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Measuring the usability of a smartphone delivered museum guide

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Abstract

Smartphones are increasingly being deployed by museums and other cultural spaces to provide guides for visitors, replacing dedicated audioguides or docents. This paper describes a study investigating a scale to measure the usability of a multimedia smartphone guide for a museum, the Multimedia Guide Scale (MMGS). Two different types of museum guide were compared: a free choice tour (FC-tour) and guided tour (G-tour). Result shows that there was a significant difference in scores on the MMGS between the two tours, between the three components of the MMGS (Quality of Interaction; Learnability and Control; General Usability) and a significant interaction between the two variables (factors and the guides). The mean scores were higher for the G-tour on the General Usability component and particularly on the Quality of Interaction component, whereas for the Learnability and Control component, scores were higher for the FC-tour Guide. The implications of these findings and the use of the MMGS are discussed.

1. Introduction

Museums and other cultural spaces (such as archaeological sites, art galleries, castles, historic churches and so on) are constantly looking for ways to improve visitors' experiences and very interested in the latest technological developments. The ongoing changes deployed by museums have consistently proved that it always driven by museum to improved their visitors' experiences, for example the introduction of different technologies in cultural spaces, from display technologies to mobile guides with audio, then multimedia tours on different devices as well as introduction of apps for smartphones, and many more increasingly sophisticated developments. This notion was supported by [1], in which they stated that looking for a new technology to keep up with the demand is one of every museum's goals and motivations. Museums were certainly very early adopters of personal mobile technologies, mobile audioguides were used at the Stedelijk museum in Amsterdam as early as 1952 [2].

Cultural spaces are beginning to encourage their visitors to use their own smartphones rather than renting dedicated mobile audio or multimedia guides. This saves the organization the cost of purchasing and maintaining their own supply of dedicated audioguides, as well as other related costs such as staff and the space required for renting out and returning the guides. Visitors also benefit, in that they do not have to worry about learning how to use different devices every time they visit a different cultural space, and possibly even having negative transfer of

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training between devices, if different devices work slightly differently [3]. For example, research by the Handscape Project [4] highlighted the importance of minimizing the learning curve for using mobile multimedia guides in museums. Having an app on one's smartphone may also encourage further interaction with the cultural material, pre and post visit to the cultural space. Some cultural organizations have already developed apps to function as multimedia guides for smartphones. These multimedia apps are rich in a range of content types such as text, images, video, audio, interactive images, panoramic images and so on. For example, an iPhone app for museum' visitors and art gallery [5-6]. If visitors are going to use their own smartphone with a multimedia app as a guide when they visit a cultural space, it is important to be able to measure the usability of the "app as guide", as we would want to study the usability of any other software and device. Cultural organizations usually have very limited resources for conducting usability evaluations, but they have many visitors. Therefore we have explored the use of a short questionnaire to measure the usability of multimedia guides [7]. In this study we concentrate on comparing two possible versions of a multimedia smartphone guide for a museum: a free choice tour (FC-tour) and guided tour (G-tour). This study was a feasibility study for a larger study to be conducted in the real world environment of a museum, so used a mock up of a museum in a number of rooms of a university.

2. Motivation

The motivation of this research is driven by the use of mobile technology within cultural spaces, which has often failed to address the importance of interaction between visitors with the exhibits while using such devices. One way or another, visitors' are on the losing end, which they either actively interact with the guides and loosing focus on the artefacts or become distracted with the guides. In addition, it is important to provide a wide range of possible solutions to accommodate the diversity in visitors by providing different types of mobile tour (free-choice or guided tour). This will reflect the notion of the diverse experience of visitors in cultural spaces which is far more than anyone can handle or grasp, so introducing new technology is not always the solution to improving the quality of that experience [8]. It is interesting that those who manage cultural spaces are eager to adopt the new available technologies but fail to understand their visitors' needs and experiences. For example, several previous studies have shown how these technologies failed to improve visitors' total experience (to name a few: [9, 10]). These technologies are only able to improve some part of the visitors' experiences because of several weaknesses which have been identified in the studies. One of many reasons may be a lack of understanding visitors' expectations and needs (for example, failing to support visitors' interactions with one another, not allowing the active construction of information, being just a passive receiver) or maybe these technologies fall into the category that was identified by Smith [11]. This research explored the use of free-choice learning concept as opposed to the traditional ways information were presented on the mobile guide (guided tour) and how these two paradigm have an impact to their users' experiences in cultural spaces. Importantly, we wanted to address whether mobile guides offering different types of tour are one of the "successful multimedia" or belong to the categories that are "*trying to do too much, using technology which is too complex, too expensive or not ready for primetime"* ([11], p.1).

3. Background

The introductions of the first 'random access' mobile guide, called *INFORM*, at the Louvre museum in Paris in 1993 significantly changed the way visitors use mobile guides in museums. The random access guide at the Louvre museum was the world's first digital wand player [12]. The random access mobile guide, or free-choice mobile guide, allowed visitors to choose which exhibits to visit in whichever order they liked. An extensive research and adoption of mobile and smartphone in cultural spaces has shown significant impact to the visitors, particularly on the visitors' engagement, learning as well as their interaction with the museums' multimedia guide. For example, in a recent study, mobile phone was use as a mobile game device for learning cultural heritage [13]. They have developed a treasure hunt games using short messaging service (SMS) to promote active learning and engaging activities in informal environment for school children. They compared learning outcomes for both, secondary and primary school children. They produced a set of scale that measured the engagement in three indicators; fun, interest and hardness. Result shows that the engagement levels were significantly higher for primary school children in all three engagement indicators. Previous studies on the use of PDA based mobile guided tours for children found that the systems are able to improve children's engagement with museum pre-defined learning activities [10].

Children are also able to spend more time with less interactive or attractive exhibitions when using such systems. This system is designed with pre-defined learning activities in which the children use the provided PDA to move around the museum exhibits.

Currently, museums have changed to more concrete functions such as enabling and facilitating active learning and also with the engagement with exhibits as well as other visitors in actively collaborating information seeking and sharing. Digital technology display devices and their associated hardware enable museums to provide a visitor a free choice of learning environment where users are given various ways to explore museum exhibitions that suit visitor preferences. In addition, the use of such technology is believed to improve the museum landscapes by enabling self-directed exploration and discovery in contrast to the more traditional approaches which follow what have been asked and given to the visitors. New technologies such as mobile and smartphones are important tools that are able to promote unparalleled opportunities for learning in cultural spaces. Through audio and multimedia tours, multimedia presentations and video guided tours, they can be seen to have enhanced their role as providers of free choice learning. Such forms provide information using such technologies that make the museum one of the more accessible and more attractive places to spend time at.

Although numerous projects have developed mobile learning applications for cultural spaces, including applications which enable interaction between visitors or group members (for example, [14, 15, 16, 17, 18]), but none of them have focused on free-choice learning. On the other hand, although some research has been conducted on free-choice learning (for example, [19, 20, 21, 22]), no study could be found which compares G-tours and FC-tours on mobile guides. In addition, to date, there have been a few studies carried out focusing on free-choice learning (for example, [19, 20]) but none of them have dealt with the use of mobile guides in cultural spaces. This study will put an emphasis on measuring usability of smartphone mobile guide using free-choice tours and guided tours.

4. Method

This study was the initial testing of the multimedia guide, so it was appropriate to do it in a lab situation. When the guide and the methodology have been validated, then we will use a real museum setting to test the different types of guides. This study is a part of larger study for measuring visitors' experiences with multimedia guides in cultural spaces. To facilitate the evaluation, the Interaction Laboratory at the University of York were configured so that that resembled a cultural space as such a museum exhibition.

4.1. Design

The design of the study was experimental using random sampling. Participants were randomly assigned into two different groups (8 in each group), one which use the free choice web-apps tour (FC-tour) and the other use the guided tour web-apps (G-tour). Participants spent as long as they wished using the web-apps, and move around the exhibitions room to view the exhibits (in the posters form) with the help of the web-apps guide. The main data collection for this pilot study is using questionnaires. The participants were given a set of questionnaires to get their views on the web-apps (iPhone tour) they have used. They were asked to complete a questionnaire covering a range of aspects of their experience with the web-apps using iPhone, including the usability, user experience and engagement with the site as well as their demographic information.

4.2. Participants

16 participants took part in this study, 12 men and 4 women, ages from 24 to 55 years, mean age of 34 years (SD=10.1). They came from various backgrounds: university students, university lecturers, researchers, administrative personnel and member of the public who volunteered to participate in this study. The majority of the participants were students (75% of the overall participants). In addition, 8 participants were English native speaker, 8 were not. The main reason for using a varied sample; university's students and staffs as well as member of the public in this study was because the study should include all types of museum visitors. Furthermore, these participants were chosen because they are familiar with the use of iPhone, thus would not require any training to use such system.

4.3. Multimedia Guide Scale (MMGS)

Previously, we have developed the MMGS for assessing the usability of multimedia guides that might be deployed in museums [23]. The MMGS was developed using a full psychometric procedure [24, 25]. The procedure is explained in full detail in [23], but can be summarized as follows:

- A large number of possible statements about people's reactions to museums were collected, mainly from the literature
- An analysis of these statements was made to reduce them to 20 non-overlapping statements
- 102 people who had visited any cultural spaces within 6 months of it's been advertised were asked to rate their experience using the statements
- a principal components analysis was used to find which statements produce similar ratings and to reduce the set of statements further to a number of specific components and were available in [23]

The questions were of close-ended questions and measured by Likert items [26], which represents scale from "1 as strongly disagree, 2 as disagree, 3 as neutral, 4 as agree, and 5 as strongly disagree".

4.4. Procedure

This study was carried out at the Interaction Laboratory, University of York using the iPhone as the mobile guide. In addition, the Interaction Laboratory was configured such that it resembles the nature of the culture spaces as such in museum exhibition. Despite of the need to conduct this research in a real museum setting, this study was the initial testing of the web apps, so it was appropriate to do it in a lab situation. When the web-apps and the methodology have been validated, then we will use the realistic setting (real museum setting).

The University of York Interaction Laboratory was divided into four different rooms that will have different exhibition on displays. The rooms are: Leather working in Viking York, Blacksmithing in Viking York, Woodworking in Viking York and Home Life in Viking York Large colour photographs of a range of exhibits from the Jorvik Viking Centre were placed on the walls in these rooms with suitable captions and labels. Participants were also provided with a floor plan of the exhibition space which showed the location of the exhibit groups. When participants arrived, they were asked to gather at the main entrance and then listen to instructions from the instructor and were asked to read and fill out necessary documents (i.e. information consent form, etc). They were asked to use their own iPhone in this study and then browsing the exhibition with the help of web-apps guide assigned to them. Participants were run individually but more than one active participant in the exhibition area at one time. It took between 15-30 minutes for each session. Participants were randomly assigned either FC-tour or G-tour by the instructor by dividing the participants into two different groups. They were then asked to complete the questionnaire provided. Finally, they were thanked for their contributions to the study and were given a gift voucher worth £10.

The material used to develop the web-apps for this study was gathered from the Jorvik Viking Centre in York, mainly from their official Viking Centre website as well as from a book called Treasures of York, written by [27]. These materials were converted into a web-apps specially designed for iPhone for this study. HTML was used to design and develop the web-apps. Two different versions of the web-apps were designed and developed to examine the free choice tour and guided tour. These iPhone web-apps were designed and developed such that their navigation suit the FC-tour and G-tour and have the same amount of information. Fig 1 shows snapshot of FC-tour web-apps whilst Fig 2 shows snapshot for G-tour web-apps. Fig 1 shows the user interface for leather working section for G-tour. The picture on the left shows the top side of the page with the navigation buttons (i.e. "Next" and "Back"), whilst the picture on the right shows the bottom side of the page. The user can continue to the next page either by click on the "Next" button or the link at the bottom of the page. Fig 2 illustrates the user interface for blacksmithing section for FC-tour. The picture on the left shows the top side of the page with only one navigation button (i.e. "Back"), whilst the picture on the right shows the bottom side of the page, which is the same as the G-tour. Fig 3 shows the interface for the FC-tour if the visitors click on the navigation link "Blacksmithing Objects" in the previous page. This function is not available for the G-tour because they will be directed to first available object in this category as shown in Fig 4 after click on the "Next" or "Leather Working Object" navigation link. The visitors for FC-tour can select which object they wanted to view. Thus making this more interesting and engaging for

visitors as they can select which object of their interest without have to views information of the object they don't like to view.

Fig. 1. A snapshot of a page in the FC-tour;

Fig. 2. A snapshot of a page in the G-tour.

Fig. 3. The interface for object selection in FC-tour;

Fig. 4. The first page after user click on available objects in G-tour

5. Results

5.1. FC-Tour Vs G-Tour

To analyze the results of the study of the two versions of the Mobile Guide, we took the answers to the MMGS and calculated the mean rating for the responses on the questions on each of the components. The results are shown in Fig 5, below. A two way analysis of variance (G-tour vs FC-tour) on these scores showed that there were significant differences between the scores on the three components ($F = 27.54$, $df = 2, 28$, $p < 0.001$), a significant difference between G-tour and FC-tour ($F = 4.53$, $df = 1, 14$, $p < 0.05$). There was also a significant interaction between these two effects ($F = 4.16$, $df = 2, 28$, $p < 0.05$), meaning that the differences between the two tours were different depending on the component. Thus we can see in Fig 5 that scores were higher for the G-tour on the General Usability component and particularly on the Quality of Interaction component, whereas for the Learnability and Control component, scores were higher for the FC-tour.
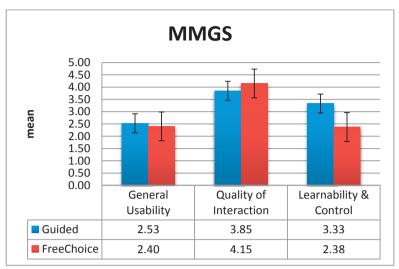
Fig 5. Mean scores on the three components of MMGS for the two Guide groups.

5.2. Post-Hoc Test

A further analysis were made to the data using Fisher' Least Significance Difference (LSD). This analysis was made because we need further analysis to see the difference between the three components in the scales. The Participants were classified into four different groups as follows: (1) Native speaker using guided tour (NS-GT); (2) Native speaker using free choice tour (NS-FC); (3) Non-native speaker using guided tour (NNS-GT) and (4) Non-native speaker using free choice tour (NNS-FC).

A post hoc analysis revealed that there are a significant different between native speaker group who using FC-tour with non-native speaker group who use a G-tour. These results are highlighted in colour in Table 1.

Table 1. Post-Hoc comparison between the native speaker group using the FC and the non-native speaker group using a GT

			Multiple Comparisons				
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
	(I) group	*(J) group*				*Lower Bound*	*Upper Bound*
LSD	1 (NS-GT)	2 (NS-FC)	-.2015	.17379	.269	-.5801	.1772
		3 (NNS-GT)	.2163	.17379	.237	-.1624	.5950
		4 (NNS-FC)	.0000	.19431	1.000	-.4234	.4234
	2 (NS-FC)	1 (NS-GT)	.2015	.17379	.269	-.1772	.5801
		3 (NNS-GT)	**.4178**[*]	**.15051**	**.017**	.0898	.7457
		4 (NNS-FC)	.2015	.17379	.269	-.1772	.5801
	3 (NNS-GT)	1 (NS-GT)	-.2163	.17379	.237	-.5950	.1624
		2 (NS-FC)	**-.4178**[*]	**.15051**	**.017**	-.7457	-.0898
		4 (NNS-FC)	-.2163	.17379	.237	-.5950	.1624
	4 (NNS-FC)	1 (NS-GT)	.0000	.19431	1.000	-.4234	.4234
		2 (NS-FC)	-.2015	.17379	.269	-.5801	.1772
		3 (NNS-GT)	.2163	.17379	.237	-.1624	.5950
Based on observed means. The error term is Mean Square (Error) = .057							
*. The mean difference is significant at the 0.05 level							

6. Discussion

We have successfully used our MMGS in a feasibility study of two versions of a multimedia smartphone guide for a local museum, using a simulated museum setting. We found that there are significance differences across three difference components (General Usability, Quality of Interaction and Learnability and Control). These components are important in measuring the user's experience when using multimedia guides in cultural space and are of considerable interest to guide developers and the personnel responsible for cultural spaces. In terms of overall effects, the FC-tour should be viewed more positively than the G-tour, as it gives more freedom of interaction. Interestingly, although this was true for the Quality of Interaction component, overall the G-tour was viewed more positively than the FC-tour. This may be because the G-Tour provided a clear route through the exhibits, and was considered good in usability and learnability terms. Thus the results from usability of guides need to be combined with information about the overall user experience in the cultural space, a topic we have also explored [23].

6.1. Quality of Interaction

It is undeniable that one of the important measures of users' experience when using multimedia guides in cultural spaces is the quality of interaction between the users and the guides. Users are said to have a more meaningful experiences when they can easily use the guide provided without having to learn and re-learn new technologies. In addition, the quality of interaction also refers to the ability of the guides to respond to the users' actions. A good multimedia guide should not become a barrier between the users and the exhibits. This will not happen when the interaction between the users and technology is seamless, without any issues or problems. For example, the use of a system that employs context-awareness that can eliminate unnecessary information but at the same time enable users to retrieve as much as possible information when needed [28, 29]. Clearly, the use of multimedia guides in cultural spaces is meant to impact on visitors in a number of different ways, be it a G-tour or FC-tour. The use of this guide in the cultural space should help users to learn more about the exhibits and at the same time have a meaningful experience in the cultural space. The option of having both a G-tour and FC-tour available will improve visitors' experiences as they can select which guide works better for them.

6.2. Learnability and Control

The mean rating for Learnability and Control component was significantly higher for the G-tour than for the FC-tour. This is an interesting and worthy of further study because, theoretically the FC-tour user should have better control of the guide and learn better compared to the G-tour users. Importantly, one of the reasons why G-tour users are more in control because they only follow a set path through the guide material, thus require less learning and increase more control of the guide. The use of FC-tour should give more users more possibility to control and choose what they want to view within the exhibition and not restrict their usage. This would suit best users who come to the museum with some knowledge about the exhibits. Previous studies have found that participants were drawn into the electronic guides and this hindered them from interacting with the exhibits, thus they were losing control in the environment [30]. The same study found that visitors who do not have any experience with mobile technologies were struggling to use the device, hence the need for designing guides that are easy to learn and control. This problem can also be addressed by allowing visitors to use their own devices and download the contents of the guides into their own devices.

6.3. General Usability

Clearly, the use of mobile guides in cultural spaces is meant to offer visitors a different way of experiencing the exhibition, be it FC-tour or G-tour. The use of a guide in a cultural space should help the users to learn more about the exhibits and at the same time give them a meaningful experience. The option of having a FC-tour or G-tour will improve visitors' experiences as they know which guides work better for them.
It is interesting that the mean rating from the G-tour users was slightly higher than that from the FC-tour users. It is important to study why the mean rating for G-tour is higher than FC-tour, given that FC-tour users' are free to choose what, which and how to learn. This is supported by the contextual model of learning that can influence the

museum learning experience which emphasis on the several contexts such as personal, socio-cultural and physical context [31]. Nonetheless, this does not affect the outcome of the study as the general usability component is about the use of the guide in a cultural space and how this technology might affect visitors' experiences.

7. Conclusion

The MMGS will be a useful tool to allow developers, researchers and museum staff to measure visitor reactions to their multimedia guides or different versions of multimedia guides. It is definitely not the *only* measure of the effectiveness of such guides that should be taken, but it does provide an efficient and easy to quantitative measure of experience with a guide. This can then be complemented with other measures, such as more qualitative information about the visitor experience, obtained via open-ended questions, either delivered in writing or in person. We have used the MMGS to begin to explore the possibilities to personalize multimedia guides for different visitors (free choice tour guide). Some museum visitors may prefer to a multimedia guide that provides them with a logical progression through a set of exhibits, whereas others may prefer to move from one exhibit to another following their own interest. For this latter type of tour, the next step in our research is to add recommendations of other exhibits that would be of interest to the visitor, based on the exhibits they have chosen to visit and possibly the amount of time they have spent visiting each. This will add further personalization and individuality to multimedia guides.

Acknowledgements

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