ensure that proper information is communicated and understood for the target users. Hence, this paper has presented eleven major elements of engagement of the MAR needed for the design of an efficient museum MAR app for the HI visitors. These elements will be reviewed by experts consisting of those from the MAR, Museum and HI. Nevertheless, there are still some future works to be done on the issue of museum MAR app for engaging HI visitors such as developing a conceptual model and guidelines for the design of museum MAR app. This will help MAR designers and developers on how to design an efficient and engaged MAR app for the HI community at large and museum HI visitors specifically.

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