MEASURING VISITORS' EXPERIENCES WITH MOBILE GUIDE TECHNOLOGY IN CULTURAL SPACES

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Abstract

The use of mobile technologies such as multimedia guides has now become very common in cultural spaces such as museums. However, there is still a lack of understanding about how visitors interact with such devices and simultaneously with the exhibits. Generally, research has investigated different types of informal learning within cultural spaces, both with and without mobile technologies, particularly the use of free-choice and guided tours.

The programme of research presented developed a scale to measure visitors' experience in museums (the Museum Experience Scale, MES), a parallel scale to measure visitors' experience in historic churches (the Church Experience Scale, CES) and a scale to measure visitors' experience with audio and multimedia guides in cultural spaces (the Multimedia Guide Scale, MMGS).

Study 1 established the appropriate methodology for the subsequent studies. A virtual museum was developed with two types of tour: Free Choice (FC) and Guided Tour (GT). Participants undertook a tour and answered a questionnaire about their experience. The study did not elicit any significant differences in visitor experience in the two different tour designs, but paved the way for the subsequent studies.

Study 2 developed the MES and the MMGS using standard psychometric principles based on 255 responses to an online questionnaire. Respondents answered questions about a recent experience of visiting a cultural space, with or without a multimedia guide. Four components were identified for the MES: Engagement, Knowledge/Learning, Meaningful Experiences, and Emotional Connection while three components were identified for the MMGS: General Usability, Learnability and Control, and Quality of Interaction.

Study 3 piloted the methodology for evaluating the use of multimedia guides in cultural spaces. Sixteen participants used a multimedia guide on an iPhone to view an exhibition set up in the laboratory and then completed the MMGS. This study successfully established the methodology and showed a significant effect of different types of guides (FC and GT) on the four MES factors.

Study 4 developed the CES by asking 272 visitors at three historic churches in York to respond to questions immediately after their visit. The resulting scale has 5 components: Emotional Connection and Spiritual Experiences; Knowledge and Learning; Enjoyment, Intellectual Stimulation and Curiosity; Immersion; and Information overload.

In a final study, the CES and MMGS were used to measure visitors' experience at a historic church, Holy Trinity Church in Stratford-upon-Avon. 59 visitors in total participated, 40 using an iPhone multimedia guide (21 FC and 19 GT) and a control group (CG) of 19 visitors without a guide. The findings showed a number of differences between the three groups on the CES and the MMGS. The results showed that introducing a smartphone guide in a historic church has interesting effects, both positive and possibly negative on visitor experience, particularly on the following aspects: time spent in the church; amount of knowledge gained; engagement with the church as well as with the smartphone guide; emotional and spiritual experience; and enjoyment and intellectual stimulation.

In conclusion, three scales were developed were used to measure different aspect of visitors' experience and were used in the realistic setting of a historic church. These scales make a contribution to the empirical evaluation of visitor experience of cultural spaces in general (with two different scales developed, one for museums and one for historic churches) and the use of audio and multimedia guides in cultural spaces.

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Declaration

I hereby declare that this thesis has not previously been accepted for any degree other than Doctor of Philosophy of the University of York. This thesis is a presentation of original work, otherwise stated and acknowledged.

Some materials contained in this thesis have been previously published at the following conferences:

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CHAPTER 1

Introduction

"Dewey's two aspects of the quality experience can be restated as follows: (1) The visitor interacts with the exhibit and has an experience, and (2) the visitor assimilates the experience so that later experiences are affected"
(Ansbacher, 1998, p.36)

The recent enormous development of digital technologies, particularly mobile technologies, has had a tremendous impact on our daily activities. Such technologies have shaped our ways of managing our daily routines, our communication, or our ways of socializing with other people. This interaction and communication between people and technology, or between groups of people with technology, are not limited to workplaces or the home but also includes 'cultural spaces'. The term cultural spaces refers to public spaces of cultural and historic interest such as museums, historic churches, art galleries, historic houses and archaeological sites, and the term cultural spaces will be used as a general term throughout this thesis for simplicity, while the more specific terms of cultural spaces, such as museums and historic churches, will be used as appropriate throughout this thesis. Other terminology used in this study is presented in section 1.1 (Mobile guides: terminology and definitions).

The programme of research presented in this thesis aims to explore and evaluate the use of mobile guides in cultural spaces. In addition, it also has the objective of measuring visitors' experience using two versions of a mobile guide tour which each use a different way of presenting information to visitors. One version of the mobile guide is known as a guided tour. This version of the tour is designed such that the information presented about artefacts or church features is in a sequence, which visitors will follow from A to Z without being able to choose which artefacts or church features they would like to see next. The second version is known as the free-choice tour. This version of the mobile guide allows visitors to choose which artefacts or church features are of interest to them at any time, without having to see the artefacts in sequential order. These two versions provide different types of informal learning experiences for visitors. I also interested in investigating how these differences in information presentation on the mobile guides have an effect on the visitors. For example, throughout the programme of research, I shall examine whether visitors who use the free-choice tour will be better off in knowledge/learning compared with the visitors using the guided tour. This will help those who manage cultural spaces to provide a better way of imparting knowledge using mobile guides, particularly the amount of information needed (less is more? or information overload?) or how the information is presented on the mobile guides. The difference in information presentation is crucial in understanding the difference between the two versions of the mobile guides.

In addition, this research programme will also explore visitors' experience when using mobile guides, for example whether visitors are having a meaningful experience, are actively engaged with the mobile guides or the artefacts, or are having difficulties whilst using the mobile guide. Furthermore, the research programme also will look into the interaction between visitors, including the possibility of an antisocial context developing by using technology as well as whether using mobile guides in cultural spaces will limit the interaction between visitors. It is also important to investigate the interaction with the mobile guides, for example the usability aspects of interaction with the mobile guides, how the information is presented on the screen, how to learn about the mobile guides' functionality and how to control the guides.

1.1 Mobile guides: Terminology and definitions

Nowadays, the use of mobile technologies, such as smart phones, is not limited to telecommunications, but opens up many new opportunities for other activities to be accessed via such devices. For example, Proctor (2011) has described how the term 'mobile' "has come to encompass ever expanding fields of platforms, players, and modes of audience engagement". She further added that the description 'mobile' refers to:

1. **Pocketable**: phones, gaming devices, personal media players and **portable** devices (tablets and eReaders);
2. **Smartphones which** run apps and give access the internet, and older **cellular phones** which do nothing more than make voice calls and send text messages;
3. **Podcasts** of audio and video content, and other **downloadable content,** including PDFs and eBooks;
4. **Mobile websites,** optimized for the small screen and audiences on the go, and **'desktop' websites**, designed for large, fixed screens but which are increasingly visited by mobile devices.

(Proctor, 2011, p.2)

Numerous terms are used to refer to the kinds of technology that are the focus of this programme of research. For clarity and consistency, the term 'mobile guide' will be used to cover technologies that are portable, such as handheld technology, mobile devices, portable devices/technology and ubiquitous technologies. In addition, the terms 'mobile guide', 'audioguide' and 'multimedia guide' will be used when necessary throughout this thesis. Mobile guides in this study refer to the mobile devices used in cultural spaces to help visitors by providing information about particular exhibits or artefacts by means of a guided tour or a free-choice tour.

The terms 'artefacts' or 'exhibits' in this study refer to the artworks, real objects, and other objects of interest on display in cultural spaces' exhibitions, either as a permanent collection or a temporary exhibition. In historic churches, aspects or points of interest are the church's features such as the altar, rood screen, choir stalls, pulpit, stained-glass windows and many more features. These terms will be interchangeably used as appropriate throughout the thesis.

There are different types of visitor to cultural spaces; they come for various reasons and measuring visitors' experiences has never been easy. Visitors' experiences in this study may include emotional and spiritual experiences, intellectual stimulation and curiosity, being mesmerized by the aesthetic of the artefacts, and many more.

Mobile guides in cultural spaces now follow one of two well-established conventions. Either they provide visitors with a particular path through the exhibits, a guided tour, introducing the artefacts and points of interest in a fixed, but logical order (often called a multimedia tour); or they allow visitors to move freely around an exhibition, selecting which order they view particular artefacts and points of interest (free-choice or random access tour). In both cases, the information provided to all visitors is the same, regardless of their particular interests in the exhibits and their personal capabilities (for example, visual or hearing impairments). The mobile guides also rely on visitors knowing where they are and informing the system (for example, by entering into the guide the number from the label of the exhibit which they are currently viewing).

Falk and Dierking (1992; see also Falk & Dierking, 2000; Falk, 2005) developed the concept of "free-choice learning" as part of their contextual model of learning to explain the way visitors to cultural spaces are not bound to guided tours of exhibitions, but are "voluntary, and guided by [their] individual needs and interests" (Falk & Dierking, 2000, p.9). In other words, free-choice learning refers to ways of learning which are based on visitors' own choices and are not directed by the views a curator (or other expert), or the objects which the curator thinks they should learn about. Visitors are free to choose what, when, and how to learn. Visitors also actively construct new ideas based on their current and previous knowledge, with or without the help of technologies such as mobile guides.

Mobile guide technology in cultural spaces, particularly multimedia guides, is now evolving towards the personalization of information. The concept of personalization should be defined in such a way that it does not overlap with other concepts such as customization, adaptability and so on which are very widely used in technology application, especially in websites (Filippini-Fantoni, 2003). There are numerous definitions which have been given to the personalization concept, but they usually refer to the context employed and are not bound to individuals, groups, regions, genders or any other classification. Brusilovsky and Maybury (2002) defined personalization as an ability to create content and presentation for different individual needs,

whilst Filippini-Fantoni (2003) defined personalization or adaptivity as the system that changes its behaviours/characteristics according to users' needs. On the other hand, Storey (2002) defined personalization as follows:

> … the design, management and delivery of content based on known, observed and predictive information. Personalization techniques match an individual, his/her preferences and Web page click stream habits with tailored content based on a user profile (Storey, 2002).

My preferred definition of personalization is: ways of changing, simplifying and presenting information using technology-oriented applications according to the user's mental model, to suit different users' preferences and needs.

People are attracted by a significant transformation of cultural spaces, especially the transformation of museums from a staid display of artefacts and a glass-boxed exhibition to a technology-oriented exhibition that allows active engagement with the exhibits as well as the technology.

Previous studies have concluded that these transformations are important to improve the quality of museum exhibitions to attract more visitors (Ciolfi & Bannon, 2002), or to create better places for informal learning (for example, Adams & Moussouri, 2002; Yu Liu *et al.*, 2006), and free-choice learning (Falk & Dierking, 2002), and a better place for 'edutainment' or entertainment (Liu *et al.*, 2007; Feix, Gobel & Zumack, 2004). Edutainment in this context of cultural spaces refers to an exhibition or mobile guide which is designed to be able to impart knowledge and at the same time have an entertainment component.

1.2 Motivation and Rationale

"Dewey's two aspects of the quality experience can be restated as follows: (1) The visitor interacts with the exhibit and has an experience, and (2) the visitor assimilates the experience so that later experiences are affected"
(Ansbacher, 1998 p.36)

With Ansbacher's (1998) comment about the visitor's experiences in mind, I have tried to focus this study on the effect of different types of mobile guide (free-choice and guided tour) in cultural spaces. With the main focus of this thesis being the use of mobile guides in cultural spaces, I compared visitors' experiences in two types of cultural space: museums and historic churches. I successfully developed a scale of visitor experience in museums and historic churches by devising the Museum Experience Scale (MES) and the Church Experience Scale (CES). In addition, I also formulated a scale to measure visitors' experiences with the mobile guides in cultural spaces, and called this the Multimedia Guide Scale (MMGS). I also 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"* (Smith, 2009, p.1).

I also wanted to address the importance of providing 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 (Pekarik, 2011). 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 fail to improve visitors' total experience (to name a few: Fleck, Frid, Kindberg, O'Brien-Strain, Rakhi Rajani & Spasojevic, 2002; Hughes, 2001; Proctor & Burton, 2003). 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 (2009) as discussed in the previous paragraph.

Those who manage cultural spaces should bear in mind that their visitors come from diverse backgrounds and want many different things when they visit cultural spaces. Their engagement with the exhibits or technologies also varies. Thus, it is important to understand and try to adapt the technology to be able to maximize meaningful experiences for the visitors to cultural spaces. Museums and other cultural institutions should balance the use of conventional ways of presenting exhibits to make them more relevant, and in step with technological changes, whether by using more effective media, technology or interactive exhibits. Nonetheless, the common goal remains.

I have compared the two versions of a mobile guide (for example, by smartphone or multimedia guide), one of which offered a free choice tour of a cultural space and the other offered a guided tour. These experiences can be in any form, not limited to the sense of engagement with technologies in cultural spaces, their exhibits/exhibitions, emotional and spiritual experience with a cultural space and its features, or the sense of being immersed through the use of such technologies in cultural spaces. The two versions of the mobile guide provide different types of informal learning experience for visitors. Importantly, this study will not measure the learning outcome from the visit to the cultural spaces, but focuses on the components that contribute to the learning. Thus, at the end, I propose frameworks that are able to measure visitors' experiences with or without multimedia guides. I also compare the different aspects of visitors' learning using two different mobile guide designs; a free-choice tour and a guided tour.

Numerous projects have developed mobile learning applications for cultural spaces, including applications which enable interaction between visitors or group members (for example, Cabrera *et al.*, 2005; Papadimitriou, Komis, Tselios & Avouris, 2007; Vavoula, Sharples, Rudman, Meek & Lonsdale, 2009; Wakkary, Musie, Tanenbaum, Hatala & Kornfeld, 2008; Yatani, Sugimoto & Kusunoki, 2004; O'Hara *et al.*, 2007; Grinter, Aoki, Hurst, Szymanski, Thornton & Woodruff, 2002), 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, Falk & Dierking, 2000; Naismith & Smith, 2006; Aroyo, Wang, Brussee, Gorges, Rutledge & Stash, 2007; Wang *et al.*, 2008; Woodruff, Aoki, Hurst & Szymanski, 2001; Hsu, Ke & Yang, 2006), no study could be found which compares guided tours and free-choice tours on mobile guides.

In addition, to date, there have been a few studies carried out focusing on free-choice learning (for example, Falk & Dierking, 2000; Naismith & Smith, 2006) but none of them have dealt with the use of mobile guides in cultural spaces. This current research programme will put an emphasis on measuring visitor experiences in cultural spaces using free-choice tours and guided tours.

This research aims to improve visitors' experience while using mobile guide tours in cultural spaces by providing cultural institutions with a framework to measure their visitors' experiences. In addition, it could suggest ways of presenting the information on the mobile guide tour which enables it to engage or stimulate curiosity about the artefacts or features in cultural spaces without having to sacrifice the knowledge or learning outcomes.

1.3 Research Questions

The research questions that the research aims to answer are:

1. What are the main features of visitors' experience in cultural spaces?
2. What are the main features of visitors' experience in cultural spaces with mobile guides?
3. How does the usability of the mobile guide affect visitors' experience in cultural spaces?
4. What are the implications of the use of mobile guides for visitors' experience in cultural spaces?
5. What are the implications of the use of guided tour or free-choice mobile guides in cultural spaces for visitors' learning?

1.4 Thesis Overview

The remainder of this thesis structure is as follows. Chapter 2 of this thesis will present a literature review covering the relevant background. This chapter is divided into a number of sub-sections which focus on cultural spaces, and specifically on museums and historic churches, and on their technologies as well as learning. This chapter will also discuss and review the current state of the art of mobile guide technologies in museums and historic churches, and consider how they shape museum exhibitions as well as visitors' experiences, whether in terms of emotional connections with the exhibits/exhibitions, their sense of engagement, or imparting knowledge or meaningful experiences. The main data collection methodology for this study was questionnaires.

Chapter 3 will discuss the first empirical study, the initial exploration by questionnaires and methods for studying the effects of mobile technologies in cultural spaces. The study focuses on the virtual museum. Two different versions of the virtual museum were designed in order to make a comparison between free-choice tour learning and guided tour learning in the virtual museum. This initial study was carried out to establish what questions should be asked in the large-scale evaluation study to measure user experiences, usability and engagement with mobile guides in cultural spaces. This study is a part of larger study for measuring visitors' experiences with mobile guides in cultural spaces (the large-scale evaluation study). A between-participants design was used, with participants experiencing either the free-choice or the guided tour virtual museum. A total of 22 participants took part in this study. I shall compare and contrast these two types of museum tour in the virtual museum and how each has an effect on visitors' experiences.

Chapter 4 presents an exploration of visitor's experiences in the museum: it describes the development of museum experience scales (MES) and multimedia guides scales (MMGS), two scales which are able to measure visitors' experiences via technology in museums. The scales were devised using a full psychometric development procedure (for example, Anastasi & Urbina, 1997; DeVellis, 2003; Kaplan & Saccuzo, 2001; Aiken, 2003; Anastasi, 1968; Murphy & Davidshofer, 1994). The procedure is explained in full detail in Chapter 4, but can be summarized as follows:

1. A large number of possible statements (an initial pool of 152 statements) about people's reactions to museums were collected, mainly from the literature;
2. An analysis of these statements was made to reduce them to 57 non-overlapping statements; 37 for the Museum Experience Scale (MES) and 20 for the Multimedia Guide Scale (MMGS);
3. 255 people who had visited any cultural space within six months of it being advertised were asked to rate their experience using the statements;
4. A principal components analysis was used to find which statements produced similar ratings and to reduce the set of statements further to a number of specific components.

The questions were close-ended and measured on a Likert-scale (Likert, 1932) ranging over 1 'strongly disagree', 2 'disagree', 3 'neutral', 4 'agree', and 5 'strongly agree'. This study used a web survey. I developed a 'scale of visitor experience' with exhibits and exhibitions in museums. This study resulted in the MES and the MMGS.

Chapter 5 (Mobile guides in cultural spaces: measuring visitors' experiences using iPhone web-app) is formulated to gather information about different aspects of visitors' experiences with museum exhibits between a free-choice tour and a guided tour of the virtual museum. This study took place at the Human Interaction Laboratory in the University of York, which was designed so that it would resemble a museum exhibition with artefacts on display. Artefacts in this study were colour pictures of real artefacts in poster form with labels. This study was the initial testing of the multimedia guide, so it was appropriate to conduct it in a laboratory situation. When the guide and the methodology had been validated, I proposed to use a real museum setting (the Jorvik Viking Centre in York) to test the different types of guide. The web-apps for this study were initially designed to be used at the Jorvik Viking Centre in York. This study is a part of a larger study measuring visitors' experiences with multimedia guides in cultural spaces.

Heuristic evaluation was carried out after the iPhone web-app development was completed in order to identify any usability issues or problems by expert evaluators.

The design employed was random sampling in which the participants were randomly assigned into two different groups (eight in each group), one of which used the free-choice web-app tour and the other used the guided tour web-app. The main data collection methodology for this study was questionnaires, in which participants were asked about their experiences with the mobile guides they had used in this study.

I used the Multimedia Guide Scale (MMGS) in this preliminary evaluation of two versions of a mobile guide tour for the Jorvik Viking Centre in York.

Chapter 6 (Exploration of visitors' experiences in historic churches: the development of a churches experience scale). This study was formulated to develop a new scale for visitors' experiences in historic churches because I felt that the visitor experience in historic churches had potentially sufficiently different aspects. Although the nature of these two cultural spaces (museums and churches) shares some similar features, there may well be components that are

not measured in the MES, particularly the spiritual aspect of historic churches. In addition, the motivation of visitors in these cultural spaces may differ, hence the need for a new study of historic churches. This study collected data from 272 visitors in three different historic churches in York, both active churches and inactive churches. The term 'inactive church' in this study refers to churches which only ran three services a year and were open to visitors everyday, whilst 'active' churches had services several times a week and were closed to visitors during these services. The inactive churches become active churches if they run services more than three times a year. It is important to differentiate between these two types of church because they have a different environment and thus give a different impact to visitors. The inactive church in this study was Holy Trinity Church in Goodramgate, whilst the active churches were Holy Trinity in Micklegate and All Saints in North Street. I formulated a scale of visitor experiences in historic churches, which is the Church Experience Scale (CES).

Chapter 7 (Comparing Visitors' Experiences in Historic Churches using iPhone Guide) presents a study which used the MMGS and the CES in the realistic setting of an historic church. The study was conducted at Holy Trinity Church in Stratford-upon-Avon. This study addressed the difference between a FC guide and a GT in cultural spaces, particularly an historic church. It highlights which factors have a significant relationship with participants using a free-choice tour guide or a guided tour.

Chapter 8 (Conclusions) sets out the implications and conclusions from the programme of research conducted for the thesis. The themes will be achievements, impact and the contributions to knowledge, as well as the limitations of the research. It also will highlight future work which might be undertaken to further elaborate the results of this thesis in the future.

CHAPTER 2

Literature Review

"Museums … are our theaters of conscience, memorials to suffering, choreographed places of ritual genuflection … it is a curiosity that serves the pleasures of spirit … we go to museum to remind ourselves who we are "

(Kimmelman, 2001, p.1)

2.1 Introduction

The work presented in this PhD research programme draws on a number of topics and each section will examine various topics of interest in the literature on museum and historic church studies; the adoption and use of technologies, particularly mobile guides technologies; different aspects of learning in informal environments such as free-choice learning, learning with mobile guides technologies and their related theories; and the adoption of technologies in religious spaces, as well as studies of visitors' experiences in cultural spaces.

The literature review will be presented in the following sections:

- Section 2.2: The use of mobile guides in cultural spaces. This will start with the historical background of mobile guide technologies in cultural spaces. The focus will be on the use of mobile guides for visitors in cultural spaces, for example:
    - How mobile guides are able to bring families and friends together;
    - The uniqueness of mobile technologies that are able to support natural interaction between visitors and exhibitions;
    - How mobile guides can be personalized to accommodate different types of visitor;
    - Mobile guides technologies for all which are able to cater for different kinds of visitor, particularly visitors with special needs. This will include mobile guides which incorporate British Sign Language (BSL) and many other facilities.
    - Mobile guides for fun and entertainment. The design and contents of mobile guide tours that are filled with 'fun' or 'entertainment'.
    - The abilities of mobile guides to support mobile learning.
- Section 2.3 Museums and Learning. The focus in this section will be on free-choice (FC) and learning through guided tour (GT) in museums. It also will examine different types of learning theory that support informal learning in museums.
- Section 2.4 Technologies in religious spaces. The use of different technologies in religious spaces, particularly historic churches.
- Section 2.5 Visitors' studies: measuring visitor experiences in cultural spaces. This will focus on visitors' experiences in cultural spaces. In addition, it will discuss in detail the abilities of mobile guides to support mobile learning experiences.
- Section 2.6 Scale development. This section will focus on literature about scale development.
- Section 2.7. Conclusion on visitors' experiences.

2.2 Use of mobile guides in cultural spaces

A recent survey of mobile guides in museums has classified them into four different groups: (1) mobile guide applications, (2) web-to-mobile applications, (3) mobile phone navigational assistants, (4) mobile web-based applications (Kenteris, Gavalas & Economou, 2011). Mobile guide applications refer to applications that run on the mobile device platform to offer tourist/visitors information or services. This mobile guide application could be a stand-alone or a network-based application, for example the application developed for the smartphone (for example, the iPhone Apps, or Personal Digital Assistant (PDA). Web-to-mobile applications use a website to offer tourists/visitors information or services using their own devices, for example Google Maps. Mobile phone navigational assistants use maps which offer tourist routes using points-of-interests (POI), for example maps on Nokia phones called Nokia Maps. On the other hand, mobile web-based applications are similar to a desktop 'web application' and provide information to visitors/tourist through a mobile guide browser.

2.2.1 Mobile guides: Historical background of the use of technologies for visitors in cultural spaces

For the past 60 years, many and varied efforts have been made by organizations responsible for cultural spaces to introduce new technologies. These changes, particularly to mobile guides, have significantly changed the way visitors interact with an exhibition, with artefacts and with the mobile guide itself. Tallon (2008) explained how these changes have ranged from the digitization of the objects to the use of emerging technologies.

The first use of a mobile guide was in 1952 in the Stedelijk Museum in Amsterdam, and took the form of Short-Wave Ambulatory Lectures (Tallon, 2008). Ambulatory lectures were lectures that were delivered to visitors using a closed-circuit short-wave radio broadcasting system and discussed individual works of art or collections in each gallery. Figure 2.1 shows the device used for the Stedelijk mobile guides. The design of this mobile guide technology was quite sleek, but the ear pieces were not comfortable because of their size, and they were made of glass. Figure 2.2 shows how this technology was used in the museum.

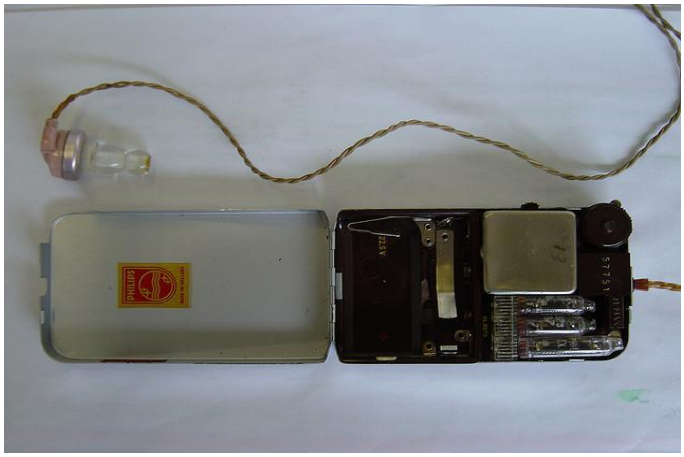


Figure 2.1. The Stedelijk Ambulatory Lecture device ***(image courtesy of Loïc Tallon of Pocket-proof)***

Figure 2.2. The Stedelijk Ambulatory Lecture in use ***(image courtesy of Loïc Tallon of Pocket-proof)***

In the 1950s, other museums began to introduce similar mobile guide technologies. Not long after the Stedelijk Ambulatory Lecture device was introduced, the American Museum of National History introduced an audio guide called *Guide-a-Phone* in 1954 into their exhibition and subsequently adopted the *Sound-Trek* audio guide in 1961 (Tallon, 2008). Figure 2.3 shows a visitor looking at a Dinosaur in the exhibition, wearing a headphone and with a portable radio receiver hanging around her neck. This portable radio-receiver operated within the broadcasting area allowing visitors to receive an audio narration of their choice by operating a dial on the front of the device.

Figure 2.3. A Sound-Trek audioguide at the American Museum of National History, New York ***(image courtesy of Loïc Tallon of Pocket-proof)***

An early portable electronic guidebook in a museum was employed using reel-to-reel tape players developed by the Acoustiguide Company in 1957 and it was a tour of Hyde Park, home of President Roosevelt (Acoustiguide, 2007). Interestingly, the electronic guidebook was narrated by his widow Eleanor Roosevelt. In this tour, visitors were able to use the state-of-the-art technology at that time, a portable reel-to-reel player. This tour focused on the estate's public and private spaces and told the stories behind each space, as well as about each visitor[1] who had been to the house and what daily life was like there.

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 (Audiogids, 2011). The random access mobile guide, or free-choice mobile guide, allowed visitors to choose which exhibits to visit in whichever order they liked. After selecting an exhibit/artefact of their interest either by entering the exhibit number or any other way of choosing the artefact, they could use the mobile guide to provide them with more information about it. Thus they could save time by not visiting exhibits which were not of interest to them, accessing 'on demand' information and touring the exhibition at their own pace (Acoustiguide, 2007).

[1] 'Visitor' here refers to house-guests who had been to the Roosevelts' home during Roosevelt's presidency.

In the early years of mobile guide usage, tours followed a pre-defined path through the exhibition, such that visitors had to view exhibits A, B, C to Z while listening to the mobile guide without being able to skip any exhibits that did not interest them. For example, the 'Art Treasures of Turkey' exhibition held in 1966 in the US National Gallery of Art used an audio tour and is illustrated in Figure 2.4. It shows a map or floor plan of the exhibition with all exhibits and the Acoustiguide route. It also shows how the navigation around the exhibition worked with the Acoustiguide. This is an example of the early days of the implementation of mobile guides in museums.

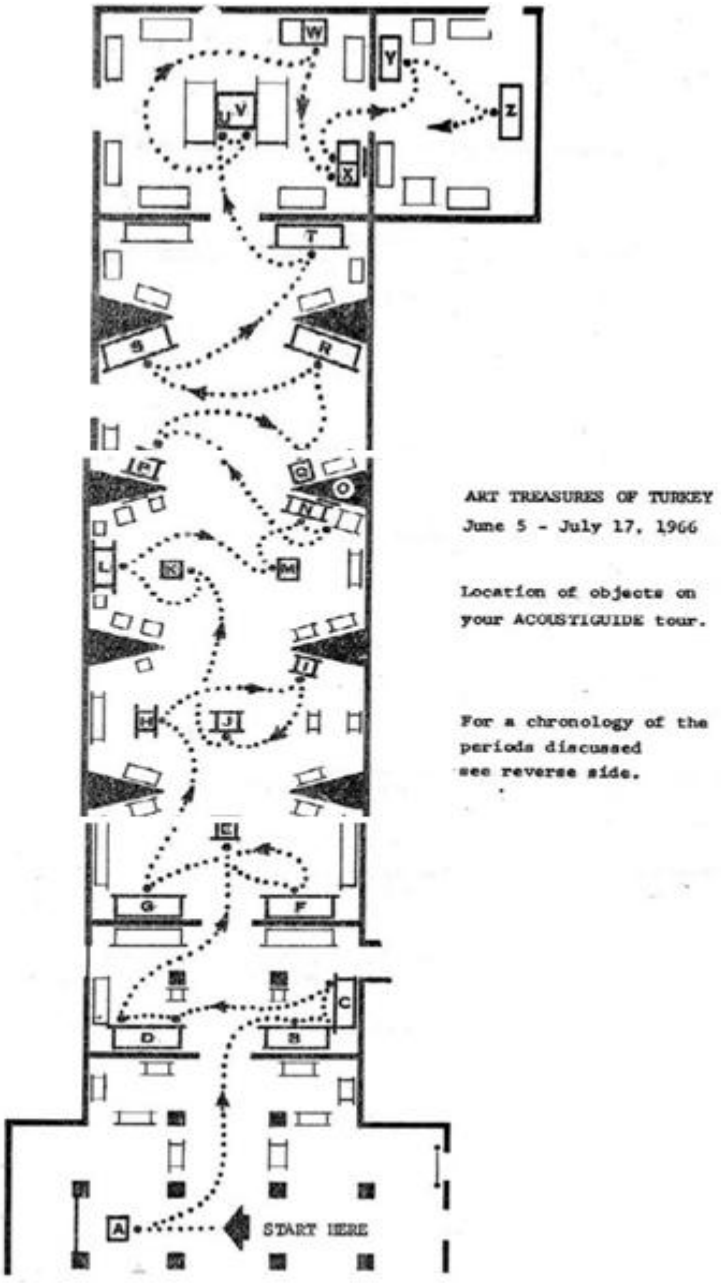


Figure 2.4. The floor plan for the '*Art of treasures of Turkey*' exhibition *(Picture courtesy of Loïc Tallon of Pocket-proof)*

As a result of this mobile guide implementation, the interaction between visitors and museums exhibits was limited. This was because visitors had to listen to the mobile guide and only focus on the objects described in the guide. Thus it limited the interaction between visitors and museums and exhibitions as they had to focus on the objects described by the mobile guide tour and move from one object to another as instructed by the mobile guide. The movement of the visitors is best described as:

"*all visitors with a receiver could only hear a specific piece of commentary at any time … groups of visitors would move through the galleries and look at exhibits as if guided by an invisible force, in complete synchronicity*" (Tallon, 2008, p. xiii-xiv).

In addition, this technique also limited interaction with other visitors because they all had to listen to the mobile guide. The use of earphones also constrained visitors in their ability to talk to other members in their group because they could only hear the audio on the mobile guide when the earphone was in use. Furthermore, visitors were not able to choose which exhibits they wanted to listen to information about because the mobile guide tour provided was predetermined by the museum curators. Visitors had to follow the mobile guide, and not the other way around. This approach is considered a curator-based approach, not a visitor-centred approach.

Research into the use of mobile guides in museums has increased with the various enhancements of technology. In 2005, Nancy Proctor made a list of 101 handheld and wireless guide tour projects available in cultural institutions, either as research projects or which had been successfully implemented, but the list was not complete (Proctor, 2005). Amongst these projects, one particular project of interest is the first PDA-based mobile tour in cultural spaces, *iGO*, which was piloted at the Minneapolis Institute of Art in 1994 (Kuehner, Schmidt, Hinze, & Glemme, 2003). The *iGO* was a modification of the early Newton PDA by a company called Visible Interactive, thus making it the 'world's first non-linear (free-choice) interactive tour deployed using PDA. Contrary to the *INFORM* guide at the Louvre Museum which only provided audio content for the museum exhibits, the *i*GO was able to offer more than audio contents. This interactive mobile guide tour allowed visitors to access information in various forms such as multimedia, audio and text throughout their visit, which was able to enhance visitors' museum experiences (Kuehner, Schmidt, Hinze, & Glemme, 2003). The following year, another enhancement was made to the *i*GO, and this new interactive tour was then called *pocket*

curator and was designed to provide both a personalized interactive tour and a meaningful experience to the visitor (Kuehner, Schmidt, Hinze, & Glemme, 2003). *Pocket curator* enabled visitors to personalize the audio and text for fifteen works of art on display. This project was piloted at the University Art Museum in collaboration with the Pacific Film and Archive of the University of California in Berkeley. In 1996, the Smithsonian Institute launched a travelling exhibition called 'American Smithsonian' and used *i*GO as a mobile guide. For that exhibition, *i*GO was used as an interactive personalized tour for 90 objects using audio and text-graphics.

Further improvements have subsequently been made to mobile guides and many museums have used video or multimedia guided tours in their museum exhibitions. In fact, most institutions have started using digital mobile guides that are capable of recording more contents than analog mobile guides and personalizing them in multiple languages for individual audiences (Proctor & Tellis, 2003). Furthermore, there has been a rapidly growing body of research in the area of technologies in museums – particularly mobile guide technology – after the first PDA was introduced. To name a few; mobile museum guide research by Oppermann and Specht (1998); PDA-based mobile guided tours (for example, Wang, Sambeek, Schuurmans, Rutledge, Stash, Gorgels & Aroyo; Yatani, Sugimoto & Kusunoki, 2004) and PDA-based educational learning activities (for example, Feix, Göbel & Zumack, 2004; Klopfer, Perry, Squire, Jan & Steinkuehler, 2005).

The enhancement of various technologies has also enabled museum visits to become more visitor-oriented and not fully controlled by curators. Various enhancements of technologies have come from the use of guided tours on mobile guides which only deliver audio contents in sequential order to the deployment of free-choice mobile guides' tour that are able to provide multimedia contents (for example, images, text, audio and video) across different device platforms as well as other localizations of appropriate technology. Visitor are now more in control of choosing the objects they want to see, which sequence they want to see them in, the amount of information they would like to have for any particular object and other personalized features that are controlled by the visitors.

The ongoing changes deployed by museums to improve their visitors' experiences shows that its always driven by museum. 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. Furthermore, Verdaasdonk, Van Rees, Stokmans, Van Eijck and Verboord (1996) stated that looking for a new technology to keep up with the demand is one of every museum's goals and motivations. They also stated that museums are constantly trying to deploy technologies to attract more visitors. For example, recently the Louvre museum in Paris has introduced 3D imagery in its mobile guides by using Nintendo 3Ds as it mobile guides (Cooper, 2012).

Research by Tallon (2006) on the evolution of mobile guides has outlined a number of important developments in mobile guides. Among these, he discussed the uniqueness of mobile guide technology in its ability to complement exhibitions within museums. It cannot be denied that most current exhibitions are equipped with this type of technology to engage their visitors. He saw the use of this technology as a medium between the exhibit labels and the museum docent[2]. He also addressed the need to intellectually engage visitors using mobile guide tours. Thus there is a need to design mobile guides that are able to actively engage and stimulate the visitors' learning within the museum.

Arguably, audio tours on mobile guides are the most significant aspect of technology that has changed the way visitors interact with cultural spaces and are still widely used. It is understandable that when mobile guides were first introduced, in the 1950s and throughout the years until the 1980s, there was little public domain research as the devices were proprietary and the companies dealing with the museums did not want the information made public (Tallon, 2006). However, with the explosion of mobile devices from the 1980s onward, a rapidly growing body of research on the use of technologies for visitors in museums has developed.

This evolution of technologies shows that mobile guides play an important role in shaping museum exhibitions. Moreover, they also have a huge impact on museums' role as cultural spaces by improving the delivery of information and being able to enhance visitors' meaningful experiences. This will be discussed in detail in the next section. The evolution of mobile guides in museums from their first inception in the 1950s is summarized in Figure 2.5.

[2] A person who teaches or facilitates face-to-face or a (human) tour guide, mainly volunteers who have a good grasp of knowledge about the subject and good communication skills (Grenier, 2005)

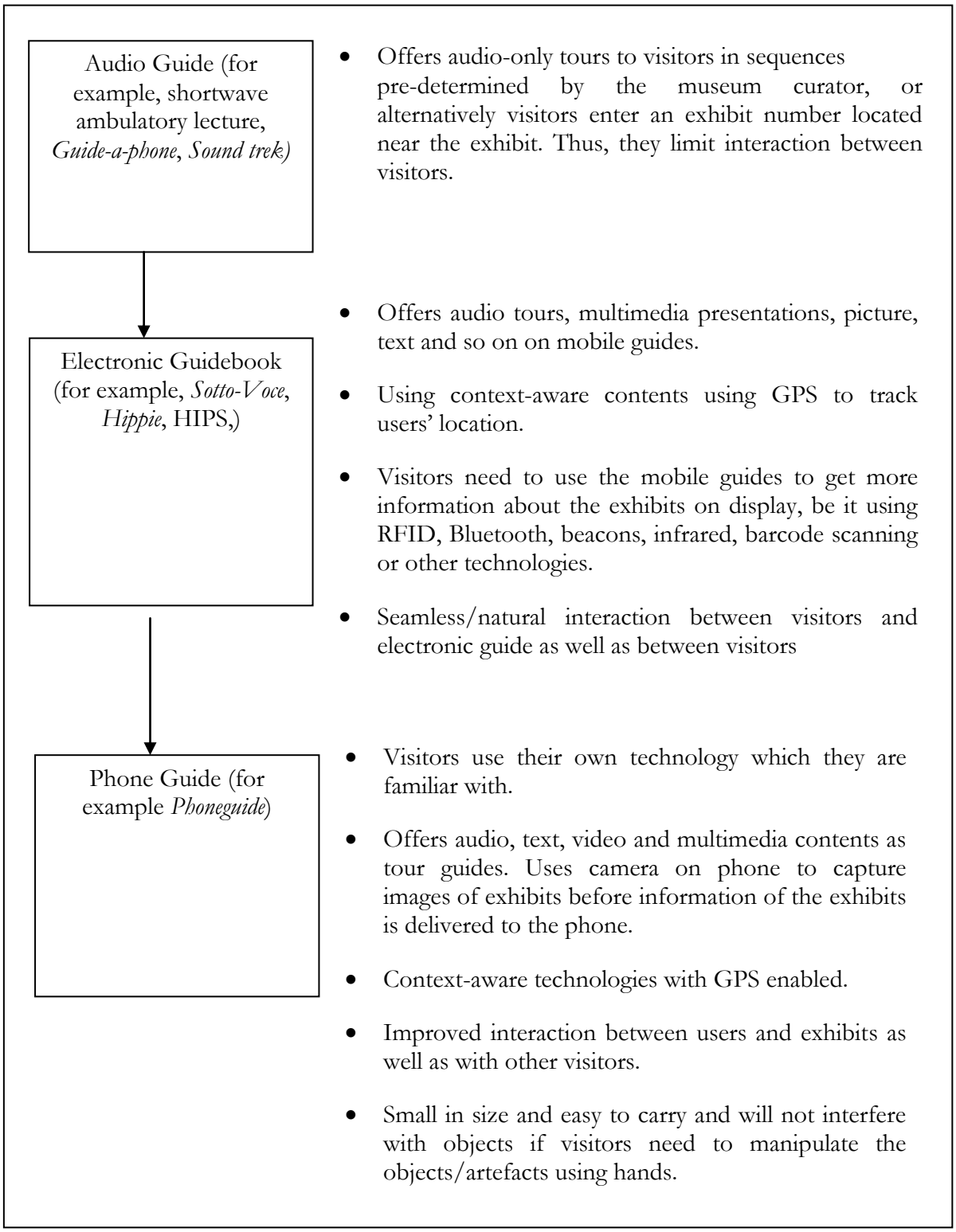


Figure 2.5. Summary of the evolution of mobile guide technology in cultural spaces

2.2.2 Mobile guides: bringing families and friends together

One of many reasons people visit museums is because they want to spend time with their family members, friends or companions (Dierking, Luke, Foat & Adelman, 2001) and the majority of museum visitors consist of families and small groups (Hein, 1998). With this in mind, cultural spaces are trying to connect their visitors with the exhibitions, and mobile guide technologies should be able to be a medium for this. Mobile guide technologies have changed the way visitors interact with museums and with other visitors. Such technologies enable visitors to actively participate in museum exhibitions in ways that have not been possible before, for example, users are able to interact with artefacts (objects), information (for example text, images, photos, video, audio and others), and are able to use the mobile guides to actively simulate the artefacts from different views or angles.

Currently, museums have changed to more concrete functions such as enabling and facilitating active learning and engagement with exhibits as well as with other visitors in actively collaborating over information seeking and sharing. The social interaction between visitors is one of the key components to ensure that visitors are actively engaged with the exhibits and their companion(s), thus achieving the goal of bringing families and friends together. In addition, these mobile guides have the potential to bring people together to actively collaborate, corroborate with each other in the cultural spaces to share their views about particular artefacts of interest.

Social interaction between different members of a group of visitors is one of the aspects that many mobile guide technologies fail to encourage. Many of the mobile guides used in museums have been configured and implemented in such a way that it is difficult for museum visitors to use the guide and at the same time to interact with their companions. For example, if someone has to listen to a commentary over headphones, it is not easy to hear what someone else is saying, and one visitor does not want to interrupt when someone else is listening. In addition, visitors who are getting bored with the conversation with their companion can switch their attention to other things. For example, Woodruff *et al.* (2001) identified the 'balancing act' which allows visitors to focus on different stimuli when they need to. The mobile guide (or referred to as 'guidebooks' in that study) enabled visitors to divide their attention according to their priorities, which they could change anytime if the current focus was not interesting or was becoming a low priority for them. In relation to the interaction between family members and/or

companions, visitors could simply shift from listening to their companion rambling when it became tedious and switch their focus to the objects in the exhibition.

Furthermore, a number of projects have addressed the social interaction issue and have tried to create mobile guide technologies for museum visitors which facilitate social interaction and/or communication between visitors to provide a more enjoyable experience, be it learning, emotional, spiritual or any other kind of experience. An example of such a project is the *electronic guidebooks*, a prototype created at Xerox PARC by Allison Woodruff, Paul Aoki, Amy Hurst and Margaret Szymanski. Initially, the guidebooks were designed so that they could provide different methods of information presentation and sharing (for example, Woodruff, Aoki, Hurst & Szymanski, 2001; Woodruff, Szymanski, Aoki & Hurst, 2001). Their aim in those studies was to ensure that their *electronic guidebooks* were able to support a meaningful experience for users by supporting visitors by enabling them to balance the interaction between the electronic guidebooks' main entities: guidebooks, visitors' companion(s) and the museums itself. This was intended to give visitors an avenue for social interaction with their companions when they were using the guidebooks. Furthermore, visitors were able to divide their attention when they wanted to. That study was conducted at Filoli, a Georgian Revival house in Woodside, California. There were fourteen participants in the study and they came in seven pairs (for example, a 70-year-old grandmother with her grandchild; a husband and wife, and other pairings). They were told to bring their glasses with them if they used them for reading. The *electronic guidebooks* were run on the PDA with a touch screen. Information about objects was presented on the guidebooks with accompanying photographs. Information about each specific object was available if a visitor tapped on the photograph. There were 42 objects of interest in the historic house. This information was available in text or audio format and visitors were free to select which one they liked and they could switch at any time from one format to the other. In addition, the audio description of the object could be controlled from the device's speaker or headphone by a volume control. If the visitor wanted to share the audio description with a companion(s), they could simply use the speaker, or they could use a personal headphone if they decided not to share with their companion(s). The evaluation of the prototype was carried out in several phases: a partial tour guide using paper guides, partial tour guides using *electronic guidebooks*, and then followed by an interview. The conversations and comments between pairs were recorded by wireless microphone and their actions were also recorded by the research escort. In addition, some cameras were placed in the corners of each room to video-tape participants' interaction with the guidebooks. The semi-structured interviews were conducted after the participants had

finished their tours in pairs to elicit information about their reaction to or experiences with the guidebooks. Social interactions between companion(s) were observed and some questions were asked during the interview session to get participants' opinions about this issue. Various feedbacks were obtained and some respondents agreed that they had been able to interact with each other while using the guidebooks. The researchers believed that the guidebooks were able to facilitate social interaction between visitors.

One interesting finding from those studies was that some participants suggested that each participant should be given a separate guidebook, as it was not easy to share the mobile guide while they were on the tour. This could be associated with the personalization of devices to each individual where each visitor has his/her own interests and aims when they visit a museum regardless of whom they have come with. They also commented on the interaction with the device which enabled them to take control of the guidebooks and exhibits, which implied that the technologies introduced had not become a barrier between the visitors and the exhibits. The researchers made several conclusions about the use of guidebooks: (1) visitors learn more with the help of *electronic guidebooks*; (2) *electronic guidebooks* have a significant impact on visitors' interactions between one another, the mobile guide's environment and contents; (3) the audio should be played on the speaker instead of the earphone to ensure that visitors and their companions could interact with each other; (4) the guidebooks motivated visitors to actively interact with the artefacts.

Another prototype was made into a reality with the development of *Sotto Voce* by researchers at Xerox PARC (Aoki, Grinter, Hurst, Szymanski, Thornton & Woodruff, 2002). This was the second prototype, with an enhancement made to overcome some problems in the first prototype in their earlier studies. *Sotto Voce* was made with the main goal of improving social interaction between visitors and their companion(s). This problem was raised during the evaluation of the first prototype (for example, Woodruff, Szymanski, Aoki & Hurst, 2001; Woodruff, Aoki, Hurst & Szymanski, 2001) by participants in the study. The second study was meant to improve the interaction between visitors and their companions even if they were wearing a headset/earphones by allowing visitors to do audio-sharing. This unique feature, called 'eavesdropping', enabled visitors to be able to hear and interact with other visitors or their companion(s) while using the guidebooks. Visitors could communicate and share with others their thoughts about the exhibits they were currently viewing. Evaluations of this study were carried out in the same way as in the previous study and the results were compared. The results

showed major improvements in the interaction between visitors because it occurred in more natural ways. In addition, the study also concluded that *Sotto Voce* significantly improved the visitors' engagement. Most importantly, visitors did not have to stay close to each other to share the guidebooks, which is important as the interaction between visitors could be metres away.

The first two studies described above (*electronic guidebooks* and *Sotto Voce*) were carried out on a closed day during which only the participants were in the historic house. In order to see how the technology worked in a real setting, another study was carried out during the normal visiting hours of the historic house (Grinter, Aoki, Szymanski, Thornton, Woodruff & Hurst, 2002). Several issues in the earlier studies had been addressed, for example how *Sotto Voce* was used to promote interaction and communication between partners in which they could coordinate the systems for shared-listening. The system was implemented with visual interface-based image maps on the PDA, which enabled visitors to select an object on the image maps to listen to audio descriptions. Visitors could select which room they wanted to visit as well as being able to control the 'eavesdrop' feature by turning it loud, off or quiet. Visitors also were given a headset. In addition, the eavesdrop feature enabled the interaction between the pairs and they could hear what their partners were listening to and could decide if they wanted to listen to the same audio description, and then turn it off, or set it to quiet mode. In contrast to the previous study, the third study comprised groups of two, three or four peoples. Similar to the previous study, participants' interaction, conversation and comments were recorded. Participants' interactions with the mobile guides were also recorded to see how long they spent on the guidebooks. They were also interviewed to gather more information about their experiences, about the eavesdropping feature as well as their typical museum visits to the museum with or without the mobile guides. The results from the study reinforced the notion of shared-learning to support the research team's previous two studies and at the same time enabled an understanding of visitors' motivations in engaging in social interaction using this feature. In addition, the information on the guidebooks enriched visitors' depth of conversation with their companions. On the other hand, some visitors were not keen on interacting with each other and switched off the eavesdropping feature entirely during the visit. One of the reasons given for this was 'we don't usually stick together', which implied that they preferred their own time at the historic house. The eavesdropping feature also made some visitors have to follow what their partner(s)/companion(s) were listening to because only one person was operating the guidebook and the rest of the group were eavesdropping. The eavesdropping feature also enabled visitors to check where their partners were.

Studies on the use of PDA-based mobile guided tours called *MUSEX* for children at the National Museum of Emerging Science and Innovation in Japan by Yatani, Sugimoto and Kusunoki (2004) found that the system was able to improve children's engagement with the museum's pre-defined learning activities. Children were also able to spend more time with less interactive or attractive exhibitions when using such systems. The aim of that study was to support children's learning using two PDAs. *MUSEX* was designed with pre-defined learning activities in which the children used the provided PDA to move around the museum exhibits. The PDA provided in the study was able to read radio frequency identification (RFID) tags and could provide the children with questions as well as choices for the answers about specific objects. *MUSEX* was an educational system based on an orienteering game which aimed to support collaborative learning in museums. The collaborative aspect of learning in that research meant that the children worked in pairs and had to answer each question correctly before they could see part of the picture in both PDAs. In addition, to enable them to answer the question correctly required the children to spend more time with exhibits and to be actively engaged with the exhibits. If only one of the children in the pair answered correctly, then the picture would not appear in either of the PDAs, only the grey screen. The same grey screen would appear on the partner screen if one child gave an answer incorrectly. This system also provided the children with interfaces that determined whether answers submitted were correct or not. At the same time, it also indicated which questions had been answered. These features enabled a further interaction between the pairs, which promoted social interaction and collaborative learning between the pairs by discussing which questions they should tackle next or what went wrong with the previous questions. Furthermore, there was also a webpage for the children to revisit their experience and learn further about the exhibits. An experiment was also conducted in the study to evaluate the system with different types of respondent (men and women), ranging from pairs of parents-child, brothers or pairs of friends. There were 25 pairs of participants in the study and although the researchers suggested that their target audience was pupils between six and twelve years old, during the study the participants' age ranged from younger than five years old to more than 45 years old. The outcome of the study showed that children will actively engage with less interactive and attractive exhibitions using such systems and at the same time improve their engagement with learning activities. This can be shown by the children's action, which was repeatedly looking back and forth between the PDA and the exhibits. The system also promoted collaborative learning and interaction between the pairs by making them decide what to see next, or look at different object, or ask their partners if they were having difficulties understanding the questions. When asked if the *MUSEX* was enjoyable, 70% of the participants

found *MUSEX* very enjoyable and 24% found it enjoyable. In addition, 48% of the participants said 'yes' the questions did facilitate their learning, and a further 36% said 'yes, very much' they had facilitated their learning.

Another example of a mobile guide tour that supported the social interaction between museum visitors was the Multimedia Tour at Tate Modern (Wilson, 2004). The museum introduced three different tours in a trial phase: a multimedia highlights tour, which was designed for users between 16 and 25, a British Sign Language (BSL) tour designed for deaf people; and a collection tour which provided all information about the artworks on display. The multimedia highlight tour focused on the Still Life/Object/Real Life and Landscape/Matter and Environment Display. The highlights of this tour were the integration of interactive features such as games and communication between visitors. Furthermore, the tour was equipped with images, audio, video and text. In addition, visitors were able to play music related to the artworks on display. To support interaction/communication between the visitors, Tate Modern introduced a feature called 'text me' which allowed visitors to send a text messages to other visitors while touring the exhibition. Evaluations of the tours were made using a focus group for both the highlight tour and the BSL tour. They also included the non-users of the tours as a control sample population. Only results which are related to social interaction between the visitors are discussed here. The 'text me' feature was supposed to encourage interaction between visitors and to allow them to interact with other visitors about the objects on display. Unfortunately, this feature failed to achieve its intended target because only pre-set phrases were provided and conversational exchange was limited to these phrases. Many visitors felt that they were not able to express their opinions with the limited phrases available and they are not able to say what they had on their mind. One of the reasons the researchers did not provide an on-screen keyboard or full text functions was because they were afraid that the visitors would not use it for discussing the artworks but for sending inappropriate messages to each other. This feature needs improvement for it to be able to provide a natural communication between visitors by not limiting them on what they can say about the artworks. Another part of the MMT system will be discussed in greater detail in the next section, supporting mobile learning but in a different context.

In another study, a hybrid multimedia mobile guided tour called *MoMo* was designed to enable visitors to search a large set of information about the artefacts in a museum (Jaěn, Mocholĺ, Esteve, Bosch & Canós, 2005). Most importantly, it also supported social interaction between visitors in the museum. *MoMo* was a multimedia guide that enabled museum visitors to

communicate and interact with each other socially by allowing them to send messages to other visitors, or even form a group of visitors with similar interests (Jaěn, MocholÍ, Esteve, Bosch & Canós, 2005). It allowed them to send messages to other visitors or to all visitors in the same group.

Many museums are not able to afford to have a new technology installed every time a new technology becomes available. It is important for researchers to re-use the same technology for different exhibitions or for different purposes. In the past, several mobile guide tour prototypes have been re-designed to improve the capabilities of the devices to be used for other purposes. For example, a change was made to the *Cicero* prototype to enhance its capabilities to support more features. Initially *Cicero* was designed to improve visitors' experiences in a Marble Museum, Italy, particularly in providing the right information using location-awareness technologies and at the same time providing visitors with visual and auditory feedback (Ciavarella & Paterno, 2004). Other changes were made to *Cicero* to support interaction between a visitor and a companion by introducing collaborative educational games called *coCicero* which were able to support collaboration and information sharing between visitors and their personalized contents (Laurillau & Paterno, 2004). Another change was made to *coCicero* to enable a multi-user game environment to be installed (Dini, Paterno & Santoro, 2007). Previously, only a single-user game was designed, but the adjustment allowed visitors to actively collaborate with other visitors to solve the game individually. This enhancement was made to ensure that collaboration between visitors was more interactive and at the same time able to promote learning in the museum. In addition, this prototype also supported five different types of game.

The important aspect of the collaborative games was that visitors needed to work with each other to solve the shared enigma that consisted of five different images forming a jigsaw. For each game solved, one piece of jigsaw was revealed. Towards the end, users had a score for the numbers of games solved throughout their visit. User evaluation was made on the prototype with a group of adults with an average age of 37. Although they thought that the game was more suitable for children, the participants in the study found the game amusing, intuitive and able to facilitate learning, as well as making visitors collaborate with each other. Thus, making this prototype was one example that was able to bring visitors and their companion(s) together. Another example of educational games that are able to bring families together was the *Mystery at the Museum* (*M@M*) game designed specifically for the Boston Museum of Science (Klopfer, Perry, Squire, Jan & Steinkuehler, 2005). One of the goals of their study was to encourage

collaboration between visitors by discussing ideas to promote engagement. They also wanted to promote a meaningful interaction and collaboration between parents and children around science and inquiry. The *M@M* game was designed particularly for collaboration between children and their parents when they visited the museum. The game was packed with various activities to actively engage visitors with mobile guides and exhibits as well as exploring the exhibition.

Visitors in that study were given a task to solve a mystery (for example, to solve a mystery of stolen artefacts) and they had to work in pairs within a group and were given a walkie-talkie and a handheld guide. They could solve the mystery by collecting clues in various ways (for example understanding information about the exhibition, examining the artefacts using the virtual instruments, interviewing the virtual characters or collecting virtual clues within the exhibition). They then had to collaborate over their findings to solve the mystery if they had gathered enough information about the stolen artefacts, and find the thief. These activities enabled the visitors to actively seek information about specific artefacts, exploring the exhibits information physically and virtually. Importantly, visitors had to be engaged with the exhibits and with the mobile guides as well as actively interacting with their team members. The researchers found that participants in the study were actively engaged with the artefacts and exhibits as well as with their team members. Parents in the study were very keen about the collaborative activities in the museum because they were actively engaged with their children more than they usually were, and it was important to them that the visit could bring them together. Participants also noted that they learned more about exhibits/artefacts that they had never seen before, which motivated them to read more about the artefacts than they would have read if they had not been looking for clues. Importantly, the use of technology, particularly the mobile guide, was able to actively engage visitors with the exhibits and with their companions, at the same time as providing a meaningful learning experience.

On the other hand, another study on an educational game similar to *M@M*, called 'Mystery in the museum' (*MiM*), for children, was developed and tested at a historical/cultural museum (Cabrera *et al.*, 2005). The idea behind *MiM* was similar to the *M@M* but focused on creating collaboration between children aged thirteen and nineteen. Participants in this study used different ways to solve a mystery either by delegating the task to find the clues or doing it in a big group. *MiM* had two different puzzles to be solved by the children, a text and an image puzzle. This game was tested in a real museum with several groups of children. *MiM* brought them

together to collaboratively solve the mystery and at the same time learn about the exhibits in the museum.

It was found that different groups of children used different strategies in solving the puzzles and the amount of time taken to solve these two puzzles was significantly different between the groups. It was also found that the image puzzle was easy to solve compared with the text puzzle. One drawback from this project was that the tour was designed to be mobile guide-oriented not museum-oriented thus affecting the amount of information learned by participants in the study compared with the other project, *M@M*.

Researchers have believed that technology, particularly PDA, is able to improve the presentation of information on a mobile guide and at the same time not disturb the physical spaces or the beauty of the artefacts or the exhibition design (Schroyen, Gabriëls, Teunkens, Robert, Luyten & Manshoven, 2007). They have also said that this added dimension will provide better visitor experiences in such places. As a result, researchers set about finding a new way of interaction within museums with the development of the *ARCHIE* mobile guide system (Van Loon *et al.*, 2007). This system was developed in a form of a collaborative museum game for school children (aged 10 to 14) with an associated learning activity, and was deployed in the Gallo-Roman Museum at Tongeren. The main aim of the study was to overcome various issues concerned with the introduction of mobile guide tours in cultural spaces. They pointed out that the earlier mobile guide tours in museums had several shortcomings, and later added, *"the device demands lots of attention, tends to displace the surrounding objects and generates the unintended side effect that is quite individual, isolated experiences"* (Schroyen, Gabriëls, Teunkens, Robert, Luyten & Manshoven, 2007, p.2). They believed that *ARCHIE* could overcome most problems found in the common tour guides by improving interaction and communication between visitors, and the personalization of contents based on visitors' interests and needs, as well as discovering the exhibits at the user's own pace using localization or location-awareness technology. The researchers were trying to remove barriers or distractions between visitors and mobile guides in order to ensure a seamless interaction between visitors and their handheld devices. Although there have been various examples in the past which have shown that some of these shortcomings have been successfully addressed (for example, *Sotto Voce*, *Cicero*, *Co-cicero*, *MiM* and many others), these researchers were hoping that their prototype was way ahead of the earlier prototypes. ARCHIE had three important aspects which they wanted to achieve: (1) the personalization of information tailored to individual needs, (2) the localization of information based on visitors' location in the museum,

and (3) to bring families and friends together through communication. In order to achieve these goals, the researchers followed the idea of an ideal museum learning experience by mapping the contextual model of learning proposed by Falk and Dierking (2000). One of the components in the contextual model of learning is the social-cultural context, which involves interaction and communication between individuals. They tested several educational game prototypes on school children. Their study highlighted that educational activity games were able to initiate social interaction and collaboration between the participants.

There have been various examples of mobile guide tour guides which have been designed to support family and group visits to cultural spaces, but not many guide systems are a mixture of different technologies. For example, *Kurio* was a hybrid system comprised of tangible computing devices, PDAs and tabletop displays (Wakkary *et al.*, 2008; Hatala *et al.*, 2009; Wakkary *et al.*, 2009). *Kurio* was a game-based guide system which required group collaboration and was designed to support constructivist learning in cultural spaces. The study was carried out at a local history museum and mainly focused on social interaction and learning with an interactive museum mobile guide. Visitors (families or small groups) were given a set of missions to solve throughout their visit and they had to work with each other and explore the museum together to fulfil the missions. There were five tangible devices which visitors could use to explore the museum: *pointer* to select an artefact, *finder* to find different locations within the exhibition, *listener* to hear the audio files, *gesturer* to mimic and collect gestures related to the artefacts, and *reader* to collect text from didactic displays. A PDA was used as a mobile guide to support their visits and was able to coordinate the team members' progress and challenges. They could discuss their progress with one another and decide if they would like to venture into another learning challenge with a different level of difficulties. A tabletop display was used to support visitors by stating their current achievement and the challenges which still had to be completed. It also provided visitors with videos and other relevant information for learning.

There were 25 parents and children who took part in the study. They were in eight groups with two to four people in each group. The participants completed a questionnaire after their visit and also took part in a semi-structured interview held by the researchers. They also were interviewed and completed a short questionnaire about their previous museums visits with technologies before they started the study. They were also asked to conduct two self-administered interviews using a script provided to them, two and four weeks after their visit. The results showed that interaction between children and their parents took place and that the museums' mobile guide

system did not get in the way. There was constant interaction between them despite the need to interact with the PDAs and other devices. The interaction between parents and children was peer-based not parental based. The researchers made the conclusion that their hybrid system provided more involvement between family members. On the other hand, the use of tangible devices allowed both social interaction and physical interaction.

Although there have been numerous studies looking into providing a good mobile tour guide to bring family members together, researchers and developers still think that many of the mobile guides used so far have failed to deliver a successful mobile guide tour guide in museums. With this in mind, a mobile guide tour system called *Minpaku Navi* was developed and tested at the Japanese National Museum of Ethnology, also known as the Minpaku museum (Hope *et al.*, 2009). This prototype was designed to be flexible such that it can be used either by one user or by multiple users. The design of the mobile guide tour also took into consideration the free-choice learning concept that empowers users to learn about exhibits at their own pace, individually or within a group.

Importantly, *Minpaku Navi* supported interactive and bi-directional information retrieval as well as a social networking framework. This mobile guide operated on a gaming console platform, the Sony Portable Playstation (PSP), with an IC card that could be borrowed from the information kiosk. Visitors were able to see their friends and various exhibits based on their footprints on the IC card. In addition, visitors were also able to see their tour on the kiosk as well as view it at home using the IC card.

Minpaku Navi was tested on 30 families at the museum. Analysis of the data showed that visitors could be classified as '*discovery*', '*learning*', '*viewing*' and '*managing action*', which referred to the ways in which they interacted with the other actors within the *Minpaku* system. This system provided a good platform to see the interaction between family members during their visit to the exhibition. The authors also explained that the interactions between family members in Japanese culture are different, and this showed when they interacted with each other at the exhibition.

Over the years, research on the social interaction between visitors (for example, companions, friends and family members) has focused on PDA. Recently, a study of social interactions between visitors in cultural heritage places has shifted into the mobile phone guide system (for example, Suh, Shin, Woo, Dow & MacIntyre, 2011). That study was a valuable addition to their

previous study 'Voices of Oakland', a mixed-reality system for cultural heritage sites, particularly the cemetery (for further details, *see* Dow, Lee, Oezbek, MacIntyre, Bolter & Gandy, 2005). It was inspired by the success of *Sotto Voce* in supporting social collaborative interaction using the guide between visitors. Most mobile guides in cultural spaces do not have the capabilities to support collaborative interaction between visitors, hence the need for designing such systems. The system was designed to be able to support different users' needs and interests and at the same time enable them to share their tour contents (such as interactive media) with other visitors or family members in the same group. The system was equipped with GPS for positioning and location-awareness purposes. One of the important features of this system was shared experiences, where visitors were able to synchronize the contents of their tour with other members of the group. If one visitor paused on the tour, the rest of the group also had the same effect. Two features, 'eavesdropping' and 'contents control', were the key success for the study. Three separate studies were conducted, using pamphlets, human guides and mobile guide tours. The within-subject studies revealed that the mobile guides were able to improve visitors' satisfaction during the tour compared with the other two methods. The contents control and eavesdropping features showed different results between a group of family members and a group of friends. These features were more successful with a group of friends. The parents were more interested in eavesdropping on their children whilst their children were more selective about what they were sharing.

In conclusion, there have been many studies investigating how to bring families and friends together in cultural spaces by improving social interaction between members of such groups. Various technologies have been introduced into cultural spaces including mobile phone guides (Suh, Shin, Woo, Dow & MacIntyre, 2011; Dow, Lee, Oezbek, MacIntyre, Bolter & Gandy, 2005); PDAs (Grinter, Aoki, Szymanski, Thornton, Woodruff & Hurst, 2002; Wakkary *et al.*, 2008; Hatala *et al.*, 2009; Wakkary *et al.*, 2009); and gaming consoles (Hope *et al.*, 2009). These different technologies have different features to support social interaction between groups of visitors, be they families or friends, in cultural spaces and have possibilities to improve group experiences in such spaces. It is also important to highlight that the different studies discussed in this section always tried to improve upon the integration of previously available technologies. This included the synchronizing features between mobile guides to share a tour's contents between members of a group; the collaborative features enabling visitors to actively interact and discuss an exhibition with other members of their group; and improving the communication and personalization of the contents.

2.2.3 Mobile guides: support natural interaction

Many achievements have been made by mobile guide technologies in museums since their first inception. Current technologies are able to provide visitors with information in various formats (for example, text, images, audio, video), and have enabled visitors to interact with other visitors and are able to provide visitors with 'on-demand' information based on their exact location in the museum. For example, the location-awareness technology embedded with Bluetooth in PhoneGuide research (for details *see* Fockler, Zeidler, Brombach, Burns & Bimber; 2005). Location-awareness refers to technology which is able to provide details of the exact current position of the device; for example, if a mobile guide is embedded with this technology, it will allow the system to recognize the location of the visitor and could provide information about the artefacts which they are currently looking at. As such, these different location-awareness technologies are also able to provide precise information to visitors instantly and are capable of providing information to visitors based on their particular areas of interest. The next generation of mobile guide technologies should be able to provide visitors with another dimension of learning by providing context-based and context-aware learning approaches. In fact, there are numerous bodies of research dedicated to this area of interest already.

With such technologies in hand, we now have the ability to create personalized and location-aware guides for visitors to augment their experience of a visit to a cultural space. Several studies on mobile guide technologies that are equipped with location awareness have been carried out. For example, a study on a mobile museum guide called *HIPPIE* (a prototype within the *HIPS* project) was one of the earliest examples of electronic guidebooks as a mobile guide for museums with built-in location-awareness (for example, Oppermann & Specht, 1998; Oppermann, Specht & Jaceniak, 1999; Oppermann & Specht, 1999). The researchers highlighted the use of mobile information technology in assisting or supporting human activities individually in museums. In that study, they illustrated the application of mobile adaptive informative systems for art excursions. This system was designed to support human activities regardless of their location, social boundaries, time, physical spaces, as well as navigation in information spaces. The system was also able to adapt to the changes of activities performed by the users as well as a user's navigation in both the physical and the information spaces. The study was designed such that the mobile guide could be used with a handheld/wearable computer or PDA, and connected with the wireless local area network (LAN). Domain expert evaluation was carried out with artists, museum curators and art educators during a one-day demo and

workshop, and experts agreed that the system had added value for the information system, especially for preparing, conducting and evaluating museum visits (Oppermann & Specht, 1999).

In response to the difficulty that visitors had whilst using a museum mobile guides, Bay, Fasel and Van Gool (2006) made an attempt to design an interactive mobile guide for museums. Their prototype, in turn, should be able to bring a new light to passive and non-engaging museum exhibitions. The study was conducted at the Swiss National Museum in Zurich and used a tablet PC with touch-screen features as an interactive device embedded with a webcam and a Bluetooth receiver. It was tested with 250 visitors at the Swiss National Museum with a set of twenty guided tours. One of the goals of the study was to enhance interaction between user and the mobile guide, thus making exhibits more attractive. This was done by interaction between the visitors and the objects using the tablet PC. The prototype allowed visitors to take pictures of any exhibit from any angle and detailed information about the object would be displayed. Also, the mobile guide could be used as a navigational system on the museum map and was able to provide information about the nearest specific places (for example, toilet, coffee shop, emergency exit door and so on) with directions to get to and from them. This technology also provided further links for the visitors to gather more information about specific objects on the internet. Moreover, the mobile guide could also be used as a location display that could map the user's location in the museum and at the same time help visitors to find their way around the museum. The interactive mobile guide was able to adapt to different views of objects or various conditions to ensure that it was able to recognize any image when requested by visitors on their tablet PC. Furthermore, it was also equipped with a zoom feature and was able to zoom the image in and out to different scales. The study was conducted to develop a mobile museum guide that was able to work in any environment or conditions and at the same time enhance visitors' experiences in the museum by providing enjoyable and meaningful experiences with easy–to-use guides.

A research by Föckler, Zeidler, Brombach, Bruns and Bimber (2005) focused on the on-device object-recognition facility on mobile phones for a museum using a single-layer perceptron in a neural network. They developed a system called *PhoneGuide* which was able to enhance museum guides. This device could to differentiate 50 different objects and their variations. This mobile phone guide has been tested at Senckenberg Museum in Frankfurt and the Museum for Pre- and Early History in Weimar.

Another study by Bruns, Brombach and Zeidler (2007) was conducted to design and develop a mobile guide able to support natural interaction. The study was carried out at the Museum of the City of Weimar. They used a lightweight object-recognition system using a double-layer neural network. It was similar to the previous study conducted by Föckler, Zeidler, Brombach, Bruns and Bimber (2005) and the new mobile guide was called *PhoneGuide*. The motivation for that study was to develop an insightful way of looking at information about specific objects by taking pictures of an object and then information about the object would appear when the system matched the objects with their information. According to the researchers, this method of point-and-shoot is easier than keying-in the code for each object in an exhibit. They used pervasive tracking technology (such as Bluetooth) for context awareness and for sensing the location of the visitors in the museums. Other pervasive technology such as RFID is not feasible to be adapted in this way because it is not available at the time for mobile phones. The *PhoneGuide* was evaluated by taking pictures of 155 objects from three different perspectives: *PhoneGuide* was able to complete the task in less than one hour and this reflects *PhoneGuide*'s suitability for use as mobile guide because of its accuracy in object recognition and the short time taken to recognize the objects.

The *Cicero* prototype was a stepping stone towards designing a more natural interaction between visitors, mobile guides and exhibits. An extended prototype from *Cicero* which allowed natural interaction called *Scan and Tilt* was designed and developed by Mantyjarvi, Paterno, Salvador and Santoro (2006). *Scan and Tilt* made the interaction between visitors and artefacts and the mobile guide easier. The user could use the PDA to scan RFID tags and information about each artefact appeared on the screen, including their location. Tilting the PDA horizontally started navigation of the same piece of information, whilst tilting it vertically explored the information in detail. This approach could help in reducing information overload as visitors only tilt vertically if they would like to know more about individual artefacts. Evaluation with several users revealed that participants agreed that a mobile guide with this scan and tilt function had a potential to improve a user's experiences in a museum. On the other hand, only 16.7% of the visitors found it easy to use the scan and tilt, whilst another 16.7% found many issues with the mobile guide. On the other hand, 67% of visitors in the study found some issues with the mobile guide. The mobile guide also supported different levels of interactivity; (1) basic navigation: the conventional way of using PDA; (2) navigation with audio feedback: this type of navigation is very useful for partially sighted or visually impaired users; (3) navigation using tilt: user navigation using only the tilt function described earlier; and (4) navigation using tilt and voice: this enabled the users to

navigate and the voice was an added value to the text information. This function was helpful for blind people (Santoro, Paterno, Ricci & Leporini, 2006).

Cultural spaces may also benefit from allowing users to bring their own mobile devices to museum exhibitions. They could also benefit by not having to provide visitors with dedicated mobile guides, thus saving the expense of purchasing and maintaining the devices, as well as the costs of staff to give them out and collect them in, and the space required for these activities. Visitors may benefit from the familiarity of using their own device as a guide during their visit, thus reducing problems of learning how to use different devices every time they visit a different cultural space, and possibly even having a negative transfer of training, if different devices work slightly differently (Haskell, 2001). Users would be able to connect to the museum system using wireless-fidelity (wi-fi) technology and personalize their own devices to suit the museum exhibition. Users may also be allowed to download some of the information available using their own mobile devices before or during their museum visit, thus making learning more meaningful and offering a more rewarding experience in the museum. Having an app on one's smartphone may also encourage further interaction with the cultural space artefacts, before or after the actual visit. For example, research by the Handscape Project highlighted the importance of minimizing the learning curve for using mobile multimedia guides in museums (Gay & Spinazze, 2002). Investigations in three culturally different museums found that visitors valued mobile guides that were very easy to learn to use and understand.

The same mobile devices used in museums might not give the same result if they are used by different individuals because of individual differences. This could happen as result of users being not competent enough in using such devices, or perhaps not comfortable with the devices themselves. Even so, the devices used might not be suited to a particular user's preferences. In order to overcome this problem, the use of user's own devices might be suggested. It cannot be denied that most of today's users are well equipped with the knowledge of using their own mobile devices, and this could benefit them in certain ways. On the other hand, this view does not apply to those people who do not have easy access to the internet prior to their visits to museums, and also to the technologically 'illiterate'.

The use of own mobile device is not new in cultural spaces and over 100 museums in the US have found that the use of own mobile phone can significantly reduce the cost of mobile guide tours (Proctor, 2007). The museum only provides the infrastructure and the visitors only spend

their 'minutes' that come with mobile phone contract when accessing the data through their mobile phone providers. Nancy Proctor made a comparison between mobile phone usage as a mobile guide tour in museums between the US and European countries. There were several factors that influenced why European countries were being left behind in using a mobile phone as a mobile guide tour in cultural spaces such as:

1. The infrastructure: many museums in Europe are located in thick-walled buildings, which prohibits good signal coverage. Extra infrastructure is needed to overcome this issue.
2. High roaming fees: many of the visitors to museums are foreigners and this could become an issue when they have to roam their phone for data access about the exhibition through the mobile phone.
3. Pay as you go: many European countries have a pay-as-you-go plan for their mobile phones, thus making it costly to use one as a mobile guide tour to access information.
4. Museums' bans on mobile phone use: many museums have a strict copyright issue and they do not want their visitors taking pictures of the artefacts or art collections.

She further compared pilot studies of using a mobile phone in Tate Modern in Europe and the San Francisco Museum of Modern Art (SFMoMA) in the US. Overall, only 22.8% of visitors at Tate Modern preferred to use a mobile phone, whilst 52.8 % preferred a mobile phone tour at SFMoMA.

To date, there have been various studies investigating how mobile phones and other technologies are able to support museums and other cultural spaces to provide more natural, meaningful ways of interacting with the collection and information about the collection and thereby enhance the visitor experience. Amongst these are the *PhoneGuide* system that is able to recognize exhibits and provide information about them when visitors point a mobile phone at the exhibit and take a picture (see Föckler, Zeidler, Brombach, Bruns and Bimber, 2005; Bruns, Brombach and Zeidler, 2007). In contrast, a study by Mantyjarvi, Paterno, Salvador and Santoro (2006) showed how visitors are able to view different levels of information (short or longer descriptions about the exhibits) on a mobile phone guide by tilting the guide horizontally or vertically.

One way to provide visitors to cultural spaces with more natural interaction is by allowing them to use their own mobile phones or smartphones as the mobile guide. One of the most recent

technological developments in cultural spaces is the use of smartphones as the vehicle for audio and multimedia guides. In some instances (for example at Tate Modern in London), the cultural space provides the device with the guide loaded onto it for visitors to borrow, but increasingly cultural spaces are developing smartphone apps for visitors to download onto their own devices. This has a number of advantages for both visitors and those managing cultural spaces. For visitors, it means they can use a device that they are familiar with and potentially browse content both before they visit the cultural space (perhaps to plan their visit) and afterwards (to follow up on items of interest). For managers of cultural spaces, although there is the upfront cost of developing an app, they do not have to worry about the expense and space taken up by dedicated equipment for audio or multimedia guides and the staff required to manage this service, which is considerable. This means that smaller and less well-financed cultural spaces are now considering deploying apps, whereas previously deploying dedicated audio or multimedia guides would not be a possibility. But what effect does this new technology have on the experience of visitors in cultural spaces? How can cultural spaces, particularly the smaller, less well-financed cultural spaces evaluate the use of such apps? In our research we are interested in exploring the visitor experience with technologies in a range of cultural spaces, as well as supporting those managing such spaces in effective evaluation of their spaces and the technologies they have deployed.

2.2.4 Mobile guides: personalizing tours for different visitors

The concept of personalization had been around many years before the advent of internet technologies and the linking of personalization to computer interfaces. To begin with, the term 'personalization' was not used widely until researchers began to refer to the personalization of internet applications. This may be due to the fact that personalization before the internet age was mainly about the personalization of computers and their interfaces and was not widely used in other applications. On the other hand, one personalization application claimed that it was first introduced as the internet application, especially in e-commerce applications, before it was widely used in other applications such as e-learning portals, tourism, finance, culture and health (for example Bowen & Filippini-Fantoni, 2004; Filippini-Fantoni, Bowen & Numerico, 2005; and Filippini-Fantoni, 2003).

With this promising technology and its potential for personalization, museums have started to use this concept in their virtual museum websites or other museums applications. Bertoletti, Moraes and Costa (2001) clearly explained that educational portals such as the virtual museum

mainly benefit from the use of personalization techniques because this could ease user navigation with the help of the personal assistance provided.

The personalization of information and contents on the mobile guides in museums is able to avoid the issue of information overload faced by users. This can be achieved by creating user models, which represent distinguishable user knowledge, goals, preferences and interest in various contexts or needs (Brusilovsky & Maybury, 2002). Filippini-Fantoni, Bowen and Numerico (2005) concluded that personalization techniques are able to help users by filtering information according to their individual needs, facilitating navigation and improving the time of information access.

As mobile guide technologies changed, a direct input system was developed by which visitors were able to personalize what they wanted to hear from the mobile guide at any particular time/selected artefacts by entering an exhibit code into the mobile guide. This enabled visitors to walk around an exhibition and choose which exhibits they were interested in and listen to the mobile guide explanation for their chosen exhibits. The mobile guide technology was empowered with audio, text, images, video and multimedia contents. This use of mobile guide technology significantly improved museum learning experiences for visitors, as well as overcoming some limitations in the mobile guides, especially with content delivery, type of media supported and context awareness.

Advances in technology mean that limitations in interaction with mobile guides can now begin to change radically. Personalization becomes important because visitors may feel overwhelmed by the amount of information provided to them in the multimedia guide. With all the supplementary background information, interviews and explanations, visitors may be having difficulties in finding the right information at the right time. Like users of the web, they can become 'lost in hyperspace' (Otter & Johnson, 2000).
The personalization concept is not limited to the content of the mobile guide tour, but can also include personalization of devices, for example visitors may bring their own device such as a PDA or a smartphone, to a cultural space and personalize the interface to the information, for example, some visitors may prefer a large font or a different colour combination.

In addition to personalizing tours for different visitors, localization technologies also have great potential to improve visitors' experience in museums. Numerous localizing and locating

technologies currently exist, including Bluetooth, infrared, Radio Frequency Identification (RFID), WiFi and GPS (Filippini-Fantoni & Bowen, 2008). As yet, none of these technologies has emerged as the definite one to use, with the exception of GPS for outdoor locating. However, localizing technologies will soon be able to do many useful things for museum visitors, not only the obvious one of saving them the necessity of reading the label on the exhibit and entering it into their mobile guide. That onerous chore will be passed to the computer, which will not only be able to understand where the visitor is now, but what route the visitor has followed to come to that point, and then provide information that suits that particular path. For example, in 2005, a system called *PhoneGuide* was developed and tested at the Senckenberg Museum in Frankfurt and the Museum for Pre-and Early History in Weimar (Föckler, Ziedler, Brombach & Bimber, 2005). That device was equipped with pervasive tracking technology for context awareness and for sensing the location of visitors in the museums. Many features of the *PhoneGuide* have already been discussed in detail in the previous section.

Mobile guide technology is usually delivered by means of mobile and handheld devices such as PDA, tablet PC and so on. This technology has also enabled a context awareness function to be employed in museums using technologies such as Bluetooth, Infra-red transmitters, Beacons, RFID tags, GPS and so on. These tracking devices can provide a visitor's location inside the museum and can be used as a point of reference to show which objects/exhibits are closer to them. In addition, visitors are able to move between galleries or exhibits by using their mobile guide as a guidance tool. This is helpful if visitors want to find their way to the nearest exit or to a toilet. Abowd, Dey, Orr and Brotherton (1998) discussed the importance of mobile guides with context awareness technologies and ubiquitous computing and how it can be applied into various applications.

A study conducted by Spasojevic and Kindberg (2001) focused on the relationship between visitors' experience and the technologies used, including modes of use and their use. In that study, visitors used mobile guides with a web browser or RFID tags to explore the museum. These technologies were supported by wireless technology which was able to provide a connection when needed. Visitors were able to personalize their visits to the museum by saving any exhibit page that was most likely to interest them and this enabled them to revisit these saved pages using a web browser. Visitors were not only able to access the information about the exhibits they had saved within the museum, but also beyond the museum walls long after their visit had ended. This personalization approach enabled visitors to perform extra research on the

exhibits they were particularly interested in outside the museum. In addition, visitors were able to discuss the museum exhibits with other visitors using the bulletin board system which enabled collaboration between visitors. Interaction between the visitor and the physical exhibits and virtual exhibits using handheld devices opens up a new dimension of 'navigation between the physical and virtual', by switching between the two.

As described by Bonett (2001) and Filippini-Fantoni (2003), segmentation is a technique used in personalization to differentiate different clusters or groups from a big population who interact with technology, and it is used to avoid the classification of each individual or users' behaviour. Filippini-Fantoni (2003) commented that personalization techniques such as segmentation used in some museum applications (for example, the Louvre Museum) enable users to be classified based on clusters or groups. For example, in Filippini-Fantoni's study, visitors were grouped as tourists, art students and experts. Such classifications according to different groups of users is appropriate in reducing the numbers of user profiles in the system, or to make a general classification based on their general features, for example, adults, disabled people, children, visitors, teachers, learning styles and many others.

Personalization does not always provide the best option for users. Some users in previous studies had difficulties using personalization technology, especially when they had to select which of the groups they belonged to (Filippini-Fantoni, 2003). They spent more time trying to figure out which group was more appropriate to suit their profile than using it as a mobile guide, thus making the system not effective. In addition, they felt that the classification of the groups was not well suited with their preferences because it only represented the common features of the group and not individual features. On the other hand, there are systems or technologies that able to generate user profiles given the information gathered from computer use (for example, user preferences, web navigation, cookies) (ChoiceStream, 2004). This system will generate a user model which is tailored to individual needs derived from the information stored.

Another example of mobile guide technology for museum applications that employs the personalization concept is the *DANAE* project that was implemented at the Museon in The Hague, the Netherlands (Brelot, Cotamanac'h & Kockelkorn, 2005). This application enabled multimedia content in context-aware environments based on a MPEG-21 platform to run on both tablet PCs and PDAs. The system offered guided tours using mobile guides with personalized contents. In addition, this system was also equipped with a function called geo-

localisation, which only delivered information according to the gallery which visitors were currently at. This was done by sensing the location of visitors in the gallery using a WLAN software-based positioning system. To further enhance the delivery of multimedia contents, a 3D Avatar was used as a virtual human guide. This virtual human guide could be personalized further by enabling a specific language, such as Dutch or English. It also supported a text to speech generator to record audio. 'Session mobility' was introduced to improve the quality of video by enabling the video from the PDA to be displayed on large flat-screen displays located within the museum. However, no evaluation of this prototype was performed and it could not be concluded what the impact would be of using such systems on visitors' experience in museums.

Similar to the example described above, a group of researchers developed two different systems, a web-based museum tour and a mobile guide using PDA, for guided tour called *CHIP* (for example, Wang *et al.*, 2008; Wang *et al.*, 2009; Roes, Stash, Wang & Aroyo, 2009). The study was conducted to see the use of PDA-based mobile guided tours by various museums in the Netherlands. In that study, guided tours were used in the museums using PDA in the same was as guided tours developed for web-based museum tours. In addition, these guided tours on the mobile guides could be synchronized with the contents on the museum's website, thus enhancing the visitors' meaningful museum experiences and so creating a more intensive, long-lasting and engaging way of presenting information to visitors. *CHIP*'s studies not only focused on the day of the visit itself, but also before visitors entered the museums. To use the system, visitors had to log into the museum website before they made a visit and a visitor could personalize the tour by providing the system (Web-based Artwork Recommender) with information about what he/she wanted from this Tour Wizard (which would then generate the appropriate guided tour). When visitors wanted to start their real visit, they were given a PDA-based mobile guide tour that could load the whole guided tour (text, video, audio, images) as requested before the visit using wireless/internet. In addition, the PDA also enabled the system to track the visitor's position and direction in the museum and show the visitor where to go next. On the other hand, users who had not prepared before their visit to the museum would be given only a standard PDA-based mobile guide tour.

Researchers in the *CHIP* project also used RFID tags that were embedded next to the artworks allowing visitors to scan the corresponding artwork to get more information about that particular artwork. This function enabled the mobile guide to provide visitors with information about artworks as well as updating their current position in the museum. Whilst the evaluation part of

that study is not yet complete (they are proposing to divide their respondents into two different groups: visitors who explore the web-based museum tour wizard first and visitors who directly visit the real museum tour), the researchers cannot conduct an empirical evaluation of the mobile guide tour because of various restrictions with the museum's website, but they have managed to carry out a qualitative analysis and compare the results with those of their previous study on one of the components of the mobile guide (*see* Wang *et al.*, 2007 for details). The previous study had concluded that the Art Recommender component in the mobile guide system positively helped users to personalize their interest with the collections as well as promote interest in the art collections.

There are various mobile guides available in museums to accommodate different visitors' needs and preferences and a recent study by Walker (2007) explored the use of mobile phone technology in museums, botanic gardens and cultural heritage sites. That study mainly focused on school children (visitors aged nine and ten) as well as adult learners studying a horticulture subject. In the study, visitors were given a mobile phone that was able to take pictures, record an audio or send a text message automatically/directly to a website for further activities; visitors were given appropriate time to manage their gallery based on the themes or the other related features. In the study, the location of the learning objects was not important, what mattered most was the links between the objects. However, all photo, audio or text recordings made earlier could only be accessed through the websites and not the mobile phone, thus limiting the interaction with the objects. Walker's study showed that the students were fascinated with the capabilities of the mobile phone guide and sometimes dominated other students in the same groups (Walker, 2007). This could be observed when a few students in the same group used the mobile phone more than the other students and at the same time were trying to explain to other students how to use it. This implies that collaboration is an important aspect in museums where visitors are engaged with each other when discussing a given task. Visitors in the study were not only able to capture an image, but also to record an audio about their task: especially discussions on the objects. Audio could also be used as an alternative to text input for visitors with writing difficulties. Walker's study drew a number of interesting conclusions. The uses of mobile guide technology were able to enhance or facilitate learning in the museum with the aid of a personalization concept. Visitors, especially young ones, were more eager to learn with the support of the mobile guide technology. In addition, they required less time to learn new technology or features embedded with the technology because they are born into a world with technologies: they are known as the 'millennial' generation. The integration of different types of

media (for example, text, audio, images) in the handheld devices could enhance visitors' learning experiences by supporting different individual needs.

Personalization using handheld technology in museums is not limited to mainstream visitors, but might also be available to visitors with special needs. In a study carried out by Knapp, Finkelman, Kee and Tanaka (2004), a mobile guide using a portable handheld computer was used to increase the accessibility of museum exhibits for visitors with physical, visual, hearing and cognitive disabilities. Findings from the study showed that people with disabilities had no problems using the system. The study also showed that such people are equally able to enjoy meaningful experiences within the exhibits. Visitors were able to interact with the mobile guide to gain information about artefacts in the exhibition by means of audio and text. In addition, visitors could also use a 'bookmark' feature to highlight their areas of interest as they toured a particular museums (this 'bookmark' information is accessible for further details on the websites or in the printed materials). The personalization of a mobile guide for visitors with special needs is a benchmark in developing handheld technologies in museums as a whole. The personalization features embedded within the mobile guides that are able to respond to different individual needs are an added advantage for museum visitors.

Personalization of visitors' experience in museums is made with the intention of eliminating barriers between visitors and exhibits. Visitors should naturally be able to interact with the exhibits using a mobile guide. The vision of developing a mobile guide that is personalized to the user is a new frontier in museum learning, but due to the technical capabilities, it was not delivered to the standard required (Tallon, 2008).

2.2.5 Mobile guides: technology for all

A survey on the use of mobile guide tours for visitors with special needs has revealed that there are numerous mobile guide tours available to support visitors with diverse needs across the globe (Proctor, 2005). Proctor explained the differences between these technologies available:

(1) A ***Sign Language Guide*** enables deaf visitors to receive information about exhibits via video footage with a sign-subtitled interpretation;

(2) A ***Subtitled Guided*** enables visitors who are hard of hearing and deaf visitors who do not know sign language to receive information about exhibits with the audio-visual tours; and

(3) ***Audio+™ Text Tours*** provide visitors with scripts of audio tours and other textual information about the tours in large print, full-screen format, and scrollable format along with the audio guide.

(Proctor, 2005)

A good example of mobile guide technology for visitors with special needs in museums is a study of portable handheld computers carried out by Knapp, Finkelman, Kee and Tanaka (2004). A portable handheld computer was designed for visitors with physical, visual, hearing and/or cognitive disabilities. It enabled them to enjoy meaningful experiences with the exhibits. They were able to interact with the mobile guide or portable handheld computer to gain information about artefacts in the exhibition. The mobile guide in that study was called the *Museum Exhibit Guide (MEG)* and was equipped with a headset and a Hip Pack Unit (HPU) and the handheld controller that acted as a Personal Digital Assistant (PDA). The PDA was used to scan the various objects in the exhibition to get more explanations on each exhibit. This *MEG* was also modified to support menu navigation using single-switch events or single-key press on a keyboard. The initial responses from the visitors in the study showed that it was a good mobile guide for visitors with different disabilities and was able to enhance a meaningful and enjoyable experience for visitors.

Several studies have been carried out to design and develop a mobile guide which supports different levels of 'accessibility'. For example, the mobile guide prototype called *Scan and tilt* which has already been described had a selection of different types of tour guide to suit visitors' accessibility, including an option to navigate the exhibition using *tilt* and *voices* (Santoro, Paterno, Ricci & Leporini, 2007). This configuration was aimed at supporting blind visitors by providing them with information about particular exhibits using a voice.

The Tate Modern Museum is also keen on improving museum experiences for special-needs groups such as deaf people (TateModern, 2009). They use a handheld computer as a mobile guide to play a video of an interpreter signing the exhibits as the tour takes place. This will enable more audiences to reach museum galleries. They first piloted this tour for the deaf in British Sign Language (BSL) in 2003 in parallel with a multimedia tour (Tellis, 2004). The BSL Tour was made available to the public in 2005 and deaf visitors were able to access 'on demand' information in their own language. Evaluations have been made of the BSL tour at the Tate Modern and the results showed that the users of BSL were satisfied with the guide and that it

had significantly improved their visit (Proctor, 2005). Only 1% of the visitors who used BSL said that the mobile guide made their visit worse, and 79% of visitors agreed that they were highly satisfied with the use of the BSL mobile guide during their visit.

A recent survey on the use of mobile tours for different-needs visitors was carried out to look into the principles of designing suitable contents to be used with a mobile guided tour or a multimedia tour for all types of visitor (Ruiz, Pajares, Utray & Moreno, 2011). The authors also discussed the main findings of the design and use of a Multimedia Guide for All (MFA). They suggested several principles which need to be taken into consideration when designing MFA, such as:

(1) ***Accessibility Mechanism*** which refers to the tools to make the contents available for all types of user. Furthermore, it should provide a single access point for all users with a configuration option, rather than different access points for different users.

(2) ***Integrating audiovisual contents*** to ensure that the delivery of the multimedia contents will be accessible to different types of user, the interface of the tour should start with people with disabilities. This means that other features for visitors with special needs (for example, sign language video, audio-visual contents) act as add-on feature(s) placed on the screen which can be hidden if not in use.

The researchers in that study developed a prototype called GVAM that was designed for visitors with physical disabilities, for example visitors in wheelchairs, or with any other type of physical disability.

Another example of a project aimed to enable visitors with different needs, particularly with reduced vision and reading disabilities, to access information about exhibits using a mobile guide have been developed and tested at regional museums in Sweden (Pareto & Snis, 2006). The portable device for that study was developed to ensure that it could support auditory and context-dependent information (a location-aware system). Audio was selected as a medium mainly because people with reading disabilities were linked with those with dyslexia, and people with dyslexia are better at understanding sound than text. In addition, people with reduced vision are usually good with sound to compensate for their lack of visual capability and they generally have better listening skills than fully-sighted people.

The researchers in that study described the requirements they should follow to design and develop the mobile guide. One of the requirements was that headphones should be used in the study to filter out extraneous noise to ensure that dyslexic users were able to understand what they were hearing. Furthermore, the headphones should be compatible with hearing aids and so not limit social interaction if the visitors had come with a friend or a guardian. The mobile guide should also allow natural interaction from the visitors to control the guide, and be robust in design and easy to distinguish for different functions. Another requirement was that the type of information presented on the guide should be straightforward with short sentences and no ambiguous words. Evaluations were made of the prototype using a mock-up prototype as well as user tests. The results from these evaluations showed that dyslexic users were quite comfortable with the technology but found the information presentation too simplified. They asked for a richer presentation of information on the mobile guide. Participants with reduced vision, on the other hand, had problems using the technology, particularly in using the buttons as there was not enough tactile information. They were able to find out that the information presented was interesting and involving, but they would like more information.

2.2.6 Mobile guides: fun and entertaining

Edutainment in museums is another innovation to attract more visitors and to compete with other popular entertainment venues, as well as to transform museum functions to be more versatile in the fast-changing world of technology. Various museums have successfully installed edutainment applications. For example, the Senkenberg Museum in Germany installed *DinoHunter* (Feix, Gobel & Zumack, 2004). Another example of a mobile guide tour which is able to support interaction between visitors in museums through cooperative and educational games is *coCicero* (Laurillau & Paternó, 2004), which has already been described. In addition, *coCicero* was designed to support communication and information sharing as well as collaboration between visitors and personalized contents. It was developed to support a visit to the Marble Museum in Carrara. Educational games are believed to provide a good way to initiate collaboration among visitors and to promote social interaction and engagement in activities related to the museum exhibits between visitors. The system was designed for mobile guides such as iPaQ PDAs. Importantly, the study highlighted the novelty of social interaction through communication using cooperative and educational games. It allowed visitors to collaboratively share information with other visitors but to individually solve the games.

Museum and storytelling is one of the current trends in museum exhibitions. It provides visitors with a narrative about an event or an object in a lively way by digital storytelling. There are numerous museums which provide such services such as the British Museum, the Modern Art Museum in San Francisco, and the National Museums of Korea (Park & Jung, 2007). There are various techniques and methods available that employ digital storytelling, either for on-line or off-line purposes. Park and Jung's study focused more on the development of digital storytelling using RFID and wireless LAN. It also focused on transforming objects into synthetic multimedia contents (such as movie, drama, animations, and game) for digital storytelling, thus creating an edutainment museum experience. RFID and wireless systems are new technologies that have shaped our museum environment for the past ten years and several museums around the globe have already had these systems installed.

Designing a tour on a mobile guide for children has never been an easy task. Designing a mobile tour which is able to promote learning while doing, is fun and is entertaining while visiting cultural spaces is even harder, particularly if it involves children. Children and adults learn in different ways. In order to attract children to enjoy their visits to cultural spaces, various efforts have been made. For example, researchers have designed a tour on mobile guides for children to use in a museum which can support a constructivist, collaborative and exploratory approach in learning (Papadimitriou, Komis, Tselios & Avouris, 2006). This mobile guide tour used PDA as a platform and was designed to be suitable for children's learning. The design followed activity theory to be able to support and promote learning. It incorporated various learning activities to be explored by the children when they visit a museum.

Children were asked to explore an exhibit by completing clues given to them, as a group or individually. They were given a mobile guide (PDA embedded with RFID) on which to read information about the exhibits and to find clues. They then gathered and shared their findings about the clues and later they were challenged to find the exhibits that matched all the clues they had gathered. The study was initially held in a room emulating museum conditions and then was tested in a real museum environment. After the children had finished their exploration, they were asked to complete a set of questions and then were interviewed. The researchers found that learning activities are important in designing a mobile guide tour for children. In addition, the children were more motivated to learn about the cultural and historical context of the exhibits. Children were indeed having fun at the museum and at the same time learned more about the exhibits during their visit.

It cannot be denied that visitors are more engaged with the exhibits, their companion(s) (for example, children with parents, a group of school children, groups of friends) or with the mobile guides if their visits are filled with interesting activities on the guides, exhibits that are able to provoke visitors' interest and curiosity, and can support collaboration with companion(s) or other visitor if needed. Obviously, one of the ways to do this is by allowing visitors to physically manipulate the objects, but it is not possible to do that for a variety of reasons.

For years, technologies have played a major role in supporting activities in cultural spaces and the use of mobile guides has been proved successful in engaging visitors. Researchers have been exploring many ways to ensure that visitors are able to take some new knowledge with them when they leave the building. This could be from supporting their children's learning activities, using a mobile guide tour in the museum, a meaningful discussion with other visitors about particular exhibits of interest, or being actively engaged with the exhibits and the mobile guides.

2.2.7 Mobile guides: support mobile learning

Organizations responsible for cultural spaces, and particularly educational personnel at cultural spaces, are particularly interested in engaging with and supporting a range of visitors using technologies. This will be discussed in detail in the next section after a discussion of user experience (UX) in museums.

2.3 Technologies in religious spaces

Technology is now part of all aspects of our lives, even our cultural lives. For many years, museums and other cultural spaces have been adapting their exhibitions to accommodate the expectations and needs of visitors. The changes come from different sources, such as technological advancements, different information provided on displays (be it digital displays or printed materials), quantity of information on displays, number of artefacts presented, exhibition design styles and so on. Part of the process is using new technologies to keep up with visitor expectations and to increase visits to cultural spaces, an ongoing goal for cultural organizations (Verdaasdonk, Van Rees, Stokmans, Van Eijck & Verboord, 1996).

Several studies have investigated the impact of various technologies in churches, for example the use of technology by the minister in a church service (*see* for example Grinter, Wyche, Hayes & Harvel, 2011; Wyche, Hayes, Harvel & Grinter, 2006). These studies have focused on the use of technologies for religious practices particularly to improve pastoral care, the church service, or

the means of communication. No studies could be found that have focused on the use of technology in the context of visitors to churches for cultural or tourist experiences.

Many historic churches have similar functions to other cultural spaces, where visitors see the church as a place of historic or cultural interest, a touristic diversion or a place for learning in an informal environment, rather than as places of worship or spiritual inspiration. As a result, there are different types of visitor to historic churches: those who come for spiritual experiences and others who come to the church for cultural and tourist experiences. And it may well be that there are some visitors who enjoy both types of experience.

There have been several studies that have explored the emotional connection and spiritual experience of visitors to cultural spaces. For example, Doering (1999) included spiritual experiences in his classification of visitor experiences in museums. Van Dijk, Kerstens and Kresin (2009), on the other hand, discussed a GPS-based walking route called *Rituals* which connected religious monuments and was developed mainly to give personal spiritual and emotional experiences to the users. Struken (1991) discussed how the Vietnam Veterans Memorial in Washington DC and its history, objects, images and other features have a profound impact on visitors, as well as the actual design of the memorial. She also focused on what lies behind the design of the memorial, which connotes the significance of the memorial for remembrance of the war.

2.3.1 Church and technologies

Technologies play an important role in our society. For example the use of mobile and handheld technologies in our daily activities, be it for communication, entertainment, or even as a mobile guide in cultural spaces. Other places of cultural and historic interest have also adopted technology similar to way that museums have. Recently, some historic churches have developed an app for smartphones. These apps can be used as a mobile guide within the church walls. For example, the Centre for the Study of Christianity and Culture at the University of York in the UK has developed an app for Holy Trinity Church in Stratford-upon-Avon (Shakespeare's church) to be used with smartphones (both iPhone and Android). This app provides information to visitors in the form of text, images and panoramic images of the Shakespeare church. Other technologies available in historic churches are as follows:

1. Interactive touch screen (for example, Holy Trinity Churches, Micklegate and Goodramgate, both in York). This provides information about the churches, their history and development as well as various church features that might be of interest to visitors, and enables visitors to be actively engaged with the church and its features. The touch screen at Holy Trinity Goodramgate was develop by the Centre for the Study of Christianity and Culture and it enables visitors to experience the church via 360 degree panoramas as well as a three-dimensional model (3D) of the church throughout the centuries (CCT, 2011).
2. Multimedia guides (for example, St Paul's Cathedral in London). Visitors to the church have the opportunity to use touch-screen multimedia guides which include images from various periods of history, videos, and audio commentaries (interviews) with the Dean, the conservation team and the director of music (Audiogids, 2011; St Paul's Cathedral, 2012). In addition, they also provide audio guides for visually-impaired visitors (St Paul's Cathedral, 2012).
3. Audio visual systems (for example, St Mary Church at Gowan in Kilkenny, Ireland). Visitors to this church are surprised by the sequence of images hidden in the pulpit which explain the history of Ireland (Leslie & Gleeson, 2005).

2.4 User Experience (UX)

The direction of users' studies about interaction with technologies has recently shifted towards the "user experience" (UX) of technologies rather than the usability of devices (for example a study by Hassenzahl & Tractinsky, 2006; O'Brien, Toms, Kelloway & Kelly, 2008; O'Brien and Toms, 2008; Hassenzahl, 2008; Law, Roto, Hassenzahl, Veermeren & Kort, 2009). UX is defined broadly, for example it was defined with related with engagement concept. As a result, engagement was defined as quality of UX with technology and is comprised of attention, affect, novelty, interest, control, feedback, challenge and motivation (O'Brien, Toms, Kelloway & Kelly, 2008). This definition is derived from previous study by O'Brien and Toms, (2008). On the other hand Hassenzahl (2008) defined UX as "*a momentary, primarily evaluative feeling (good-bad) while interacting with a product or service……. Good UX is the consequence of fulfilling the human needs for autonomy, competency, stimulation…. through interacting with the product or service*" (p.12).

Hassenzahl and Tractinsky (2006) summarize the UX concept from various literature and suggested that it can be divided into three different perspectives as illustrated in Figure 2.6 below. One of the perspective is the emotion and affect which mainly focuses on the affective

computing concept and how it can influence users' emotions. Second perspective mainly focuses on the experiental that have two aspects of technology use: its *situatedness* and *temporality*. It is important to note that these experiental components are inter-related. The third perspective, beyond the instrumental approach has the goal to create more holistic and complete HCI using non-instrumental aspects of HCI. They further explained that "*UX is a consequence of user's internal state…, the characteristics of designed system, and the context (or environment) within which the interaction occurs*" (Hassenzahl and Tractinsky, 2006, p95)

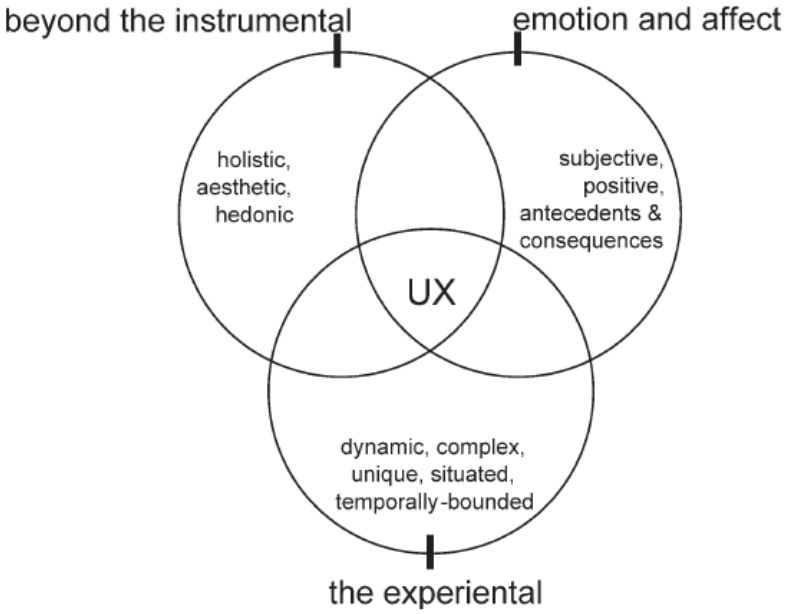


Figure 2.6. Facets of UX (from *Hassenzahl and Tractinsky, 2006, p95*)

In a study by Law, Roto, Hassenzahl, Veermeren & Kort, (2009), they conducted s survey to gather more information about the preferred terms for UX definition and UX statements amongst the UX community. Respondents (UX community) in this study were given a set of statement to rate using 5 points Likert Scale. They also asked to comments on the preferred definition of UX by choosing one or more definition (total of 5 definition given). As a result of this study, they propose that UX is something personal and 'within the person' but also may be influenced by other people or groups before, during or after using the product or services. Law et al also propose that the contextual factors are the most important influences in UX, which the experience is within the individual; although some of the respondents in the study said that it could be other factors and further expressed that *"Only an individual can have an experience but I believed it can be externalised (albeit poorly) and recognised and related to by others"* (Law, Roto, Hassenzahl,

Veermeren & Kort, 2009, p726). They also suggested that the term 'user experience' "… *be scoped to products, systems, services and a object that a person interact through with a user interface"* (Law, Roto, Hassenzahl, Veermeren & Kort, 2009, p 727). This is illustrated in Figure 2.7.

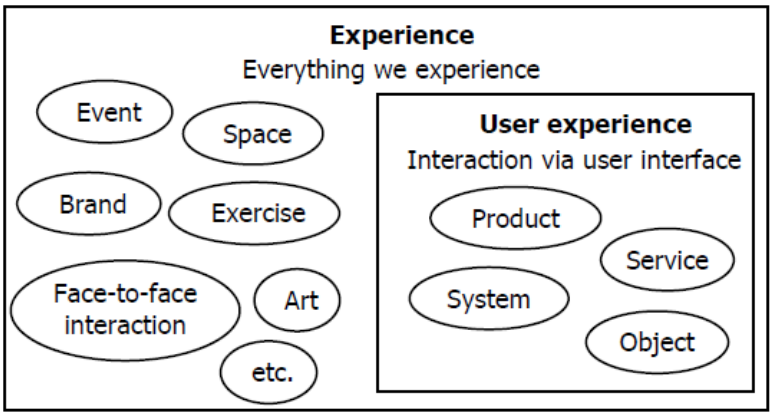


Figure 2.7. UX of technology in relation to other experiences (from *Law, Roto, Hassenzahl, Veermeren & Kort, 2009, p. 727*)

2.4.1 Technologies for visitor experience in cultural spaces

As Wasserman (2011) wrote, "*In this era of ubiquitous information, mobile inherently connects. Institutions have the opportunity to bring people together through experiences - either explicitly through events and activities or through the inherent convergence of public space*" (p.11). It is important to understand that Wasserman's notion of the importance of cultural space institutions such as museums to use different technologies particularly incorporates using a mobile guide for bridging the gaps between exhibits and visitors to cultural spaces.

It is arguable whether technology is a valuable means by which to augment museums and museum exhibitions and it is not a new concept in museums studies. To date, there are various technologies available in museums to support museum exhibitions directly or indirectly, and every technology used makes an impact on the exhibition or the visitors. For example, digital technologies have been opening new possibilities in exhibition design and contents for the past 40 years (Parry, 2007), whilst a comprehensive study of the impact of technology on the museum by Bearman and Geber (2008) suggested that technologies in museums have changed the way museums communicate with their visitors and that this transformation is necessary and technologies are expected to be used widely over the coming decades.

It is important for museums and other cultural spaces to explore whether technological enhancements can help them to attract more visitors and provide different ways of learning or of interaction between visitors and exhibits and each other. Previous researchers have tried to understand the visitor experience with interactive technology in cultural spaces particularly how visitors approach, perceive and use physical spaces and how visitor experience can be related to the design of the exhibition and their exhibits (Ciolfi, Bannon and Fernström, 2001). This experience is important in shaping visitors' museum experiences, particularly with interactive technology and exhibitions.

A study by Ciolfi, Bannon and Fernström (2001) introduced the concept of participatory design when designing museum exhibitions. In the study, museum management had selected user groups, namely art experts, other curators and academics in related field to give their input about designing the museum exhibition (*Out of Storage Gallery*) but they did not have much input from the visitors to the museum. Despite this lack of contribution from the museum visitors, they proceeded with the design of the exhibition with interactive technologies and conducted an informal evaluation. They made observations of numerous different types of visitors: art students, school classes, foreign tourists during weekdays, art amateurs, tourists from Ireland and Dublin, families during the weekend. A subsequent study by Hall and Bannon (2006) further discussed the different types of stakeholders who were involved with the design of *Re-Tracing the Past* gallery at Hunt Museum, Limerick, Ireland such as: *"visiting children and school groups; teachers; the curatorial, educational and managerial staff of the museum; the museum docents(specialist guides); and John Hunt's biographer and Personal friend, Professor Emeritus (University of Limerick) Patrick Doran"* (p.232).

The study by Ciolfi, Bannon and Fernström (2001) investigated issues that arise as a result of integrating technology into the physical space of the museum and that need to be addressed to ensure successful interaction between visitors, technology and exhibits. They made numerous observations about visitor behaviour whilst interacting with the technology. One of interesting findings from this study is that *"we have noted how visitors do not engage with a number of the interactive media installations- a common finding in many museum and exploratoria around the world. Our analysis has attempted to show how an understanding of the physical settings, together with an understanding of visitors behaviours can allows us to understand why certain of the technological installations were problematic in terms of user acceptance and use"* (p.605). They also discovered some problems with the exhibition arrangement, especially the installation of interactive multimedia that are at a distance away from the object. This could explain why visitors did not engage with technology in the museum. In

addition, another design issue highlighted in this study concerned the amount of information given to the visitors, how to reduce the information overload and not compromise their enjoyment, fun and other meaningful and an engaging experiences. For example, Ciolfi, Bannon and Fernström (2007) also highlighted in subsequent study that *"We analysed visitors' physical flow through the museum, their behaviour and episodes of social interaction. The content of the interactive exhibition was also designed collaboratively on the basis of the objects' official records, the docents' knowledge and interview with experts on the collection"* (p.358).

Public spaces other than museums have also looked for new ways to engage their visitors and willingly adopt new technologies. For example, 3D cinema, interactive windows displays (*see* for example the interactive Starbucks storefront in Canada[3]) and other public places such as sea life parks, and theme parks.

With this long history of technological advancement, it cannot be denied that many people are fascinated by the use of new technologies in their daily lives. As a result, technologies have come to dominate our lives in many ways. These technologies in turn become more dominant and apparent in shaping our world, whether in education or learning, in cultural, societal and humanities aspects, and also within the entertainment and communication industries. For example, the use of technologies in museums (Mintz, 1998) or the use of mobile guides for navigating and experiencing a museum (Thom-Santelli, Toma, Boehner & Gay, 2005), the use of ICT for older adults, mainly the over 60s (Selwyn, Gorard, Furlong & Madden, 2003) and many more. Mobile phone technologies also play a major role in assisting everyday learning activities (Vavoula & Sharples, 2001).

Furthermore, these technologies have become smaller, mobile, wearable and even more embedded within us (Weiser, 1991). Within the computing technology, the terms 'ubiquitous computing' and 'the disappearing computer' vary in their meaning yet shares some features. 'The disappearing computer' can be defined as when technologies already in use which are bulky, complex, heavy and expensive become smaller and easier to use, or even embedded or wearable. In addition, they become affordable, ubiquitously available, and thus make things that were luxuries a few years ago become a necessity in our lives. This is supported by various powerful portable platforms such as Palm OS, Mobile 3G, Tablet PCs, Handheld PCs, Symbian OS, and many more. The availability of wireless networks such as wi-fi and WiMax has made this use of

[3] http://www.endgadget.com/2011/02/07/interactive-storefront-displays-show-up-at-canadian-starbucks-w/

technology even more promising. These developments have become more apparent in the past decade and many people and institutions have benefited from these changes, including cultural spaces. For example, the use of location-awareness technology with mobile guides in cultural spaces (*see* Fockler, Zeidler, Brombach, Burns & Bimber; 2005; Oppermann & Specht, 1998; Oppermann, Specht & Jaceniak, 1999; Oppermann & Specht, 1999).

The 'ubiquitous computing' concept, on the other hand, refers to the bringing of computing into the human world and it is available anywhere, anytime and without boundaries. Weiser (1991) explained the concept of 'ubiquitous computing' as

> *"The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it … Ubiquitous computers will also become in different sizes, each suited to a particular task"* (Weiser, 1991 p.67-75).

The technologies discussed in cultural spaces may vary in the nature of their usage and representation, but their goals remain similar. Some technologies are also able to act as either input devices (mobile phones can capture images before there can be processes to identify their category), display devices (mobile phones as a hardware to project multimedia contents onto a wall) or other available technology used in various applications, such as interactive kiosks or displays in public spaces. The uses of such technologies are changing rapidly. In their early evolution, such technologies were only available to research institutes or laboratories and were intended for research purposes, but now they are accessible to almost everyone. This has happened because of changes in the scale, size and price of these technologies since they were first introduced.

It is important to provide a conducive environment to visitors to cultural spaces particularly when the technologies introduced becoming a part of the environment. Ciolfi (2004) explained about the integration of ubiquitous technologies within the physical spaces and why it is important to the visitors' experiences. One of the issues she discussed is the design of the environment that could give an impact to visitors, for example different elements introduced and placed within the physical spaces. She further added "these experiential concepts of spaces highlight the relationship between the features of the space and *cultural*, *social* and *personal* elements proposing them as the fundamental aspects of the experience to be taken into account" (Ciolfi, 2004, p4). These concepts of experiential experiences and the different dimensions of places are based on work by Tuan (1977). These concepts was introduced into the exhibition

design within the EU SHAPE project (Ciolfi and Bannon, 2002; Ciolfi and Bannon, 2005). The concepts of different "spaces" and "places" were discussed in great detail in Ciolfi and Bannon (2005; 2007). Among these are "enhanced spaces", "anthropological space" and many others. They described the importance of these concepts in designing cultural spaces, particularly museum by giving several examples of the successful past studies. They also describe the design and evaluation of museum exhibitions, for example the *Hunt Museums Projects*, *Cabinets of Curiosities*, *Re-Tracing the Past*. A study by Ciolfi and Bannon (2002) has successfully developed a novel interactive exhibition space that successfully measured visitors' experiences in museums according to the "localized experience" perspective as describe in Ciolfi and Bannon (2005; 2007).

2.4.1.1 Mobile guides: support for mobile learning experiences

> *"In the digital age, learning can and must become daylong and lifelong learning experience. National education initiatives should aim to improve learning opportunities not only in schools, but also in homes, community centres, museum and workplaces."*
>
> (Resnick, 2002, p.36)

Museums have been struggling with their exhibits and their environments where digitization is changing the museum landscape. Previously, the museum has acted as a site of restoration and storage, and then as information provider and exhibit presenter. Currently, museums have changed to take on more concrete functions such as enabling and facilitating active learning and also visitors' engagement with exhibits as well as other visitors in actively collaborating on information seeking and sharing.

For many years now, museums have been keen on using technologies in their exhibitions. This effort can be seen in the use of various mobile guides installed within museums. For example, the Tate Modern has its mobile guide using multimedia guided tours on PDAs and there are also similar guided tours using PDAs in various museums in the Netherlands. Other examples include the Swiss National Museum in Zurich, which employs an interactive mobile guide using a tablet PC; the Blanton Museum of Art at the University of Texas at Austin, which has installed an interactive handheld museum guide (Pocket PC), and the Museon in The Hague, which uses both a tablet PC and a PDA, and not to forget the use of a gaming console to support mobile learning in a museum, particularly in the Minpaku museum in Japan. It can be concluded that mobile guide technologies are appropriate for creating conducive learning experiences in

museums. Arguably, when users are actively engaged in such environments, they are actively constructing their own knowledge from the artefacts/exhibitions compared with being merely passive receivers who are not able to reconstruct the received information.

Mobile guide technologies with digital display and their associated hardware enable cultural spaces to provide visitors with a free-choice learning environment in which users are given various ways to explore the exhibitions to suit each visitor's preferences. In addition, the use of mobile guide technology is believed to improve museum landscapes by enabling self-directed exploration and discovery compared with the more traditional approaches which only guide the visitors. For example, the brainstorming sessions with school children in the *ARCHIE* project described earlier revealed that children do not like the idea of associating museum visits with a learning visit (Schroyen, Gabriëls, Teunkens, Robert, Luyten & Manshoven, 2007). They see their visit as interactive session with activities rather than acting as passive visitors or observers. With this in mind, researchers developed *ARCHIE* which comprised several educational-based learning activities to promote learning indirectly to suit the children's requirement for learning in museums. At the end of the visit, children should have developed various skills such as observing the museum exhibition, collaboration, and processing information about the artefacts in the exhibition or exploring the information about the exhibits autonomously to suit their interest while using the PDA-based game activities.

The broad ability of mobile guide technology has given a significant impact to improving cultural landscapes over the past decade. The ability of such technology is most valuable when it is able to improve visitors' learning experiences in cultural spaces. Learning-with-technology enables different variations of learning to be potentially employed in a cultural space. Cultural spaces should move beyond their 'walls' (comfort zones) and promote and represent their exhibits by enabling visitors to appreciate museum collections in various ways that suit them. Using internet technologies, visitors from around the world are able to access museum collections/exhibitions by accessing on-line museum websites (also known as virtual museums) and thus gain the benefits from them. Museums with integrated technology have been changing rapidly over the past decade and sometimes the technology used today can become obsolete tomorrow. This view was shared by Cameron (2001), who was concerned about the need to change the current practices of museum exhibitions to engage visitors and to support a variety of audiences.

A study on the learning experience with a mobile guide was carried out at Van Abbe Museum in Eindhoven, the Netherlands (Bartneck, Masuoka, Takahashi & Fukaya, 2006). That study adopted the contextual model of learning into the design of *ubiNext*, the mobile guide system for the museum. It used PDA to provide information about artworks and had features to suggest which art might be of interest to the user. The system can be used in two different modes, without recommendations (*no*Reco) or with recommendations (*ubiNextReco*). Another feature of the system is its ability to personalize the tour to suit a visitor's interest. Visitors can personalize the system on the museum website before visiting the museum and then download the application for their PDA on-site. This is called *self*Reco, whilst the other option available is curator recommendation (*curator*Reco). Both *self*Reco and *curatorReco* are guided tours. A between-participants study was carried out to examine the learning experiences between these various conditions, such as technology condition (*ubiNextReco, selfReco, curatorReco, noReco*), self-recommendation using *PostScribe* (*selfRecoPostScribe*) or self-recommendation using pen and paper (*selfRecoPaper*). A total of 148 school children aged between fourteen and eighteen took part in the study. The study was carried out in pairs and each pair in the technology condition was supplied with one PDA and one audio recorder, but in the *self*Reco paper-based condition, they had one tour student to guide them. The results revealed that there was no significant difference between *self*Reco and *selfRecoPostScribe* which implied that the large screen did not improve the learning experience. The use of mobile guides does not improve learning about the art thus reflecting that the use of a mobile guide does divide the attention between artefacts and the guide.

Further enhancements have been made to the *ubiNext* mobile guide system to overcome the issues raised in the earlier study (Bartneck, Masuoka, Takahashi & Fukaya, 2007). Participants in the subsequent study could choose to have one PDA each or to share one PDA in each pair. This was because users in the previous study had not liked to share the PDA and this had affected the study. A between-participants study was formulated to see the learning experiences between users. There were two groups of users (single or couples) and two guide conditions (audiovisual: movies and audio commentary, or visual: only text and still images). A total of 189 participants took part in the study aged between 12 and 75. The results showed that age did not play a significant role in the use of a mobile guide. The researchers concluded that the participants preferred to use an audiovisual to a visual guide, thus justifying the need to use PDA in museums in preference to traditional tours.

In the near future, mobile guide technology will dominate our daily activities. It is becoming a source of interactive digital environments, information portals, education, entertainment and tourism. These mobile guides are important tools which 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 diversity in providing information using mobile guide technologies is making the museum one of the more accessible and more attractive places to spend time at.

One of the ways to achieve the museum's goal in attracting prospective visitors and promoting free-choice learning in cultural spaces is by applying mobile guide technologies in cultural spaces' exhibits. Museums play unique roles in supporting, facilitating and promoting learning practices in cultural spaces. Notwithstanding its growing function as part art-house cinema, part tourist attraction and part boutique, the museum is still an institution of enlightenment and entertainment in the classic sense, and now more than ever it is obliged to guide visitors toward critical viewing and experiences.

The use of interactive multimedia in museums is not a new phenomenon. It varies in the technologies employed ranging from multimedia kiosks to audio or multimedia guided tours. The use of interactive multimedia for handheld devices was studied by Evans and Strerry (1999), who focused on developing a new interactive multimedia application for mobile guides which was able to enhance visitor enjoyment and learning experiences in museums. The multimedia guide application was deployed to portable computers at the Museum of Science and Industry in Manchester. The methodology of the study was front-end analysis as well as a formative and summative evaluation. In summary, the development of the multimedia application for the mobile guides took place before the exhibition design, during the exhibition design and after the visitors had left the exhibition. A total of 100 adult visitors took part in the study and only visitors aged over sixteen were recruited due to the fragility of the mobile guides. Fifty visitors were asked to experience the exhibition naturally and the other fifty with the mobile guides using portable computers. Visitors were asked to complete a questionnaire before and after the visit to measure changes in their knowledge and understanding about the exhibits. Visitors in the mobile guide control group were asked additional questions about the technology they had used. Visitors' behaviour in the study was also recorded using another mobile guide with an application which was able to see behaviour patterns throughout the visit. Findings from the study showed that the use of mobile guides was able to enhance learning about the exhibits.

Furthermore, it also increased the time spent in the gallery because visitors were able to explore the exhibits in detail. This showed that visitors were engaging with the exhibits.

Nonetheless, the use of mobile devices could lead to another problem with human cognition, best described as split attention. This occurs when human information processing has to divide focus between a real object and a mobile guide at the same time. In the museum, the added dimension of technology integration could make visitors' focus shift from real artefacts to the mobile guide display. These phenomena could be well explained by the Cognitive Load Theory (Sweller, Merrienboer Van & Paas, 1998), which suggested that the human working memory has less capacity when dealing with new information and so this will affect, in turn, human information processing. This could be overcome by ensuring that the information displayed on the mobile guide can actually be supported by human information processing, especially working memory. In addition, the information provided should be easily comprehended, especially if it needs to be related to real objects in the exhibition. It is crucial for us to understand the balance between the cognitive load of the mobile guide and the cognitive load of studying the artefact itself. Another problem for visitors is the large amount of information that can be available in mobile guides. This can also lead to cognitive overload and to 'being lost in hyperspace' (Otter & Johnson, 2000).

There is a significant relationship between visitors' engagement and the social experience of using a mobile guide in a museum. Jaěn, MocholÍ, Esteve, Bosch & Canós (2005) developed the system prototype called *MoMo* for the PDA to reduce the information overload when visitors actively use the guide. The motivation for the study lay in the need to design a system able to reduce the information overload when displaying it on the browser. They outlined three main criteria for the multimedia contents browser on mobile guides: (1) *functionality* of the device to minimized learning curves; (2) *simplicity* of the design as well as the contents to ensure that it is intuitive for everyone; and (3) *generality* and *flexibility* which mean that the device should be easily used for different platforms or different types of institution. They also outlined generic design rules for multimedia applications for a mobile guide system, which are as follows: (1) *Design for limited physical spaces* which should take into consideration the limited screen size when using multimedia (images, video, etc); (2) *Design for limited attention* which is important because the multimedia application for the mobile guides is an aid for the visit, not the major exhibit to demand focus and dividing the user's attention between the museums' artefacts and the mobile guide; (3) *Design for hierarchical interaction* that can provide easy access to information because some

visitors like to have short explanations about the artefacts and others like fully-detailed information; (4) *Design for memory load* to ensure that visitors do not struggle to remember all the functions of the device, thus affecting their experiences at the exhibition; (5) *Design for visual enjoyment* which includes the aesthetic to motivate visitors to have an enjoyable experience.

A study on effect of mobile guides on the learning and social interaction between visitors at Carlsbad Cavern National Park in US was carried out with 254 visitors with and without mobile guides, as well as informal observations of 700 visitors (Novey & Hall, 2006). The researchers were trying to investigate (1) the average time spent on each exhibit and on listening to the mobile guide, (2) signage reading behaviour when listening to the mobile guide tour, (3) different knowledge gained between mobile guide tour group users and non-users, (4) the effect of the mobile guides on the social interaction between visitors, and (5) attitudes of the mobile tour guide users towards the tour. The evaluation of the mobile guide tour was carried out using observation and questionnaire. Pre-test results from the study showed that there were no significant differences between the two groups (mobile guide tour users and non users). The results showed that mobile guide tours users spent as much as twice as long at each location of the exhibits. In addition, mobile guide tour users also spent significantly more time listening to the mobile guides at each location. There was no difference between groups for signage reading. There was no significant difference between users in the two groups on the knowledge gained or on the social interaction between the visitors in the groups. Users with the mobile guides had a positive attitude toward the use of mobile guides for learning in an informal learning environment.

In another study, Tate Modern has revisited its use of mobile guide technology by introducing visitors to a new form of mobile guide technology. The Tate Modern Multimedia Tour Pilot was a 45-minute tour of the *Still Life/Objects/Real Life* galleries delivered to visitors using a wireless network (Proctor & Tellis, 2003). This *Multimedia Tour Pilot (MMT)* was embedded into HP iPAQ computers. Proctor and Tellis further discussed various *MMT* functions such as:

1. **Interactive survey and response:** This enabled visitors to record their opinion before and after using the mobile guides.
2. **Creative Play:** Visitors were able to mix a soundtrack when viewing Edoardo Paolozzi's visual collages.
3. **Location-specific content delivery:** This feature enabled visitors to receive the contents on their *MMT* according to their location in the gallery.

4. **Visitor tracking:** This tracked visitors' location and at the same time was able to alert museum staff if the mobile guides failed or they needed any technical assistance.
5. **Visitor paging:** Museum staff were able to page visitors if needed.
6. **Visitor profiling:** This mobile guide was able to record the use of the gallery by visitors.
7. **Visitor e-mail facility:** This enabled visitors to email themselves about the gallery for further action.

The main evaluative techniques in the study were a combination of questionnaires and focus groups. The *MMT* system was tested on more than 800 visitors and software was used to log on to visitors' activities on the *MMT*. This software showed how the visitors utilized the tours, the rooms they visited and what other functions were used.

In addition, this mobile guide technology was demonstrated to the various parties – visitors, curators, technologist, and artists – to gain more feedback about the system. Questionnaires were given to the 852 visitors from around the world who used the *MMT* and the demographics and profiles of respondents were recorded. Overall, visitors were satisfied with the use of this *MMT* and spent more time visiting Tate Modern's galleries. On the other hand, younger visitors were happy with the *MMT* because it was easy to use, while some older visitors found the contrary. Both questionnaire and focus-group respondents were happy with some features provided by the *MMT*, such as interactive messages, audio, video, interactive and intuitive interfaces, as well as audio-visual coherence. They also commented on some features such as long messages, blank screens, text, and help menus. Some of these functions did not work properly and so did not help users in some ways whilst they were using the tour.

Another attempt was made to improve visitors' experiences during their visit to a museum by designing and evaluating a mobile guide tour on PDA for the Museum/Library Stratis Eleftheriadis Teriade in Greece (Micha & Economou, 2005). In that study, researchers were trying to design an application that was able to provide information and interpretation about the museum's collections. The study revealed several important issues in regard to the interaction with PDA such as (1) the information about the particular exhibits/exhibitions on the PDA should be short and supported by audio, so that users could either read the information or listen to the audio commentary, (2) the interaction between the users and the system should be natural and the audio commentary should not come between them, (3) the system should be able to provide visual feedback on users' interaction with the mobile guide. Furthermore, the design of

the mobile guide tour on the PDA enabled visitors to choose the exhibits to suit their interest, or they were automatically guided through the gallery based on their location. System evaluations were made with 30 university students. They were asked to visit the gallery without the mobile guide and with the mobile guide. The visitors stated that the mobile guide was able to support their visit by providing the right information for each exhibit and they also spent more time at the exhibition compared with the part of the study when they were not supplied with the mobile guide. The study also concluded that visitors were able to find the different types of exhibit on display with the help of the mobile guide, thus there were no issues with the system navigation.

Manning and Sims (2004) carried out a study with an interactive handheld museum guide (on a pocket PC) to explore the impact of mobile guides on museum learning. Their guide, known as *The Blanton iTour*, was first installed at the Blanton Museum of Art at the University of Texas at Austin in 2003. The mobile guide contained numbers of videos of artist and curators, textual information and creative play components. A written survey was applied to gather more statistical data about *The Blanton iTour*. The targets of the survey were *The Blanton iTour* visitors and non-*iTour* visitors (visitors who did not use *The Blanton iTour*). At the same time, usability testing, testing with visitors, docents, curators and technology were also conducted. The visitors' profiles were collated to get their demographic information and were ranked accordingly. The survey was conducted with 239 visitors at the museum using *The Blanton iTour* and 149 not using it. The results from the study are felt to be rather promising because most of the visitors were satisfied with the *The Blanton iTour*. The study also drew some conclusion that visitors were more engaged with the exhibits, spent more time exploring the exhibits, and were able to link experiences with prior knowledge. Moreover it enabled visitors to share their experiences with other visitors. Visitors rated the learning experiences with *The Blanton iTour* higher than without it.

The use of technology in museums has required major changes to be made to the museum settings in order to enable such technology to be incorporated and well adjusted in the environment. A recent study by Naismith and Smith (2006), on the other hand, proved that this change was not necessary. They performed this study at the Lapworth Museum of Geology, Birmingham University in UK using multimedia tours on mobile guide technology. The study aimed to explore the use of mobile guide technology in a museum using a learner-centred approach but at the same time retaining the traditional look and design of the museum. That particular museum was chosen because it had the traditional look and exhibit presentation

design. A learner-centred approach was used to deliver more visitor experiences according to users' own choices. In the study, researchers classified the visitors into four different groups based on the classification devised by Morris, Hargreaves, and McIntyre (2004).

The mobile guide used in the study was equipped with a GPS system to provide context-aware contents to the visitors. This study was performed using Pocket PC 2002 and visitors were equipped with the multimedia tour. Evaluations of the study were made using informal observation of the visitors and questionnaires after the visit followed by semi-structured interviews. The outcome from Naismith and Smith's (2006) study showed that this multimedia system in the Lapworth Museum of Geology was only suitable for visitors who belonged to the 'followers' group. Minor modifications were needed for the tours to meet other groups' expectations. The study only focused on the usability aspect of the mobile technologies and not the learning aspect. There is room for improvement to this study by examining the free-choice learning and its effects on the different categories of visitor.

The use of a mobile phone as a mobile guide has moved from small and dense spaces within four walls (for example, art galleries, museum exhibitions, historic houses and many others) to bigger spaces such as huge cultural heritage sites or tours of a town. The capabilities of the mobile phone technology can be enhanced by being equipped with GPS, powered with more battery life and supported by a bigger network coverage (for example, the 3G network). In a recent study, the mobile phone was use as a mobile game device for learning about cultural heritage (Botturi, Di Maria & Inversini, 2009). They developed a treasure hunt game using short messaging service (SMS) to promote active learning and engage users in activities in an informal environment for school children. This study was carried out in the city of Lugano, Switzerland, to learn more about the culture and history of the town. They compared learning outcomes for both secondary and primary school children. They produced a scale which measured the level of engagement using three indicators: fun, interest and hardness. The results showed that the engagement levels were significantly higher for primary school children in all three engagement indicators. Furthermore, the results showed that levels of engagement were more than had been expected for both primary and secondary school children.

Another example of using the mobile phone for learning about an archaeological site was the development of a mobile tour system called *explorer!* (for example, Ardito, Buono, Constabile & Pederson, 2007; Ardito, Buono, Constabile, Lanzilotti & Piccino, 2009). The researchers found

that the use of a mobile guide tour enriched learning experiences about culture for visitors to historical sites. Another study was conducted by researchers using mobile phones in which the nature of the interaction with the mobile guide was similar to other studies (Botturi, Di Maria & Inversini, 2009). The study was carried out at Egnathia, an historical site at an ancient city in the Apulia region in the south of Italy. The visit was a part of the city's learning curriculum. An in-house evaluation with several participants was carried out using the 'Wizard of Oz' muMUWOz interface. A pilot study was held before a field study at the actual site. The study compared the experience between two groups of students, one using the mobile guide tour and the other using a paper-based guide. Groups of 3-5 students were given two mobile phones and a paper map. They had to explore the park and find the points of interest by interacting with a mobile phone that allowed users to view 3D reconstructions of the historical monuments using the application on the phone. Participants in this study found that the game on the mobile guide was fun and enjoyable. On the other hand, there was no significant difference in learning between using the paper guide and the mobile guide. They concluded that the use of the mobile guide did not distract the children from learning about the archaeological site.

Technological developments have radically changed the size of hardware and interactive devices into smaller, highly mobile, ubiquitous and sometimes even invisible devices. This has been best described by Walker and Winters (2005) as "*the ability to interact with a computer merely by moving around a space, all input and output devices are more or less hidden*" (p.1). Walker and Winters argued that humans are now able to interact with computers using location-tracking technology or 'non-interactive computing' devices. This is beyond standard interactive devices (for example, mouse and keyboard). They also added that these technologies are available but invisible or embedded everywhere within the environment or within us. They also discussed how these technologies will shape our lives in the future. In fact, there are already numerous applications in various fields that use this ubiquitous computing concept and many have benefited from it. For example, the use of the ubiquitous computing concept in developing wearable computers and display devices, and wearable eyewear for various applications such as Augmented Reality (AR), Virtual Reality (VR), Personal Digital Assistant (PDA) and so on. Furthermore, the concept of 'personal computer' becomes irrelevant with the enhancement of technology because these technologies have made a giant leap by making it possible to have many computers in a physical environment all connected to one another seamlessly. In turn, people are capable of accessing the information anywhere, anytime at their own convenience. Weiser (1993) further explained that

"long-term the PC and workstation will wither because computing access will be everywhere: in the walls, on wrists, and in 'scrap computers' (like scrap paper) lying about to be grabbed as needed" (Weiser, 1993, p.71). The concept of 'the disappearing computer' and 'ubiquitous computing' or technology should be exploited further in cultural spaces to improve interaction between humans and technology. Of particular interest to museums, such developments and enhancements give a new perspective to museum exhibits by using mobile guides as their interactive devices. This was exemplified by Yu-Liu, Hsu Tan and Chu (2006) in their study of the ubiquitous museums learning environment to overcome difficulties found in the general guided tour museums. The researchers used various technologies such as mobile guides to accommodate the different mobile guide technologies used, such as RFID system, wireless and others. In that study, the RFID reader was used to read RFID tags and provide detailed information about specific objects on the visitor's PDA screen. On the other hand, museums which suffer from lack of space when designing their exhibits could benefit from this study by implementing the ubiquitous model of museum exhibits and providing RFID tags for their objects. Visitors in turn would be able to view detailed information about the exhibits using the PDA.

The results from Yu-Liu, Hsu Tan and Chu's study drew a definite answer to the effectiveness of the system in facilitating visitors' learning within the museum walls. They used RFID tags, WLAN and embedded system technologies to construct an ubiquitous learning environment. They developed two models in the study: the assistance model and the ubiquitous model. In the assistance model, the relevant technologies were used to assist the instructor to teach outside the classroom and to provide context-aware material to improve outdoor teaching. For example, a RFID tag on an information board and wireless network for communication were employed; and a PDA was used to display information read from RFID tags. On the other hand, the ubiquitous model mainly enabled more interaction between users in a small space where they could use the context-aware material provided by the instructor. This model also used RFID tags and wireless network. In addition, they used real learning objects and students were able to learn using the mobile guides. In the study, they divided the students into two different groups, an e-learning group and a control group for traditional learning, and they conducted pre- and post-tests.

The students were given a set of tasks based on the learning activity. The e-learning group had the use of mobile guides that could read RFID tags and send the answer using WLAN only. On the other hand, the control group students used pen and paper to answer the questions and used

their home computer to edit the report before submitting it to their instructor. After conducting an experiment with two teachers and 72 students, the researchers claimed that 'ubiquitous museum' technology was able to overcome problems found in general guided tour museums because it was able to provide museum-like experiences to visitors in a place which lacked space to present the information for visitors. In addition, the learning performances of students with the technology were better than those of the control group.

2.4.2. Measuring visitors' experiences in cultural spaces

The diversity of visitors to cultural spaces is one of their unique attributes and is becoming a major challenge for these venues to meet their visitors' needs. How can they address the variety of interests and needs of all their visitors? Different groups of visitors have different ways of enjoying their time in cultural spaces, be it for information discovery, a school visit, or just a diversion. In addition, visitors may come alone, or be accompanied by family members or friends. For decades, museums have been making changes to their exhibitions to accommodate the needs of various people. The changes come from different sources, such as technological advancements, different information provided on displays, whether digital display or printed materials, the quantity of information on display, the number of artefacts, exhibition design, and so on.

As cultural spaces introduce these exciting new mobile guide technologies, it is important to understand how they affect the visitor experience. Research into human/computer interaction has recently been interested in how engaging and immersing people find their technologies (for example, Cheng & Cairns, 2005; Jennett *et al.*, 2008; Haywood & Cairns, 2005) as well as how useful and usable they are. They have even begun to explore how to apply this paradigm to the study of museum exhibits (Haywood & Cairns, 2005).

It is necessary to know what visitors' expectations are when they visit cultural spaces. The following characteristics should be taken into consideration by cultural spaces to improve visitors' experiences: 1) cultural spaces should present their exhibits in a way which is suitable for different kinds of audience; 2) they should also meet visitors' expectation to be mentally and physically engaged with an exhibition and exhibits; 3) furthermore, exhibitions should allow some interaction between visitors especially if they come as a group (family members, friends, children, groups of adults) (Dierking & Falk, 1998).

According to Morris, Hargreaves and McIntyre (2004), there are four different modes of behaviour among visitors in museums, especially when they select and engage with the museum exhibits: 'browsers', 'followers', 'searchers' and 'researchers'. These four different types of visitor need different types of technology in museums, as well as different kinds of information presentation. Browsers, for example, do not require as much information as researchers because they only browse and select exhibits that most appeal to them. On the other hand, researchers require more explanation about each artefact in the exhibition and may require extra information related to the exhibits. Followers, on the other hand, only follow what has been provided to them and usually will be happy with the use of the mobile guide provided by the museums. A searcher is quite different from the other groups because he likes to search the exhibit/artefact based on keyword(s) rather than the thematic presentation.

It is important to transform museum exhibits to suit the interests of different kinds of individuals and groups in order to attract more visitors (Ciolfi & Bannon, 2002; Ciolfi, 2004). In the study reported in these papers, they conducted a series of data collections at several museums in Europe under the auspices of the Situating Hybrid Assemblies in Public Environments (SHAPE) Project. They studied visitor behaviour in the museum, for example which part of the exhibitions is of interest to visitors, the interaction between visitors and the exhibitions, as well as their interaction with other visitors. The study showed that visitors' observation and direct interaction with the exhibits (visitors are allowed to open the cabinet and touch the artefacts) enabled them to collaboratively understand about the artefacts, they became mesmerized about the features and developed emotion responses. This was found for both for children and adult and adult visitors. The researchers make an important finding that "Living Exhibitions" employs in this study are not suitable to be used with the traditional museums setting which use technologies such as touch screen and audioguides as they limits the interaction between visitors and the exhibits as well as other visitors. On the other hand, a study by Bannon, Benford, Bowers and Heath (2005) highlighted the importance of combining RFID technologies and other media to support group collaboration and interaction within the exhibition.

Measuring the experiences of visitors to cultural spaces is a complex undertaking. Pekarik, Doering and Karns (1999) used data from interviews and surveys to extract the experiences that visitors find satisfying in museums. They found that there were four key categories: object experiences, cognitive experiences, introspective experiences, and social experiences. Pallud and

Monod (2010), taking a theoretical perspective, proposed that visitor experience in museums can be understood in terms of context, self-projection, embodiment, re-enactment, historicity and possibilities of being. Prior to this study, Monod and Klein (2005; 2005a) established a framework to evaluate cultural heritage systems using eight components: context, self-projection, embodiment, re-enactment, historical self, inquiry into being, possibilities of being and the universality of uniqueness.

Researchers have made a classification of the possible outcomes of visits to a cultural space. Learning in a museum or other cultural space is not merely the acquisition of new knowledge but 'educational experiences' that could fall under one of the five components: cognitive, affective, social, skills development and personal outcome (Gammon, 2001; Gammon, 2003). Gammon further added 'educational experiences' in museums to include interaction with an object, using interactive guided tours, visits to the exhibition, or by simply attending an event in a museum. Hooper-Greenhill *et al.* (2003) produced the GLO described earlier, which comprised: increase in knowledge and understanding; increase in skill; a change in values and attitudes; enjoyment, inspiration and creativity; activity; behaviour and progression. On the other hand, Packer (2008) proposed three levels of experience of meaning in a museum which were not related to the learning outcome:

1. The attributes of the settings that visitors value (for example, layout, ambience, signage, and many others);
2. The experience that they engaged in (object, cognitive, introspective, social);
3. Benefits that they derived (psychological well-being, subjective well-being and restorative feelings).

Packer (2008) also highlighted the importance of *restoration* which relates to the restorative effect of an environment's experiences such as ***being away, fascination, extent*** and ***compatibility***.

Kotler and Kotler (2000) have proposed three strategies to improve visitors' experience:

1. Improving museum-going experience that not merely focuses on the object experiences but overall experiences
2. Community services which involve the local community
3. Market repositioning towards entertainment which how to design the exhibition and their exhibits

Monod and Klein (2005, 2005a) proposed a framework for the evaluation of the e-Heritage system. This framework consists of:

1. ***Context*** which refers to the shared values of the historical or cultural importance of the artefacts;
2. ***Self-projection*** of the visitors towards the character/artefacts which places them in the situation of the artefacts;
3. ***Embodiment*** refers to the relationship that one might have when interacting with the objects;
4. ***Re-enactment*** is how visitors are able to project themselves into the history and 're-live' the history;
5. ***Historical self*** relates to how the artefacts, values or other aspects of cultural spaces can have effects on our own lives;
6. ***Possibilities of being*** which reflects that our present days are only as they are as a result of past actions;
7. ***Inquiry into being*** in which the visitors are able to reflect on the alternative of what could have happened;
8. ***Universality in uniqueness*** which helps visitors to see the historical uniqueness of their own existence.

On the other hand, previous study by Pallud & Monod (2010) have successfully measured visitors' experience with technologies using six main criteria from the Phenomenological framework based on previous work of Monod and Klein (2005) :

1. ***Context*** which refers to the shared values of the historical or cultural importance of the artefacts;
2. ***Self-projection*** of the visitors towards the character/artefacts which places them in the situation of the artefacts;
3. ***Embodiment*** refers to the relationship that one might have when interacting with the objects;
4. ***Re-enactment*** is how visitors are able to project themselves into the history and 're-live' the history;
5. ***Historicity*** relates our present-day lives with our past history;
6. ***Possibilities of being*** which reflects that our present days are only as they are as a result of past actions

Doerings (1999, see also Pekarik, Doerings and Karns, 1999) summarized that visitors' experiences can be described in four categories/components:

1. ***Object experiences*** that enable visitors to experience the 'real things' or feel a sense of wonder;
2. ***Cognitive experiences*** which involve the intellectual or cognitive aspects of the visitors;
3. ***Introspective experiences*** which focus on visitors' reflections as a result of their visit (either exhibits/artefacts or the exhibition itself);
4. ***Social experiences*** which involve interaction with other visitors.

In conclusion, different studies have approached the issues of how to improve visitor experience in museums and other cultural spaces in different ways. For example, some researchers have analysed the visitor experience from a philosophical perspective, whilst others have addressed different aspects of the visitor experience empirically, including the cognitive, intellectual and emotional aspects. Finally others have investigated the interaction between visitors individually and exhibits, or between visitors in groups and exhibits. In addition, the technologies used in each study were tailored to suit the needs of the particular cultural space. Furthermore, cultural spaces have used technologies that have been changing rapidly over the past decade and sometimes the technologies used today may become obsolete in the near future. The introduction of apps for smartphones may well turn out to be a turning point because visitors are now able to use the same device with different apps installed for different cultural spaces. In addition, the ability of these apps to be used for different devices provides considerable flexibility for the deployers. With the ongoing changes in the way museums design their exhibitions to accommodate new technologies, it is necessary to study what effects these technologies have on visitors' experiences. This programme of research will address the importance of providing a diverse set of possible solutions to accommodate the diversity in visitors by providing different types of mobile tour.

2.5 Learning in museums and other cultural spaces

Many still regard the museum as a place for displays of artefacts in glass boxes, with text labels and lengthy descriptions attached (Hawkey, 2001, 2004). Yet many working in the museum sector now see the role of a museum as multi-faceted, not limited to the process of acquisition, preservation, documentation, conservation, presentation and explanation of artefacts. In particular, many now see museums as an important source of information and a place for people to learn through the exhibits and exhibitions. In addition, the old perception of the museum has

been changed by the use of digital technologies, particularly mobile guides and interactive displays. Thus the nature of learning in museums and cultural spaces has become an important and widely researched issue. Researchers and commentators in the museum sector have used traditional theories of learning to understand how best to support visitors but have also have looked at the particular ways that visitors to cultural spaces learn. Notably Falk and his collaborators (see for example Falk and Dierking, 2000) have investigated how visitors in museums and other cultural spaces learn.

In the past, museums had their own ways of presenting their collections, ranging from pictures, text, real artefacts, glass boxes, and so on. Each exhibition was designed in the curator's style and from the curator's perspectives or views. Visitors had to accommodate themselves to understanding the curator's perspective and the contents of 'his' exhibition. As a result, visitors were distracted by this situation because they had to look for information beyond the information displayed by the curators when they viewed the artefacts. This could possibly have affected the learning processes in museums because users were not able to integrate current information with previous information in schemata, or actively seek for new knowledge from artefacts/exhibits. This can be related to the constructivist learning point of view; learning takes place if learners are actively engaged with the information by constructing their own understanding about the exhibitions and integrating it with their previous and new knowledge. This constructivist learning paradigm will be discussed in detail in the next section.

Learning has been described as a permanent change in the learner's behaviour and attitudes, psycho-motor skills and cognitive processes (Bloom, 1956). This definition is not accepted by all researchers and there are different theoretical schools of thought (for example, Behaviourist, Cognitivist, Humanist, Situated, Social and others) each having their own definitions. Behaviourists, for example, believe that learning is a change in behaviours and is measurable by looking at the changes in the person. These changes can be seen as a result of reinforcement from the association of stimulus and response given during the learning processes. Cognitivists believe that learning is a change in human cognition. This could happen when learners are relating new knowledge with their old knowledge or schemata.

Building on the learning theories which focus on the three main aspects as described above (behaviour and attitudes, psycho-motor skills and cognitive processes), various researchers have applied these three components to museum studies to produce classifications of learning in

museums. Gammon (2001) classified learning in museums into five main components: cognitive, affective, social, skills development and personal (Table 2.1 shows the detailed explanations of each category in this classification). In his argument, 'learning in museums' is not merely the acquisition of new knowledge but 'educational experiences' that could fall under one of the five components in the classification. He further expanded 'educational experiences' in museums to include interaction with an object, using interactive guided tours, visits to the exhibition, or by simply attending an event in a museum.

Cognitive	Actively seek for new knowledge and construct meaning from new and prior knowledge; integrate new knowledge into existing schemata; able to put prior knowledge into context;
Affective	Accept other people's contribution. Changes in attitudes and values; increase understanding of other people's view-points
Social	Social skill development through various activities
Developing skills (Mental and physical)	Mental skills such as reasoning, deduction, problem solving, decision making, etc., and physical skills such as experimentation with the exhibits, the use of technologies, etc.
Personal	Changes in motivational aspect of learning, self improvement, inspired, curiosity, sense of wonder, etc.

Table 2.1: Learning in a Museum *(adapted from Gammon, 2003)*

Hooper-Greenhill *et al.* (2003) produced a new classification also known as a generic learning outcome (GLO), which comprised an increase in knowledge and understanding; an increase in skill; a change in values and attitudes; enjoyment, inspiration and creative activity; behaviour and progression. This classification was much the same as previous learning theories, but had additional emphases on the learning outcomes. These generic learning outcomes can be represented in the Venn diagram shown as Figure 2.8 below. In this classification, knowledge and understanding refer to the prior knowledge and use it in new ways, making relationships between things, making sense of something, deepening knowledge or information about something as well as being able to give specific information about specific objects, exhibits or events. 'Skill' on the other hand is not only limited to the mental and physical skills, but also includes aspects of communication, emotional and social talents. Attitudes and values are

important because they reflect individuals in many ways; for example, positive and negative attitudes towards the use of mobile guide technologies in museums. It also includes visitors' perception of the use of such technologies in museums, as well as their opinions as the users or about other visitors in the museums. Enjoyment, inspiration and creativity are important aspects of museum learning. For example, a meaningful visitor experience can be using mobile guide technologies in a museum, or the use of such technology to be able to provoke creative and innovative thoughts during a visit. The use of mobile guide technologies also may inspire visitors in many ways and enable them to explore museum exhibits in many ways. Activity (action), behaviour and progression may reflect the visitors' understanding, learning or changes of view about exhibits. The action or activity they perform using mobile guide technology may enhance their understanding about particular exhibits or object within the exhibitions.

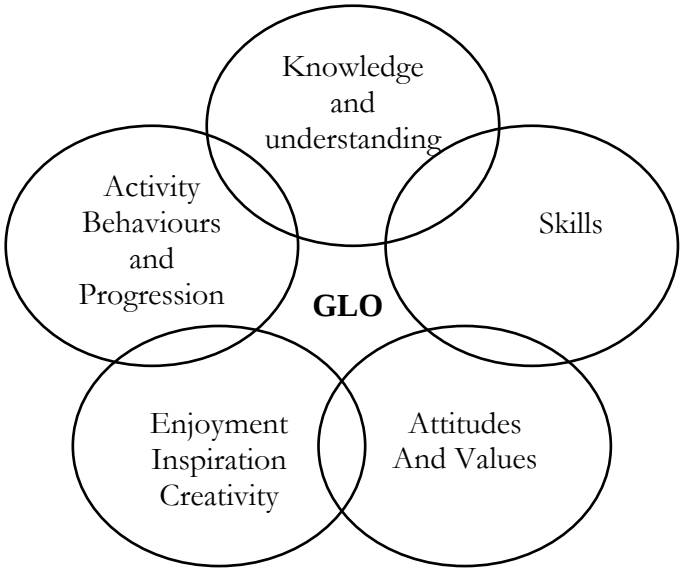


Figure 2.8: Generic Learning Outcomes (GLOs) (from *MLA 2004*)

Learning in museums is not a new study and has been debated for the past few decades. Researchers have been struggling with the notion of learning in the museum itself: do you follow formal learning as in the classroom, or adapt to new ways of learning (for example, free-choice learning)? This debate became more interesting as museums started using various technologies in their exhibitions; especially with the rise of mobile guide technologies. The integration of technology into learning material is believed to enhance people's problem-solving abilities and present them with opportunities to experiment with creative thought regardless of their environment, be it in formal or informal settings.

Museum educators should reflect on how to engage and support various audiences using technologies, by no means limited to mobile guide technologies. The exhibits should be designed so that they can engage and provide meaningful experiences to visitors. Russell (1994) addressed the importance of providing a meaningful, enjoyable experience for visitors to facilitate learning. Museums have started to offer additional and different kinds of learning activities to suit the variety of their visitors (ranging from very young children, school children, teachers/educators, tourists, disabled people, and the technologically illiterate right through to 'normal' visitors). These examples will be discussed further in a later section.

2.5.1 The Contextual Model of Learning and Free-Choice Learning in Museums

The contextual model of learning consists of three overlapping contexts: physical, socio-cultural and personal; all of which are important for interaction and meaning-making in a museum context (Falk & Dierking, 2000). This conceptual model/framework of learning conjectures that learning is influenced by these three components and, as such, these overlapping contexts will affect the ways in which visitors interact with each other, with objects, with mobile guides, and at the same time, with the learning and meaning-making they gather from these different contexts. Ideally, this should be studied in detail to explore how a technology affects free-choice learning in cultural spaces, especially in museums. Previous studies (for example, Falk & Storksdieck, 2005) have used this model to study user behaviour at science learning centres or museums, and to examine how they learn in such an environment.

Falk & Storksdieck (2005) summarized the three different aspects of the contextual model of learning by identifying twelve main factors that give impact to the museum learning experience. These factors are as follows:

Personal context

1. Visit motivation and expectations;
2. Prior knowledge;
3. Prior experiences;
4. Prior interests;
5. Choice and control.

Socio-cultural context

1. Within-group social mediation;
2. Mediation by others outside the immediate social group.

Physical context

1. Advance organizers;
2. Orientation to the physical space;
3. Architecture and large-scale environment;
4. Design and exposure to exhibits and programmes;
5. Subsequent reinforcing events and experiences outside the museum.

Falk & Storksdieck (2005) performed a study based on these factors by conducting pre- and post-visit interviews and using observational and behaviour measures using tracking systems placed at various spots in the centre of the exhibition. Their finding was arguable because although the model provided a useful framework for studying how people learn in science centres or museums, it was also dependent on the individual visitor (who they are, what they know; what was the purpose of their visit, and other factors that could significantly affect the result of the study). Thus, as the study can be seen to unravel the interaction between these components, such factors must not be neglected when studying about learning in museums or in a science exhibition context.

Falk & Storksdieck (2005) also made the conclusion that the underlying models of learning in museums resemble the 'stochastic model' which assumes that the 'initial states' such as motivation, prior knowledge and interest are important but are also changeable throughout the interaction with the museums exhibits.

Over the years, we can see the changes from active human-guided tours to the use of technologies. For example, the use of PDA, mobile phones, audioguides, smartphone guides and others. One of the reason for all these changes is that "*most guided tours are pre-planned, didactic presentations, delivered more or less the same way each time*" (Camhi, 2008, p.276). In addition, these tours are usually undertaken in a group, thus limiting the interaction between the visitors and the exhibits, as well as not being able to engage visitors, who easily lose interest if the exhibits are not of interest to them. The use of technologies, particularly mobile technologies, is destined to overcome these problems but the guided tour on a mobile guide does not on its own overcome some issues. Visitors have to follow the pre-set sequence of exhibits to ensure that they are not missing the information about their objects of interest. The introduction of random-access guides or free-choice tour guides is enabling visitors in the cultural spaces to use these guides to help them understand the exhibition in their own way and at their own pace.

2.5.2 Learning Theory and Museums

Hein (1995, 1998) provided detailed explanations of the relationship between theories of knowledge and theories of learning in the museum context. These two theories are both extremely important and derive from educational theory. Importantly, he clearly distinguished the components of these theories and applied them in a museum context. Hein suggested a model through his analysis of knowledge and learning theories, as shown in Figure 2.9 below. The theory of knowledge has two distinct bodies of knowledge (epistemological views), which are that: knowledge is independent to the learner and; knowledge is in the mind which is actively constructed by learner. On the other hand, the theory of learning also could be represented in two dimensions, which are that learning is a passive process (knowledge is incremental adding into a *tabula rasa*), and that learning is an active process (learners constructing meaning).

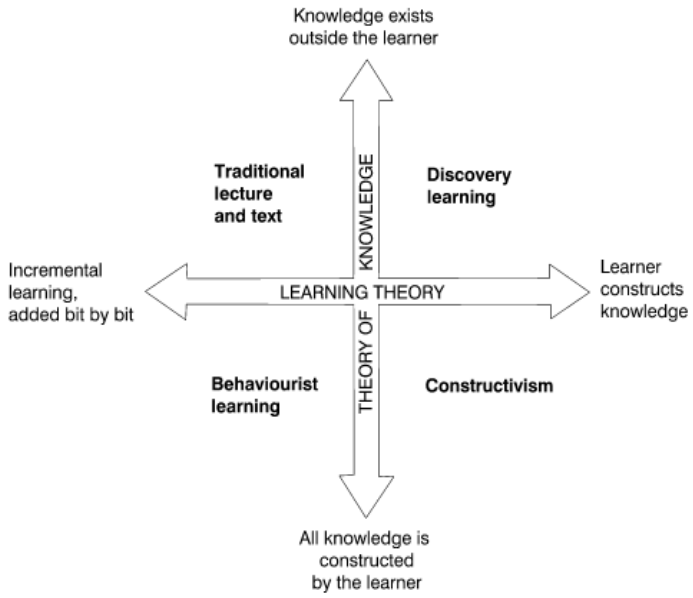


Figure 2.9: 2D model of knowledge and learning (From *Hein, 1998*)

From an understanding of the various learning theories discussed by George Hein, learning within museum walls should be designed such that it appreciates the different strategies in each of the learning theories. Visitors or learners in museums are varied in their learning styles, thus they should be encourage to engage with museums and exhibitions in various ways.

This view was supported by Johnson and Quinn (2004) who emphasized those museum exhibitions should have multiple points of entry and should not be limited to one entry and one exit. This multiple entry will support free-choice learning because users are free to choose where to start and what to see or learn. Museums should also provide a wide range of active media to

be used alongside the exhibitions. Essentially for Johnson and Quinn, variety in activities will support the different learning styles of the individual. Exhibitions should be designed such they could enable various perspectives and this will accommodate differences in visitors. Exhibitions must be accompanied by various activities to actively engage visitors with the exhibitions and have various learning experiences and outcomes. Furthermore, exhibitions should take into consideration the museum's learning aspect so that it enables learners to experiment and to challenge their beliefs and understanding as well as their critical thinking abilities.

2.5.3 Constructivist Learning Theory and Museums

Hein's model of learning discussed in the previous section has been successfully applied to museum learning contexts and is shown in Figure 2.10. This figure represents learning theories and their respective types of museum. This section will focus on the constructivist learning theory and the constructivist museums. This learning theory emphasizes the learners: individuals who learn in museums, actively engage with learning activities and construct new meaning from their new or prior knowledge.

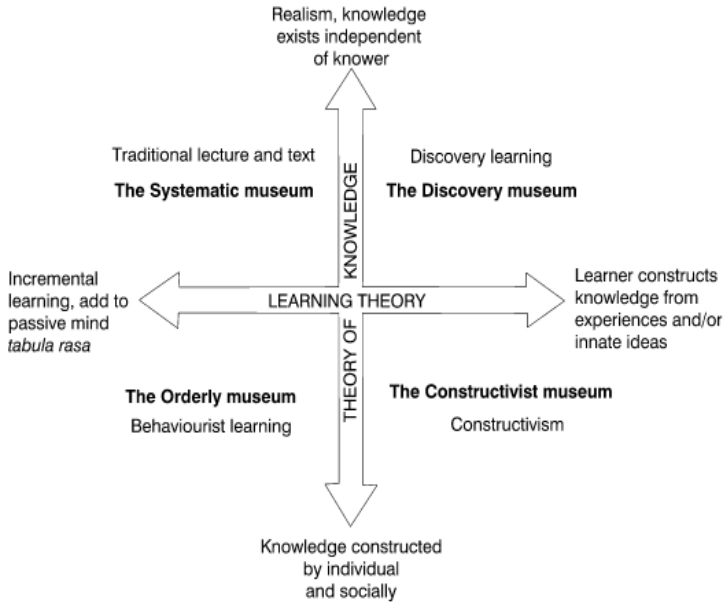


Figure 2.10: Adapted 2D model of knowledge and learning in museum (from *Hein, 1998)*

Museums where exhibitions offer free-choice learning enable visitors to learn about exhibits according to their own ways of constructing meaning from the exhibition, and not only from the curator's point of view. Learners also actively construct new ideas based on their current and previous knowledge. This view was supported by Hawkey (2002), who explained that learning in

an informal environment using technology (for example, ICT) could be differentiated by learner's choices and not by the information provided by the expert.

The roles of personalized learning are significantly important where visitors are actively seeking information, and they are able to construct new knowledge from previous knowledge and are less dependent on the curator information displayed. This could be related to Jonassen's view (a constructivist view) about learning with technology as described below,

"Learners do not learn directly from technology [or teachers, or books]; they learn from thinking about what they are doing" (Jonassen, 1999, p.194).

2.6 Methodologies in user experience research

The evaluation of the visitors' experience is a crucial part of this study, since it will determine the outcome of this research and validate the research objectives. In recent decades, cultural spaces studies have been revolutionized by the change of direction and the methods used to study the cultural spaces themselves. With the enhancement of and intensive research into museum exhibitions, especially the use of mobile guide technologies, the avenues for improvement are constantly expanding. There are various methodologies available to support such research: qualitative, quantitative, experimental, grounded theory and many others.

The choice of methodology to be used in every research project is based on the scope and aspects of the research itself. In addition, the choices of methodology used must also be in accordance with the components that will be evaluated. To date, there are various evaluation methods available for museum educators, researchers and curators, such as formative evaluation, summative evaluation, and front-end evaluation. In addition, there are various data collection methods available to assist in collecting and processing data in the museum context. Renaissance East of England has listed the common evaluation methods (types of data collection) that are suited to museum studies (Renaissance East, 2008). These are shown in Figure 2.11 below.

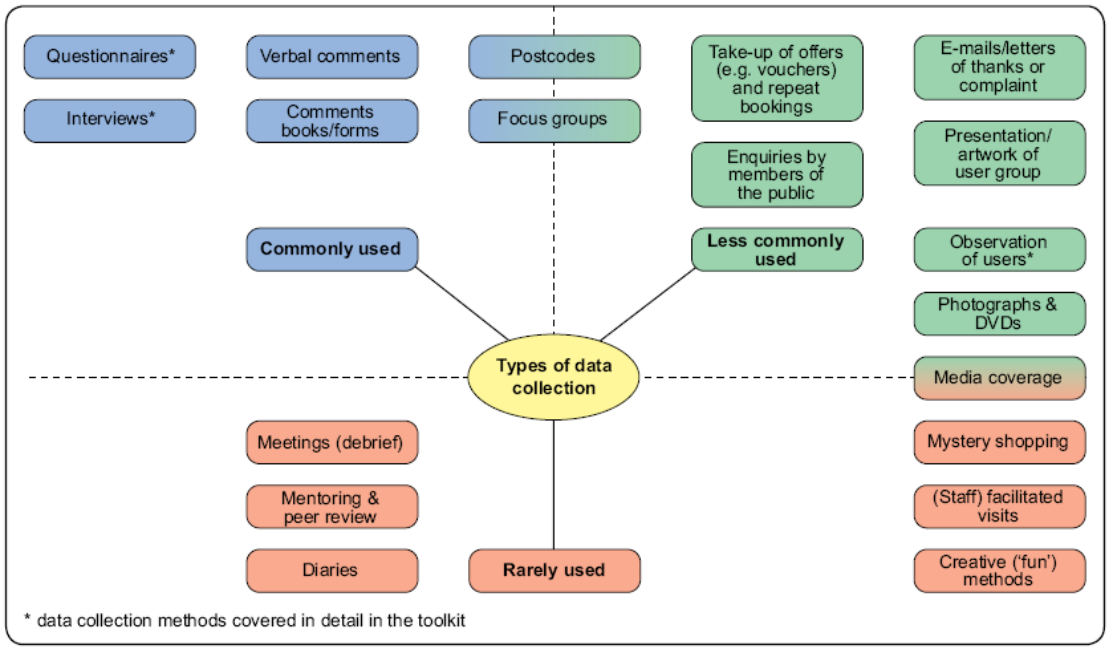


Figure 2.11. Common evaluation methods (methods of data collection) in museums *(*from *Renaissance East, 2008)*

Although there are standard procedures for designing a scale, the steps involved in designing scale items are varied. Some researchers prefer to use items from existing scales and adapt them to their own studies on the grounds that this can save time, whilst others are prepared to take the effort because they would like to create their own scale items. Boehner, Gay and Larkin (2005) used scale items created for the Renwick Gallery but they found some weaknesses in them after conducting their evaluation. The two main weaknesses discovered were that the four-point rating which they used was not suitable for the study because it had less variation compared with a five-point or a seven-point rating. Another weakness which they discovered was in the ratings which they asked visitors to apply to different elements of their experience with audio and video.

Naismith and Smith (2006) did not describe in detail how they constructed their questionnaire items. Their research focused on the use of multimedia tours on mobile guides. Their study was carried out in a museum with a traditional environment and setting and it aimed to evaluate the efficiency and effectiveness of a mobile guide tour as well as the levels of satisfaction amongst different users. In that study, questionnaires from previous studies conducted by previous study were used (for example a study by Naismith, Sharples and Ting, 2005). The focus for each of the studies was different, but they shared the same characteristics.

Research into mobile learning was carried out by a group of researchers from Finland and they concentrated on the design and implications of fragmentation in mobile learning (Syvanen, Pehkonen & Turunen, 2004). In that study, Mobile Learning Questionnaires (MLQ) was used because the questionnaire was already tested. The MLQ was used to test how fragmentation is related to the learning styles of each individual using various technologies. That study was the pre-pilot study for an examination of mobile learning and it was carried out to test whether MLQ were suitable to be used in the subsequent mobile pilot research. Initially MLQ was developed to see the how users interact and use the mobile guides for learning.

Rocchi, Stock and Zancanaro (2006) did not discuss how they had developed the items for their questionnaires but they did describe how they combined and conducted factor analysis for the scales used in their study. That study focused on four dimensions of scales: control, involvement, easiness and intention of use. Items were tested for their reliability and the values gathered ranged from 0.79 to 0.9, which are quite high and acceptable for use. In a recent study conducted by Pianesi, Graziola, Zancanaro and Goren-Bar (2009), the researchers discussed how they had designed and evaluated mobile guides for museum use. They explained their process of developing items for their questionnaire.

2.7 Conclusions

Although there are several studies have successfully developed frameworks to measure visitors' experience in museums, but it is important to highlight that most of the frameworks developed by previous researchers are remain conceptual because they have not been tested with visitors in realistic situations of museum visits. For example, a study by Monod and Klein (2005, see also Monod and Klein, 2005a) which mainly focuses on the development of the framework to evaluate the use of information technology in cultural heritage, but the framework has not been tested with visitors. In addition, another example of a framework that has not been tested with visitors was proposed by Kotler and Kotler (2000). Thus, the evaluation of the visitors' experiences using technology, particularly mobile guides is of importance for the cultural spaces, but as yet unexplored. A rigorous empirical evaluation methodology needs to be developed to measure visitors' experiences and at the same time test the frameworks.

CHAPTER 3

Study 1: Virtual museums: free-choice tour (FC) vs guided tour (GT)

3.1 Introduction

Before a full-scale study evaluating the use of mobile guide technology and visitors' experiences in cultural spaces can be conducted, several initial studies needed to be performed to choose appropriate methods and measures for the study. Therefore, a preliminary empirical study was performed as the first phase of this research. This chapter presents the first study to establish an appropriate methodology for the subsequent large-scale study, whilst the next chapter focuses on a further empirical study to establish appropriate scales for the large-scale study.

Unlike the large-scale study, this study was not performed in the real setting of a cultural space. This study was performed by creating a virtual museum to be viewed on a desktop computer. There are advantages in using only a virtual museum for the study. First, it was considered to be more efficient for gathering information about users' reaction to museum type materials. Second,

it made it convenient for comparing the free choice (FC) and the guided tour (GT) options that would be explored in more detail later in the research programme. Finally, it could be performed anywhere that had the information installed.

3.2 Objectives

The main objective of this study was to decide which questions that should ask to measure visitors' experience of and engagement with mobile guides, both on guided tours and free-choice tours, and their usability. This study also aimed to compare the two types of museum tour in the virtual museum.

3.3 Method

3.3.1 Participants

There were 22 participants who took part in this study. The participants were from various backgrounds: university students (undergraduates and postgraduates), university lecturers, researchers, and other members of the public who volunteered to participate in this study. The majority of the participants were students (77% of the overall participants). The main reason for using a varied sample such as this (students, staff and members of the public) was because the sample should be representative of all categories of museum visitors, and not limited to students and university staff only. The participants ranged in age from 18 to 53, with mean age of 31 years. In addition, all these participants were familiar with the use of the internet for information browsing, thus did not require any training to use the system.

3.3.2 Design

Two versions of a virtual museum tour were prepared: one was a free-choice tour and the other was a guided tour. A between-participants design was used, with participants experiencing either the FC or the GT virtual museum.

Participants were asked to spend as long as they wished browsing the virtual museum to become familiar with the material. They were told that they would be asked questions about the material to ensure that they did study it carefully.

3.3.3 Virtual Museum

The material used to develop the virtual museum for this study was gathered from the Royal Armouries Museum in Leeds, mainly from the official museum website. These materials were converted into a virtual museum for the purposes of this study. Hypertext Mrkup Language (HTML) was used to design this virtual museum.

Two different versions of the virtual museum were designed in order to make a comparison on visitors' experiences between FC and GT in the virtual museum. Figure 3.1 shows the screenshot for the HOME screen for both the FC virtual museum and the GT virtual museum. The HOME screen for both versions shared the same interface design.

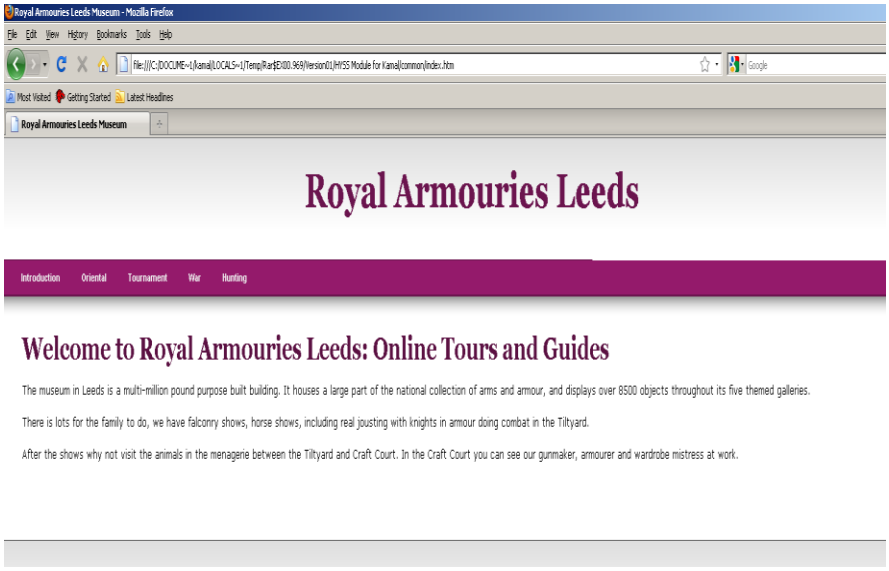


Figure 3.1. A snapshot of the 'Home' screen for both GT and FC virtual museum

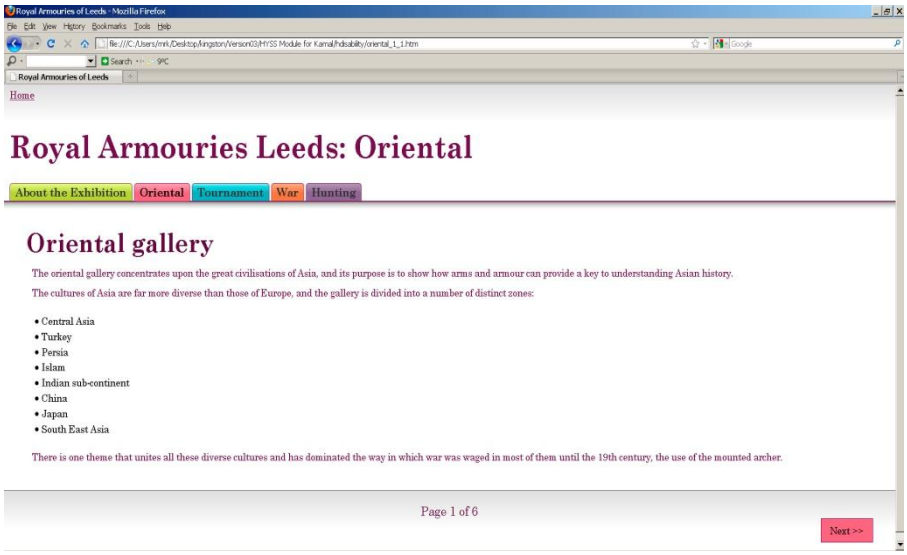


Figure 3.2. A snapshot of navigation menu for the GT virtual museum

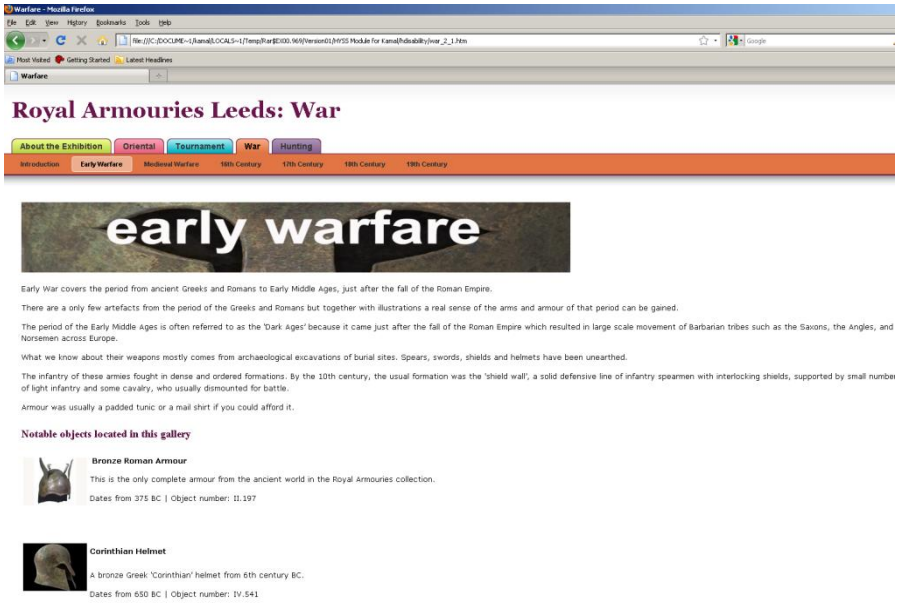


Figure 3.3. A snapshot of the navigation menu for the FC virtual museum

Figures 3.2 and 3.3 shows the navigation menus for both the FC and GT virtual museum respectively. There are significant differences in the interface design for navigation buttons between Figures 3.2 and 3.3. The navigation buttons for the GT virtual museum in Figure 3.2 do not have any pull-down menus from the buttons. In addition, the navigation for the GT virtual museum was designed in sequential order (page 1, 2, 3 and so on) and the users moved to the next page by clicking on the 'Next' button. On other hand, the navigation menu interface for the FC virtual museum shown in Figure 3.3 has pull-down menus for users to choose whatever next page they like (for example, other buttons 'introduction', 'early warfare', 'medieval warfare', and so on appeared when the main menu 'war' was selected). There were no page numbers at the bottom of the page, nor a 'Next' button.

Figure 3.2 also illustrates the design of the guided tour virtual museum with details (for example, buttons, banner, information on artefacts) as opposed to the free-choice tour virtual museum design shown in Figure 3.3.

3.3.4 Questionnaire

The questions used in this study were constructed by reviewing questions used in previous studies (for example, Jennett *et al.*, 2008) and materials developed by the Council for Museums, Libraries and Archives (from the MLA websites question bank). The components of the Generic Learning Outcomes (GLO) model developed by the MLA were particularly useful in developing the range of questions for this study. The GLO consists of knowledge and understanding, skills, attitudes and values, activity, behaviour and progression, as well as enjoyment, aspiration and creativity (MLA, 2004).

Potential questions were read by several native speakers of English to check their comprehensibility. They were also checked by the PhD supervisor against the GLO model. The questions for this study were divided into two types, close-ended questions and open-ended questions. Close-ended questions were measured on a scale from 1 indicating 'strongly disagree', 2 'disagree', 3 'neutral', 4 'agree', to 5 'strongly agree' as described above. These are known as Likert items (Likert, 1932). The open-ended questions mainly focused on the participants' general views about the virtual museum as well as their previous museum visits (for example, their experiences with the use of any technologies within museums as well as about the museum exhibition itself).

Initially, I had a set of twenty-six close-ended questions, ten open-ended questions and three questions about the participants' demographics backgrounds. The questions were piloted before they were used in the study in order to determine how long the participants would spend on the experiment and the questionnaire. Obviously, it is not a good idea to make participants spend too much time on answering the questionnaire. Therefore, a selection process was undertaken to carefully sort and analyse the question pool. If the initial items were similar to one another, I chose the one that seemed clearest and most appropriate to my study. The final questionnaire consisted of a number of different sections: (i) information about the participant's experience of the virtual museum, with fourteen close-ended questions and three open-ended questions; (ii) general views on museums (not related to the virtual museum which they had visited) from various aspects such as the use of mobile guides and other technologies in museums, engagement and interaction with the technologies, information presentation/visualization and learning, with only three open-ended questions; (iii) the participant's demographic information, with three questions.

Table 3.1 shows the questions (close-ended) asked to get the participants' views on the two different virtual museum tours. The full questionnaire can be found in Appendix A.

Table 3.1. Close-ended questions

Q1	I felt engaged with the virtual museum
Q2	The virtual museum held my attention
Q3	I found it is easy to navigate the virtual museum
Q4	The page layout was consistent throughout the virtual museum
Q5	The graphics on the virtual museum were boring
Q6	I enjoyed the layout of the virtual museum
Q7	There was too much text on each page of the virtual museum
Q8	I got bored with the contents of the virtual museum
Q9	The information about the museum exhibits on the virtual museum was clear
Q10	I was overwhelmed by the amount of information on the virtual museum
Q11	The virtual museum provided me with intellectual stimulation about the exhibits
Q12	Having looked at the virtual museum, I was still interested to know more about the exhibits
Q13	The design of the virtual museum motivated me to learn about the exhibits
Q14	I felt I was able to learn independently about the exhibits from the virtual museum

3.3.5 Procedure

Participants for this study were asked to come to the Human Computer Interaction Laboratory at the Computer Science Department, University of York. Participants were run individually, one at time. It took between fifteen and forty minutes for each session. Participants were randomly assigned either the free-choice or the guided tour virtual museum by the instructor.

Below is the chronological order for the procedure of the study for each participant:

1. ***Briefing Session***: When the participants arrived, they were asked to take a seat in front of the computer and then listen to instructions from the instructor. They were told that their virtual museum navigation would be recorded using software called Morae[4]. The recording process would start once they started to browse the virtual museum and would stop after they had finished browsing the virtual museum.

[4] http://www.techsmith.com/morae.asp

2. ***Informed Consent Form***: Participants were asked if they had any questions. They were then told to read and fill out the consent form and were informed that they could withdraw from the study at any time (*see* Appendix B).
3. ***Instructions***: Participants were then asked to read the instructions on the instruction sheet (*see* Appendix C).
4. ***Interaction with the virtual museum***: Participants were asked to browse the virtual museum for as long as they liked until they thought they were familiar with the material as they would be asked questions about the content. They were asked to browse the virtual museum in the way that they would usually browse a website for information searching. Participants were also told that they would be asked a set of questions at the end of the study.
5. ***Questionnaire***: Participants were asked to complete the questionnaire provided.
6. ***Debriefing Session***: During the debriefing session, the experimenter (instructor) explained the purpose of the study and answered any questions which the participants had. The experimenter (instructor) thanked the participants for their contributions to the study and they were each given a gift voucher worth £10.

3.4 Results

3.4.1 The descriptive features of the sample

There were 22 participants in this study with a mean age of 31 (SD=8.35). There were equal numbers of participants of each gender, eleven of them were female and eleven were male.

3.4.2 Relationships between questions about virtual museum experiences (close-ended questions)

Correlations between the answers to the Likert items were calculated to explore the relationships between questions. The correlation (Pearson coefficients) matrix is shown in Table 3.2.

The values from Table 3.2 (highlighted in colour) show a number of significant relationships within the data, both positively correlated relationships and inverse relationships. These values are highlighted in bold. For example, Question 8 correlates positively with Questions 5 ('I enjoyed the layout of the virtual museum') and 7 ('There was too much text on each page of the virtual museum'), but negatively with Questions 1, 11, 12, 13 and 14. Question 8 was 'I got bored with the contents of the virtual museum'. It makes sense that this question correlated with others

in these ways because question 1 was about engagement with the virtual museum, question 5 about the virtual museum graphics and question 7 about the amount of text in the virtual museum. In addition, questions 11 to 14 focused on the participants' views on the virtual museum pertaining to learning, motivation and curiosity.

However, although some significant relationships occurred (highlighted bold) in the table 3.2, this analysis implies the need for a larger sample of people in order to understand the full nature of responses to museum experiences.

Table 3.2. Correlations between virtual museum tour experiences items

		Q01	Q02	Q03	Q04	Q05	Q06	Q07	Q08	Q09	Q10	Q11	Q12	Q13	Q14
Q01	Pearson Correlation	1													
	Sig. (2-tailed)														
Q02	Pearson Correlation	.396	1												
	Sig. (2-tailed)	.068													
Q03	Pearson Correlation	-.040	.082	1											
	Sig. (2-tailed)	.859	.716												
Q04	Pearson Correlation	.006	.193	.370	1										
	Sig. (2-tailed)	.980	.391	.090											
Q05	Pearson Correlation	-.377	-.084	-.359	-.377	1									
	Sig. (2-tailed)	.084	.712	.101	.084										
Q06	Pearson Correlation	.268	.257	-.139	-.145	-.332	1								
	Sig. (2-tailed)	.228	.249	.538	.521	.131									
Q07	Pearson Correlation	-.339	-.133	.187	-.241	.327	-.156	1							
	Sig. (2-tailed)	.123	.556	.404	.281	.137	.488								
Q08	Pearson Correlation	-.532*	-.300	-.318	-.404	**.690****	-.041	**.576****	1						
	Sig. (2-tailed)	.011	.174	.149	.062	.000	.855	.005							
Q09	Pearson Correlation	-.020	.013	-.296	-.138	-.068	.297	.092	.119	1					
	Sig. (2-tailed)	.931	.956	.182	.540	.763	.179	.685	.599						
Q10	Pearson Correlation	.187	.224	.076	.041	-.194	.422	.223	-.035	.366	1				
	Sig. (2-tailed)	.404	.317	.737	.856	.387	.050	.319	.876	.094					
Q11	Pearson Correlation	.223	.202	.158	.263	-.384	.330	-.343	**-.448***	.404	.320	1			
	Sig. (2-tailed)	.318	.367	.482	.237	.078	.134	.118	.036	.062	.146				
Q12	Pearson Correlation	.354	**.584****	.017	.252	-.119	.036	-.437*	**-.609****	-.055	.035	**.472***	1		
	Sig. (2-tailed)	.106	.004	.940	.258	.599	.875	.042	.003	.809	.879	.027			
Q13	Pearson Correlation	**.529***	**.634****	.110	.346	-.295	.352	-.327	**-.574****	-.083	.410	**.561****	**.679****	1	
	Sig. (2-tailed)	.011	.002	.627	.115	.183	.108	.137	.005	.715	.058	.007	.001		
Q14	Pearson Correlation	.147	-.014	.082	.292	**-.537****	-.097	-.394	**-.481***	.229	.101	.190	.030	.030	1
	Sig. (2-tailed)	.515	.949	.717	.187	.010	.666	.070	.023	.306	.656	.397	.895	.896	

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

3.4.3 Reliability of individual questions

The idea behind the reliability concept is whether the score gathered from a study/test is good. If the score from the study is reliable, other researchers who conduct the same study using the same procedures should be able to get the same score. Reliability refers to a measure or a questionnaire which produces the same or similar responses with multiple testing using the same or similar instruments (Bordens & Abbott, 2008). In this study, the reliability of the individual questions used in the questionnaire was measured.

Various tests can be used to assess the reliability of a test measurement, such as the Kuder-Richardson formula (Rudner & Schafer, 2001), the Spearman-Brown prediction formula (Brown, 2001) and others. This study used the Cronbach's alpha test (Santos, 1999). This is the common method used in reliability analysis. The details of the analysis for Cronbach alpha are shown in Table 3.3 below.

Table 3.3. Cronbach's alpha results for the virtual museum tours experiences items

	Scale Mean if Item Deleted	*Scale Variance if Item Deleted*	*Corrected Item-Total Correlation*	*Cronbach's Alpha if Item Deleted*
Q01	45.36	13.385	.180	.321
Q02	45.18	12.061	.549	.198
Q03	44.45	15.784	-.036	.378
Q04	44.50	15.024	.059	.362
Q05	46.00	18.190	-.377	.523
Q06	45.41	14.063	.274	.306
Q07	46.09	16.563	-.202	.448
Q08	46.32	18.323	-.432	.503
Q09	45.05	13.950	.201	.319
Q10	46.09	11.325	.525	.172
Q11	45.14	12.885	.453	.245
Q12	45.23	12.755	.303	.272
Q13	45.73	10.874	.604	.134
Q14	45.27	16.113	-.128	.410

Many researchers have suggested that an acceptable level of reliability for a psychometric test is above 0.7. Table 3.4 below shows the acceptable and unacceptable levels of Cronbach's alpha coefficient (DeVellis, 1991, p.85).

Table 3.4. The acceptable and unacceptable levels of Cronbach's alpha coefficient

Alpha coefficient	*Implied Reliability*
Below 0.6	Unacceptable
Between 0.6 and 0.65	Undesirable
Between 0.65 and 0.7	Minimally respectable
Between 0.70 and 0.8	Respectable
Between 0.8 and 0.9	Very good
Above 0.9	Consider shortening the scale

The analysis in Table 3.4 shows that none of the items had an acceptable value. Therefore, some changes needed to be made, either to the questionnaire items or to the number of the sample size (*n* value). In the literature, there has been some debate about the sample sizes to determine whether the alpha value is appropriate. Kline (1986) and Nunnally & Bernstein (1994) suggested that a sample size of 300 is appropriate, whilst Charter (1999) suggested that a sample size of 400 is needed.

3.4.4 Differences between GT and FC virtual museums

Though there were problems with the reliability of the questionnaire, an analysis of the differences between the FC and GT versions of the virtual museum was conducted to explore this type of analysis for further studies in the project. A problem with making a comparison between the FC and GT of the virtual museum may have been that the participants spent different amounts of time on GT virtual museum or the FC virtual museum due to the different designs. This was investigated by measuring the time people spent in the virtual museum (*see* Figures 3.4 and 3.5 below).

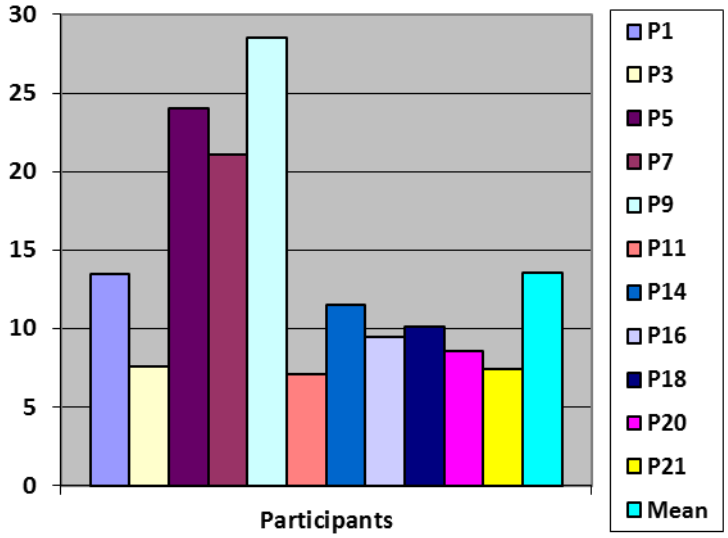


Figure 3.4. Time taken (in minutes) by GT participants

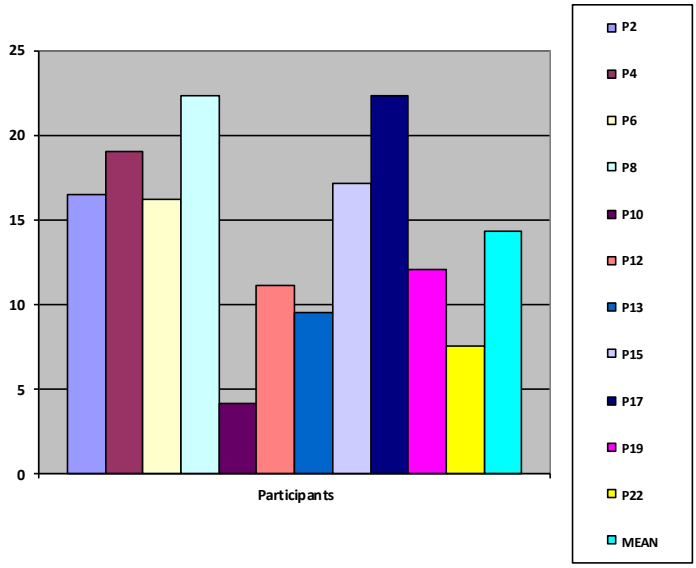


Figure 3.5. Time taken (in minutes) by FC participants

The average time which participants spent in the GT virtual museum was 14.43 minutes, and 14.35 minutes in the FC virtual museum. This result shows that there was very little difference between the two groups. The time spent between participants varied, ranging from 4.10 minutes to 28.50 minutes. Participants on the GT virtual museum spent between 7.05 minutes and 28.50 minutes, while participants on the FC virtual museum spent between 4.10 minutes and 22.33 minutes. More time spent in the virtual museum does not mean that users were actively engaged

with the virtual museum or that they learned more than users who spent less time in the virtual museum. The differences could be because some users were having difficulties when they were navigating the virtual museum. Previous research carried out by Sandifer (1997) showed that the average time visitors spent on an exhibition was 70% of the total time of their visit, and it varied, depending whether they were alone or with family members. Serrell (1997) conducted a series of data collections in various museums, art galleries, aquaria, zoos and so on in order to find the duration and time spent by visitors. In one exhibition, 'Discovery and Deceit', he found out that the average time visitors spent in the exhibition was nineteen minutes and that the longest time spent was 68 minutes. These data were from nineteen visitors to that particular exhibition.

3.4.5 In-depth analysis of open-ended questions

A number of open-ended questions were asked to gather more information about participants' views regarding their experiences with their recent museum visits as well as their experiences with the virtual museum tours in this study. The analysis of these questions was conducted manually. (*See* Appendix D for full details of the data.)

Results from this analysis are shown in Tables 3.5, 3.6, 3.7 and 3.8 below. Tables 3.5 and 3.6 shows participants' responses to questions about the virtual museum they had just experienced: what they thought was the most memorable aspect (Q15), the worst aspect (Q16) and what changes they would like to see (Q17). On the other hand, the comparison in Tables 3.8 and 3.9 shows participants' responses on their recent museum visits from both groups respectively.

Many participants in this study agreed that the most memorable aspect of this virtual museum was the navigation, while the worst aspects were texts, fonts and lengthy information. In addition, they also added that they would have liked to have a better virtual museum with more interaction, less text and more graphics, as well as more related links. Tables 3.5 and 3.6 provide more details.

Table 3.5. Participants' comments from the GT participants on the virtual museum (questions 15, 16 and 17 from the questionnaire)

Participant	*Memorable aspect (Q15)*	*Worst Aspect (Q16)*	*Changes (Q17)*
Participant 1	- Simple - Linear design	- Not able to explore further - Thumbnail pictures	- Interactivity
Participant 3	- Museum pictures	- Difficult to know how much information provided.	- Pictures of museum itself
Participant 5	- Learn about exhibition	- NEXT button was hidden, needed scroll	- Search facility - Navigation button on top
Participant 7	- Clear and easy navigation	- NONE	- Add more images
Participant 9	- Pieces on display	- Little details of objects	- More details - More pictures from different angles
Participant 11	- virtual museum navigation	- Unclear photos	- Images: Large sizes
Participant 14	- Easy navigation	- Too much information	- Music, sound
Participant 16	- Smooth navigation	- Too much text	- Background
Participant 18	- Pictures explained the story	- NONE	- More pictures - Way information presentation
Participant 20	- Interesting pictures navigation	- Small fonts	- Bigger pictures - Bigger fonts
Participant 21	- Interesting pictures	- Small fonts	- Bigger pictures - Bigger fonts

Table 3.6. Comments from the FC participants on the virtual museum (questions 15, 16 and 17 from the questionnaire)

Participant	*Memorable aspect (Q15)*	*Worst Aspect (Q16)*	*Changes (Q17)*
Participant 2	- Layout and font	- Toolbar not fixed	- Navigation on the left
Participant 4	- Clear-graphics, texts - Easy navigation	- Figures without details - Text quite large - Button at Top	- Button at Top should not remain frozen - Smaller text - Other details – times, fares, etc
Participant 6	- In-depth reading	- Too much info for short time	- Nothing- clear layouts/images
Participant 8	- History	- Info about exhibition/ gallery	- Divide long text into sections - Better quality of pictures
Participant 10	- Pictures of big banner	- Lack of links on texts for more info	- More links for artefacts information
Participant 12	- Easy navigation	- Pages were boring	- More pictures, colours, - More accessible
Participant 13	- Easy to get information	- Too many words	- Info for each artefact on different pages
Participant 15	- Knowledge	- Boring	- More pictures
Participant 17	- Pictures	- Text	- Background colour
Participant 19	- Proper breakdown information	- Inconsistent layout	- Enlarged images - Exhibition structured
Participant 22	- Layouts and consistency	- Massive information, - Boring graphics	- Graphics - Information presentation: easy to read, not lengthy

Table 3.7. Comments from the GT participants on their previous museum visits (questions 18, 19 and 20 from the questionnaire)

Participant	*Question 18 Visited any museum/gallery last year?*	*Question 19 What is the most interesting when visiting museum/gallery?*	*Question 20 Ever use audio/ multimedia guides?*
Participant 1	YES	Sense of history	YES
Participant 3	YES	Visual impact with visitor Interaction	YES
Participant 5	NO	History	YES
Participant 7	NO	History	NO
Participant 9	YES	Everything on exhibition/ displays	YES
Participant 11	YES	Galleries, History, Story	YES
Participant 14	YES	The information	NO
Participant 16	NO	Artefacts	YES
Participant 18	YES	Objects (artefacts)	NO
Participant 20	NO	Artefacts, stories and their impacts	NO
Participant 21	YES	Collections	NO

Most of the participants had visited museums, art galleries or heritage sites in the last year. Out of 22 participants in this study, sixteen participants, or 72.7%, had visited museums/gallery/heritage sites within the last year. In addition, only thirteen of the participants, or 59% of them, had ever used audio or multimedia guides when visiting such places. However, most of them agreed that the collections at these places made the visits interesting but that other aspects also played a role. Tables 3.7 and 3.8 show more details.

Table 3.8. Comments from the FC tour participants on their previous museum visits (questions 18, 19 and 20 from the questionnaire)

Participant	*Question 18 Visited any museum/ gallery last year?*	*Question 19 What is the most interesting when visiting museum/gallery?*	*Question 20 Ever use audio/multimedia guides?*
Participant 2	YES	Paintings	NO
Participant 4	YES	Themes	YES
Participant 6	YES	Paintings	YES
Participant 8	YES	Jewellery, cookery	NO
Participant 10	YES	Interactive exhibits for live experience	YES
Participant 12	YES	Interactive images	YES
Participant 13	NO	The collections there	NO
Participant 15	YES	Artefacts	NO
Participant 17	NO	Objects (artefacts)	YES
Participant 19	YES	Links between place/objects with background	YES
Participant 22	YES	Contents, displays	YES

3.5 Discussion

The results from the initial study showed that the process and procedures for the evaluation studies were not completely adequate. This meant that the questionnaire that was used was not effective enough to be used in the subsequent studies. Changes needed to be made to the questionnaire or the virtual museum design itself. These results were taken into consideration when designing the pilot study to ensure that the methodology of the pilot study would be effective. No changes were made to the virtual museum design as it was a one-off prototype and no further study would be carried out using the existing virtual museum prototype. The next study will use a different prototype (a prototype using the mobile phone as a mobile guide).

Various aspects contributed to the lack of significant outcome of the results of this study. These are:

1. ***Virtual museum design***: Some of the participants were happy with the virtual museum design and were able to navigate the virtual museum easily. On the other hand, other participants may have had difficulties with the design. Some participants thought that the linear or sequential navigation was not easy to follow because they had to follow pre-defined specific paths and they preferred freedom in choosing what they wanted to see next or, in other words, they were more familiar with the free-choice tour navigation.

   Participant 3 from the GT group said "*it was to some extent difficult to know whether the content had more pages or not*".

   Participant 5 from the GT group mentioned the design of the navigation buttons that were not visible. He commented that *"The Next button is sometimes hidden. You have to scroll down to see it"*.

2. ***Interactivity***: Interactivity is one of the main factors contributing to the success of a good virtual museum. A virtual museum should be interactive in various ways to ensure that it is able to deliver the intended message. Some of the participants were not happy with the interaction in the virtual museum, hence the insignificant result.

   Participant 1 in the GT group suggested that the virtual museum should have "*more interactivity, more links*".

   Participant 12 in the FC group said that *"pages were boring, I wanted something more interactive"*.

3. ***Images***: Images (pictures) are a very important component in virtual museum design. For a virtual museum, images are important for portraying the messages or images for each artefact. The lack of images in some sections could inhibit the learning process. It is true that, as suggested by one participant, more pictures from different angles will give a better effect.

   Participant 18 from the FC group suggested that "*Add more pictures and change the way they represent the information"*.

"The virtual museum needs to have bigger, better and more pictures" (Participants 1, 7 and 19 in the GT group).

Participant 9 in the GT group wrote, *"More pictures from different angles to give a better feel for the objects on display"*.

4. ***Navigation***: Some participants found the navigation of the virtual museum to be good, while others found it a little confusing. This was due to the fact that there were two different prototypes and some participants did not like the version given to them. Everyone has their own preference of virtual museum navigation, and this affected the result.

   Participant 1 (GT group) commented "*simple, almost linear design*".

   Participant 22 (FC group) said "*the layout and its consistency*" was the most memorable aspect of using the virtual museum.

   Participant 4 (FC group) felt that "*it was very clear, both graphical and textual, and very easy to navigate*".

   Participant 19 (GT group) wrote "*inconsistent layout between first and subsequent pages*".

5. ***Text***: It is important to have text in a virtual museum to provide information, but too much text is not good for the learning process. Participants were distracted by the lengthy information and they suggested that the information should be divided into different sections with the aid of images.

   Participant 8 from the FC group suggested *"divide the long text paragraphs in different sub-sections, like the different parts of the museum"*.

   Participants also suggested that the amount of text should reflect the amount of time participants spend in exhibitions.

   Participant 8 from the FC wrote *"It was a lot of information to take in for a short time scale. I would like longer time to research more"*.

6. ***Links***: The lack of links in the virtual museum may also have contributed to the lack of significant results. Participants were eager to know more about some artefacts on display but they were disappointed that there were no links to get more information on these objects. Participants from both groups suggested having more links for the artefacts.

   "*Some frustration about not being able to go further, e.g. when I saw an interesting picture, I wanted to click on it and find out more*" (Participant 1 from the GT).

   "Lacks of links to the texts to take me to more information on artefacts" (Participant 10 from the FC group).

7. ***Environment***: The location, equipment(s) or other physical factors can lead to different results as users react to different physical settings. Falk and Dierking (2000) emphasized the contextual model of learning, which includes personal, socio-cultural and physical contexts. Thus, there is a possibility that the participants reacted or responded differently to the virtual museum because it was given to them in a different environmental setting. The result might be different if the participants were placed in a real museum exhibition environment.

8. ***Number of Participants***: The number of participant for the study was not sufficient. Different results might be obtained with a different number of samples; therefore the number of participants for this study should be increased. Initially, it was not easy to get more people to participate in the study, and various ways was used to attract more participants.

There are various aspects which needed to be taken into consideration for the next phase of the study. One of the factors that contributed to the insignificance of the results was that the virtual museum was not able to support different types of media (images, texts, sounds, video, animations and so on). The virtual museum merely consisted of text and images. Some participants suggested that the virtual museum should include more pictures, videos or sounds, and fewer texts. In addition, participants' prior experiences, knowledge and interests also contributed to the different results. Motivation also played a major role in the participants' museum experiences. Participants were able to make sense of their recent encounters by linking the new information to their existing knowledge and understanding based on prior experiences.

3.6. Conclusions

This study has attempted to design a set of general questionnaire items that could be used in the subsequent study. These sets of items were tested on two groups of respondents with two different virtual museum designs. This study raised various issues that have to be taken into consideration when designing the next study. The results from this study were inconclusive, thus more work was needed as suggested in the previous section. Nonetheless, the study became a good reference for designing the subsequent study, for both the contents of the museum guides and the questionnaire items. This study also highlighted the participants' comments on the use of these two types of museum guides (FC and GT).

CHAPTER 4

Study 2: Measuring visitors' experiences in museums: the development of the Museum Experience Scale (MES) and the Multimedia Guide Scale (MMGS)

4.1 Introduction

The study described in this chapter was the second step in this research programme. Using the recommendations which emerged from the preliminary study described in Chapter 3, this subsequent study developed two scales to measure visitor experience in cultural spaces such as museums. One scale is to measure general visitor experience with the cultural space and its exhibits and the other scale is to measure the usability and user experience with a mobile guide that might be used in the cultural space. .

4.2 Objectives

The objective of this study was to develop a scale to measure visitors' experience in cultural spaces such as museums and a scale to measure their experiences with mobile guides.

4.3 Method

4.3.1 Respondents

The intention for this study was to recruit as many respondents as possible, ideally more than 185 respondents, as a principal component analysis (PCA) of 62 items would be conducted on the results. The size of the sample is important when administering a set of questions to enable the responses to be appropriate for PCA. Previous researchers have argued about the number in an acceptable sample, for example Gorsuch (1983) suggested five respondents per question, with a minimum of 100 respondents regardless of the number of items, whilst Cattell (1978) recommended between three and six respondents per item, with a minimum of 250.

After this current study had been publicized for about twelve months as widely as possible on email lists and advertised on the web (for example, as a Facebook ad), there were 255 respondents who completed sufficient questions for analysis.

The sample comprised 88 male and 167 female respondents. The respondents' ages ranged from 18 to 67 years. The respondents came from diverse demographic backgrounds (for example, various places or countries, education or work backgrounds). It is essential to have a range of respondents in this kind of study. The variety in the respondents in this study will give more robustness to the results of the study by providing more data and different aspects for consideration.

Of the respondents, 102 had used a mobile guide during their museum visit, whilst 153 had not. In addition, 146 respondents were native English speakers, 106 were non-native English speakers, and three respondents did not provide their information on this issue.

4.3.2 Design

The study used a standard psychometric scale development methodology (for example, Anastasi & Urbina, 1997; DeVellis, 2003; Kaplan & Saccuzo, 2001; Aiken, 2003; Anastasi, 1968; Murphy & Davidshofer, 1994). Respondents were asked to rate a set of statements provided in the form of a web survey in order to obtain their views on their recent museums visits. Questionnaires were distributed to the respondents in this study by means of an on-line questionnaire via web surveys. A PCA was conducted on the answers to the statements to create the two scales.

4.3.3 Statements

The initial pool of statements was constructed by reviewing questions and statements used in various previous studies (for example, Davis, Bagozzi & Warshaw, 1989; Jennett *et al*., 2008; Naismith & Smith, 2006; Novak, Donna & Fai Yung, 2000; Pekarik, Doering & Karns, 1999; Pianesi, Graziola, Zancanaro & Goren-Bar, 2009) and materials developed by the UK Council for Museums, Libraries and Archives (MLA websites, question bank and exit surveys). Furthermore, the components of the Generic Learning Outcomes (GLO) model developed by the MLA were particularly useful in developing the range of statements/questions/items for this study. I followed similar processes to those used by previous researchers in developing a scale (for example, Boehner, Gay & Larkin, 2005; Naismith & Smith, 2006; Pianesi, Graziola, Zancanaro & Goren-Bar, 2009).

Two pools of statements were developed on the related themes 'Visitors' experience of a museum' and 'Visitors' experience of a multimedia guide'. A pool of 152 possible statements was initially gathered, but obviously it is not possible or practical to ask respondents to respond to so many items in a single session. Therefore, a process of carefully sorting and analysing the potential statement was undertaken. Three evaluators then used a consensus process to reduce the number of statements by grouping them into themes and if initial items overlapped with each other, I chose the one that seemed clearest and most appropriate to this study. The initial statements are available as Appendix E.

For each statement (for example, 'I felt emotionally involved with the exhibition'), respondents stated their agreement level on a Likert rating scale from 'strongly agree' (coded as 5), 'agree' (4), 'neutral' (3), 'disagree' (2) and 'strongly disagree' (1) (Likert, 1932). This resulted in 57 statements: 37 for the Museum Experience Scale (MES) and 20 for the Multimedia Guide Scale (MMGS). The final choices of the statements for the questionnaire are available as Appendix F.

These initial scales were presented on-line as a web survey using QuestionPro[5] software to be completed by people who had visited a museum in the previous six months, with or without a mobile guide. The complete questionnaire presented on-line, including questions about participants' demographic backgrounds, can be found as Appendix G.

4.3.4 Procedure

The respondents accessed the statements on-line by visiting the web survey website[6]. The study was widely publicized via numerous email lists and an advertisement on Facebook. To encourage participation, a prize draw for Amazon gift vouchers (20 vouchers, 10 pounds each) was offered to all participants.

Respondents were asked to rate the statements provided in order to obtain their views about a recent museum visit (within the last six months). Respondents were advised in the opening instructions that the questionnaire would take at most ten minutes for the statements about their museum experiences and a further five minutes for the statements about their experience with mobile guides. All respondents completed both the museum experience statements and the multimedia guide statements if they had used a mobile guide on their museum visit. In addition, respondents were also asked to reply to a short questions to gather information about their visit to a museum (for example, which museum, how long the visit lasted, how many people were in the party and several similar questions), as well as standard demographic information after completing their questionnaire.

4.4. Results

4.4.1 Reliability analysis

A reliability analysis was performed on the 57 items in the questionnaire and the results given in Table 4.1 show that the items were highly related to each other with a value of .943. With the Cronbach's Alpha value of .943, the items were clearly suitable for further analysis.

[5] www.questionpro.com
[6] http://museumexperiences.questionpro.com

Table 4.1. Reliability test for the questionnaire items

Reliability Statistics	
Cronbach's Alpha	N of Items
.943	57

4.4.2 Principal Components Analysis (PCA)

A principal components analysis (PCA) is an analysis of data which indicates which items can be grouped or put together, or can be summarized into one factor, or are correlated to each other (StatSoft, 2011). This study employed PCA to determine which items/statements (variables) could be grouped together to form a category or a component within the data. Before PCA can be conducted, other tests such as the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity need to be performed. The KMO measure is a sampling adequacy test to determine whether the partial correlations between variables are small, whilst Bartlett's Test of Sphericity tests whether the correlation matrix is an identity matrix, which would indicate that the factor model is inappropriate (SPSS Base 16 user's guide, 2007).

Table 4.2 shows the results of both the KMO test and Bartlett's Test of Sphericity. The table shows that the KMO value was relatively high at 0.916, compared with the minimum or acceptable value of 0.6 for the data to be reliable. Bartlett's Test of Sphericity also showed a significant value ($p<0.05$), thus allowing me to carry out a PCA.

Table 4.2. Result of both the Kaiser-Meyer-Olkin test and Bartlett's Test of Sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.916
Bartlett's Test of Sphericity	Approx. Chi-Square	13925.982
	Df	1596
	Sig.	.000

The data gathered from this study were divided into two categories, one to be measured on the museum experience scale (MES) and the other to be measured on the multimedia guide scale (MMGS). Further analyses of these data are reported next in two separate sections.

4.4.3 Museum Experience Scale (MES)

A PCA was carried out on the 37 statements on museum experience to see how they correlated to each other. Four components of museum experience emerged from the PCA:

- ***Engagement*** with exhibitions or exhibits;
- ***Knowledge/Learning*** gained from understanding and information discoveries;
- ***Meaningful Experiences*** from the interaction with the exhibitions/exhibits or other visitors; and
- ***Emotional Connection*** with the contexts and contents of the exhibits/exhibitions.

Factor loadings for each component are shown in the Table 4.3. A *factor loading* is a measure of how strongly each statement relates to the overall components (from 1.0 = perfect relationship to 0.0 = no relationship at all, and only statements with a factor loading over 0.43 are listed). The rule of thumb about factor loadings is that if the number of respondents is more than 150, the cut-off is 0.4 (Stevens, 2002).

In addition, further analyses were made to reduce the number of items in each component. If two or more similar statements were in the same component, the statement with the higher factor loading was preferred. The final version of the MES consisted of only five items in each component, as shown in Table 4.4.

Table 4.3. The four components on the MES and their factor loadings before further analysis

Engagement		*Knowledge/Learning*	
I enjoyed visiting the exhibition	0.69	The information provided about the exhibits was clear	0.64
I felt engaged with the exhibition	0.69	I could make sense of most of the things which I saw and did at the exhibition	0.57
My visit to the exhibition was very interesting	0.68	I liked graphics associated with the exhibition	0.52
I felt I was experiencing the exhibition, rather than just visiting it	0.65	My visit enriched my knowledge and understanding about specific exhibits	0.52
I was completely immersed in the exhibition	0.58	Visiting the exhibition was fun	0.43
I felt focused on the exhibition	0.57	I like graphic-based information as supporting material at museum exhibitions	0.43
My visit to the exhibition was inspiring	0.56	I discovered new information from the exhibits	0.43
The exhibition held my attention	0.56	I gained knowledge that I can use or have used as a result of my visit	0.43
I was interested in seeing how the exhibition would unfold as my visit progressed	0.48		
I felt emotionally involved with the exhibition	0.47		
While at the exhibition, I became unaware of what was happening around me	0.46		
Meaningful Experience		*Emotional Connection*	
During my visit I was able to reflect on the significance of the exhibits and their meaning	0.74	The exhibition enabled me to reminisce about my past	0.55
During my visit, I put a lot of effort into thinking about the exhibition	0.53	My sense of being in the exhibition was stronger than my sense of being in the real world (*reversed relationship*)	0.52
Seeing rare exhibits gave me a sense of wonder about the exhibition	0.50	I was overwhelmed with the aesthetic/beauty aspect of the exhibits	0.47
After visiting the exhibition, I was still interested to know more about the topic of the exhibition	0.43	I wanted to own exhibits like those that I saw in the exhibition	0.45
Seeing real exhibits of importance was the most satisfying aspect of my visit to the exhibition	0.43	I felt connected with the exhibits	0.45
		I like text-based information as supporting material at museum exhibitions (*reversed relationship*)	0.43

Table 4.4. Statements on the final MES and their factor loadings

Engagement		*Knowledge/Learning*	
I enjoyed visiting the exhibition	0.69	The information provided about the exhibits was clear	0.64
I felt engaged with the exhibition	0.69	I could make sense of most of the things I saw and did at the exhibition	0.57
My visit to the exhibition was very interesting	0.68	I liked the graphics associated with the exhibition	0.52
I felt I was experiencing the exhibition, rather than just visiting it	0.65	My visit enriched my knowledge and understanding about specific exhibits	0.52
My visit to the exhibition was inspiring	0.56	I discovered new information from the exhibits	0.43
Meaningful Experience		*Emotional Connection*	
During my visit I was able to reflect on the significance of the exhibits and their meaning	0.74	The exhibition enabled me to reminisce about my past	0.55
During my visit, I put a lot of effort into thinking about the exhibition	0.53	My sense of being in the exhibition was stronger than my sense of being in the real world (*reversed relationship*)	0.52
Seeing rare exhibits gave me a sense of wonder about the exhibition	0.50	I was overwhelmed with the aesthetic/beauty aspect of the exhibits	0.47
After visiting the exhibition, I was still interested to know more about the topic of the exhibition	0.43	I wanted to own exhibits like those that I saw in the exhibition	0.45
Seeing real exhibits of importance was the most satisfying aspect of my visit to the exhibition	0.43	I felt connected with the exhibits	0.45

4.4.4 Multimedia Guide Scale (MMGS)

A similar PCA was conducted on the responses to the twenty Multimedia Guide questions grouped with each other. As a result, three clear *components* or groups of questions which were linked together emerged. These components were:

- ***General usability*** of the multimedia or mobile guide; whether the functionality was appropriate, whether it was helpful;
- ***Learnability and control,*** whether the guide was easy to learn to use and whether the user felt in control; and

- ***Interaction with the guide***, this is considered part of usability, but interestingly in this questionnaire, the aspects concerning interaction with and feedback from the guide were clearly regarded by the respondents as significantly separate.

Table 4.5 shows the statements which relate to each component and their *factor loading* for the MMGS. The questions that are labelled *reversed relationship* mean that high ratings on those questions are associated with low scores on the scale.

Table 4.5. The three components on the MMGS and their factor loadings

General Usability		*Learnability and Control*		*Quality of Interaction with the Guide*	
I will use an audio/mm guide again when I visit an exhibition *(reversed relationship)*	0.76	I felt I was in control of the audio/mm guide	0.78	The audio/mm guide clearly provided feedback about my actions	0.72
The audio/mm guide was a distraction	0.74	Learning to operate the audio/mm guide was easy	0.74	It was clear to me when the audio/mm guide was taking the initiative to offer me information and when I needed to ask it for information	0.54
The information given by the audio/mm guide was too lengthy	0.73	Using the audio/mm guide did not require much training	0.70	I became unaware that I was even using any controls on the audio/mm guide	0.48
It was difficult to determine where I was in the exhibition with the audio/mm guide	0.68	The controls of the audio/mm guide were difficult to understand *(reversed relationship)*	0.64		
The audio/mm guide helped me to navigate around the exhibition *(reversed relationship)*	0.67	The audio/mm guide presented information in an understandable manner	0.54		
Using the audio/mm guide enhanced my exhibition visit *(reversed relationship)*	0.65	I found it difficult to read the text on the screen of the audio/mm guide *(reversed relationship)*	0.53		
The audio/mm guide was complicated to use	0.51				
It was difficult to select the option I wanted with the audio/mm guide	0.51				

4.4.5 Initial use of the MES and MMGS

As an initial use of the MES, I compared the experience of respondents who had made a museum visit with a mobile guide with the experience of those who had made a museum visit without a mobile guide. There was a significant difference in mean scores across all four components between these two groups (Analysis of variance $F_{1, 253} = 3.66$, $p < .05$). There was also a significant difference between the four factors ($F = 149.50$, $df = 3, 759$, $p < 0.001$). There was no interaction between the group and factor variables.

Figure 4.1 shows the mean scores on the four components for the multimedia guide and non-guide users. It can be seen that scores on all four components were higher (that is, more positive) with a mobile guide, although that difference was only significantly higher on the Engagement component, with the mobile guide users being significantly more engaged than non-guide users (Fisher's LSD $p < 0.05$). The lack of significant difference in the other three components is interesting in itself. Interestingly, differences in the Emotional Connection and Meaningful Experiences components were relatively small.

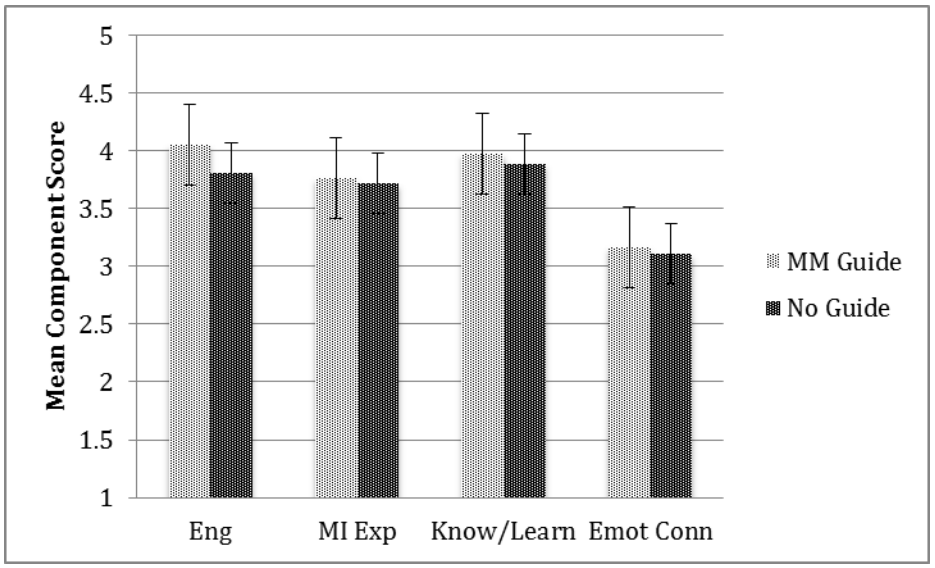


Figure 4.1. Mean scores on the four components for mobile guide and non-guide users

I conducted further analysis of the MES and I compared the experience of respondents between native English speakers and non-native English speakers. Details of these analyses are available as Appendix H. From the results shown in Figure 4.2, it can be concluded that there was no significant difference between these two groups (Analysis of variance $F_{1, 253} = .144$, $p=0.70$, n.s).

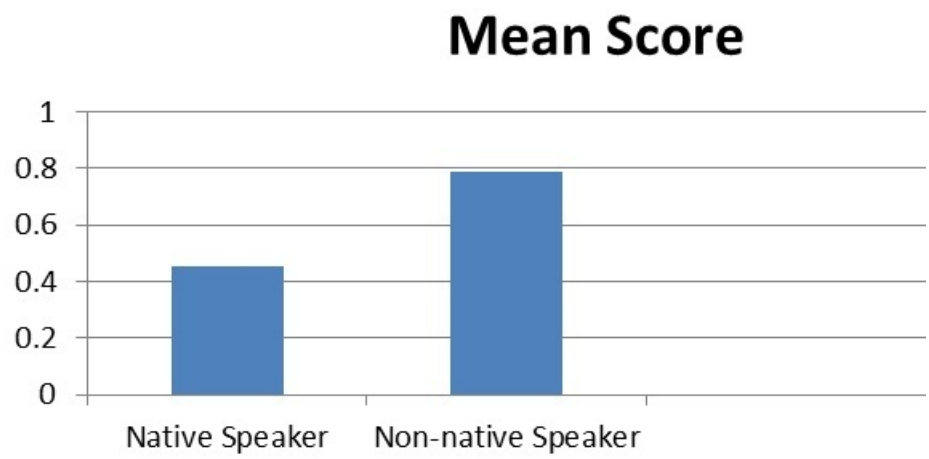


Figure 4.2. Mean scores of respondents who were native English speakers and those who were non-native speakers

Another analysis was carried out to see whether there was a difference in museum experience between the genders. From the results shown in Figure 4.3, there was also no significant difference between male and female respondents (Analysis of variance $F_{1, 253} = .576$, p= .57, n.s).

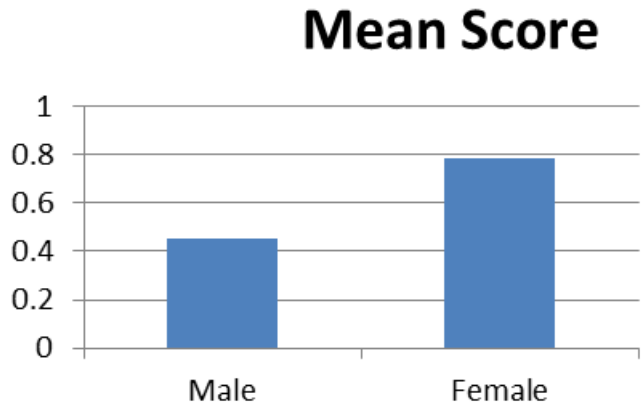


Figure 4.3. Mean scores between male and female respondents

4.5 Discussion

The outcome of this study on the development of scales to measure visitors' experience with exhibits in museums and the usefulness and usability of mobile guides is that it has shown potentially interesting and useful results. I have developed a Museum Experience Scales (MES) with four components (Engagement, Meaningful Experience, Knowledge/Learning and Emotional Connection) and a Multimedia Guide Scale (MMGS) with three components (General Usability, Learnability and Control, Quality of Interaction with the Guide).

4.5.1 Museum Experience Scale (MES)

The MES was successfully used to compare the visitors' experience in a museum with or without a multimedia guide. The discussion will focus on the four main components identified in this study, and will provide a basic understanding of visitors' experiences within cultural spaces. The four components of Engagement, Meaningful Experience, Knowledge/Learning and Emotional Connection which emerged from the Museum Experience Questionnaire are meaningful and seem useful to help many researchers and practitioners to understand visitors' experiences in cultural spaces, especially with multimedia guides which are increasingly available for these cultural spaces.

4.5.1.1 Engagement

The results clearly show that engagement is the component that should be explored further. It was the only component which showed a significant difference between mobile guide users and non-guide users. However, these results do show that introducing technologies such as mobile guides is achieving their presumed aim, to make the museum experience more engaging for visitors. This finding supports previous research that the use of mobile guides is more appealing to visitors when compared with more conventional and traditional ways of presenting information (Boehner, Gay & Larkin, 2005). For example, a recent study by Vavoula *et al.* clearly showed that children were more engaged with exhibits, and at the same time learned more about the material, when using multimedia phones as a guide (Vavoula *et al.*, 2009). A similar study by Naismith and Smith (2006) showed that visitors had fun and engaged with the use of handheld devices and kept themselves on task. In addition, handheld devices have been found to help to engage visitors with their surroundings (Naismith, Sharples & Ting, 2005). It can be concluded that the sense and level of engagement with exhibitions and exhibits in cultural spaces clearly varies between visitors and may be influenced by a range of factors such as prior knowledge, motivation, interest, technology, time spent in the exhibition and so on.

4.5.1.2 Knowledge and Learning

The results from the MES showed that using a multimedia guide produced only slightly higher scores on the knowledge component, although there might have expected to be an even greater difference between multimedia guide users and non-users on this component Nevertheless, the result supports a previous finding by Naismith, Sharples and Ting in the Winterbourne Botanic Garden, Birmingham, which concluded that visitors' knowledge was increased by the use of a multimedia guide (Naismith, Sharples & Ting, 2005). Clearly this will also be a useful area for

further and more in-depth research. Arguably, visitors expect to learn and gain some knowledge from exhibitions and this is one of their motivations for visiting cultural spaces. In addition, visitors enjoy visiting museums because it enhances their knowledge about the particular exhibitions/exhibits and at the same time they would like to know more about the exhibitions/exhibits/artefacts after their visits.

4.5.1.3 Meaningful Experiences

Obviously meaningful experience is one of main goals of visiting cultural spaces. In order to achieve this goal for visitors, cultural spaces strive to present their exhibitions in ways that are easy for visitors to understand and need least effort to understand the underlying messages. Moreover, museum exhibitions should be designed in such a way that they are able to attract visitors' attention and at the same time engage their visitors. The presentation of information, on the other hand, should be in moderation, neither too lengthy so that it could bore visitors nor too sparse that it could fail to communicate with them at all. Labels and images used should be in the right proportion, with not too much text or too few images and *vice versa*, but they should create interesting tensions to challenge and stimulate visitors. On the other hand, the clarity of the information presented in mobile guides or multimedia guides should take into consideration in terms of the various visitors who have different needs. Ideally, visitors' experiences should score well on both the knowledge and learning as well as the meaningful experiences components.

4.5.1.4 Emotional Connection

Clearly cultural spaces also strive to be places which offer their visitors more than just clearly-presented information. Cultural spaces should move from being places which provide and disseminate information or amusement with their exhibitions to being places which are able to integrate various responses, such as a sense of wonder, emotional connection, joy, and many other feelings beyond simply knowledge or a diversion. Interestingly, the emotional connection between visitors and exhibits/exhibition in this study did not increase with the use of multimedia guides.

4.5.2 Multimedia Guide Scale (MMGS)

The second part of the discussion focuses on the three components identified in the MMGS. The three components of general usability, learnability and control, and quality of interaction with the guide can be used as guidelines for designing a mobile guide to be used in museums or cultural spaces.

4.5.2.1 General Usability

Usability factors are the core components to be taken into consideration when designing products /devices because they can affect the usage of such devices. The use of mobile guides in cultural spaces should improve the user's experience. Obviously, the use of mobile guides in cultural spaces is one of the ways by which museums can attract more visitors and at the same time to offer their visitors a different way of experiencing the exhibition.

4.5.2.2 Learnability and Control

Various technologies have been deployed in cultural spaces to improve visitors' experience, be it mobile guides, display technologies and many others. Importantly, visitors should have to spend less time learning how to use such technology than on learning more about the exhibition with the help of the technology. A mobile guide for use in a cultural space should be designed in such a way that it is easy to use and requires little time to master.

4.5.2.3 Quality of Interaction with the Guide

Arguably, the quality of interaction with a mobile guide is the key factor in measuring the successful use of mobile guides in cultural spaces, especially in measuring the user experience (UX) when using such mobile guides. Users have said that they have more meaningful experiences using a mobile guides when they are in control and able to achieve the presumed aim.

4.6 Conclusions

Meeting visitors' needs and expectations within cultural spaces is crucial to stimulate learning, to engage visitors and at the same time to create meaningful experiences for visitors. The results from this study show that the development of scales to measure visitors' experience with exhibits in museums seems useful and meaningful for many researchers and practitioners in the museums field. The four components of Engagement, Meaningful Experience, Knowledge/Learning and Emotional Connection on the MES can be used as a benchmark for creating a meaningful experience for visitors. I have used the MMGS to evaluate the use of different versions of mobile guides (in this case, FC and GT) in cultural spaces in study 3 (*see* Chapter 5). The scales which I devised will enable me to assess the effectiveness of these two different versions of personalization and how it affects visitors' experiences, mainly the engagement component.

CHAPTER 5

Study 3: Mobile guides in cultural spaces: measuring visitors' experiences using an iPhone web-app

5.1 Introduction

Study 3 was the pilot study for the main study in this research programme, to be presented in Chapter 6. Study 2, described in Chapter 4, focused on the validation of the instrument (questionnaires) for the research programme. On the other hand, Study 3 focused on the design, development and testing of a prototype, a web application (web-app) on an iPhone to present either FC or GT information about museum exhibits to visitors. In this study, the web-app for the research programme was designed so that it would be able to be integrated with and used with an iPhone. The web-app was designed and developed using HyperText Markup Language (HTML). This process will be discussed further in the next section.

Before a large-scale evaluation of FC and GT material can be conducted, several other studies, including this study, need to be carried out to ensure that the large-scale evaluation is optimal.

Study 3 was carried out in the University of York Interaction Laboratory using the iPhone as a mobile guide. For this study, the Interaction Laboratory was configured so that it resembled the lay-out of a museum exhibition.

Despite the need to conduct this research in a real museum setting, this part of the study was the initial testing of the web-app, so it was appropriate to carry it out it in a laboratory situation. When the web-app and the methodology have been validated, I will be able to use a real museum setting.

5.2 Objectives

The main objective of Study 3 was to design, develop and test a web-app that could be used in the subsequent study (*see* Study 4: A large scale evaluation of visitors' experiences in cultural spaces, described in Chapter 6). In addition, I was also interested in acquiring more information about participants' sense of engagement as well as their experiences with and attitudes towards mobile guides. Furthermore, I was also interested in comparing two different tour designs on mobile guides, a FC and a GT.

5.3 Method

5.3.1 Participants

There were sixteen participants who took part in this pilot study. They came from various backgrounds, for example, university students (undergraduates and postgraduates), university lecturers, researchers, administrative personnel and members of the public, who all volunteered to participate in this study. They comprised twelve men and four women whose ages ranged from 24 to 55 years with a mean age of 34 years. The majority of the participants were students (75% of the overall participants). In addition, eight participants were native English speakers and eight were not. The main reason for using a varied sample in this study was because the study should include all types of museum visitors. Furthermore, these participants were chosen because they were familiar with the use of the iPhone, and thus would not require any training to use the web-app.

5.3.2 Design

The participants in this study were randomly assigned into two different groups, one of which used the FC web-app and the other used the GT web-app. Participants spent as long as they wished using the web-app, and moved around the exhibition rooms to view the exhibits (in the form of posters) with the help of the web-app guide. Exhibits in this study were pictures of real artefacts presented in the form of posters. Participants in this study were run individually. One of the reason why these participants were run individually because despite visitors go to museum in groups, most of them using the guide individually.

The main data collection method for this study was questionnaires. The participants were given a set of questions in order to obtain their views on the web-app which they had used. They were asked to complete a questionnaire covering a range of aspects of their experience with the web-app using an iPhone, including the usability, user experiences and engagement with the web-app as well as their demographic information.

It is important to evaluate the web-app before it can be used in the large-scale evaluation planned for the cultural spaces study to follow. Two types of evaluation were conducted, which were using the questionnaire as a research instrument as well as heuristic evaluation.

5.3.2.1 Heuristic evaluation

Heuristic evaluation is a widely-used and well-known usability assessment method (Nielsen, 1989). It served in this case to identify any problems with the user interface of the system. It was important to test the system for any known errors or interface issues before the system was tested with the users. Heuristic evaluation is the simplest, quickest and easiest evaluation of a usability interface and is also known as 'discount usability engineering'.

Heuristic evaluation was carried out after the iPhone web-app development was completed. It was important to identify any usability issues or problems at this stage. This evaluation was carried out by both my PhD supervisors, Prof. Helen Petrie and Dr Christopher Power who had knowledge of the user interface and evaluated the usability aspects using Nielsen's heuristics. In this study, the heuristic evaluation was carried out to identify the usability issues pertaining to the design and contents of the iPhone web-app. After careful analysis of the web-app, quite a number of issues were raised by the evaluators in regard to the usability aspects.

The problems identified by the evaluators through the heuristic evaluation are listed as Appendix N, together with their solutions. The web-app went through another cycle of analyses before it could be used in the pilot study.

5.3.3 iPhone Web-app

The material used to develop the web-app for this study was gathered from the Jorvik Viking Centre in York, mainly from the official Viking Centre website as well as from a book called *Treasures of York*, written by Kyriacou, Mae and Rogers (2004). These materials were converted into a web-app specially designed for iPhone for this study. HTML was used to design and develop the web-app. Two different versions of the web-app were designed and developed to examine visitors' experience with a FC and GT.

5.3.3.1 Web-app development: FC vs GT

Figures 5.1 to 5.11 show the user interface of the iPhone web-app for the FC vs the GT. They shared the same interface for the first few pages before they specialized into their own separate streams.

Figure 5.1 shows the screenshot for the 'HOME' screen for both the FC and GT guide. They shared the same user interface design and contents. On the other hand, Figures 5.2 onwards will show the differences in the design of user interface for the FC and GT.

Figure 5.1. Screenshot for the HOME screen for both the FC and GT guide

Figure 5.2 shows the user interface for the leather working section for the GT. The picture on the left shows the top side of the page with the navigation buttons ('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 clicking on the 'Next' button or the link at the bottom of the page.

Figure 5.2. Interface for the leather working section in the GT

Figure 5.3. Interface for the blacksmithing section in the FC

Figure 5.3 illustrates the user interface for the blacksmithing section in the FC. The picture on the left shows the top side of the page with only one navigation button ('Back'), whilst the picture on the right shows the bottom side of the page, which is the same as that for the guided tour.

Figure 5.4 below shows the interface for the FC if the visitor clicks on the navigation link 'Blacksmithing Objects' in the previous page. This function is not available for the GT because users will be directed to the first available object in this category, as shown in Figure 5.5. The visitors using the FC could select which object they wanted to view. This made the guide more interesting and engaging for visitors as they could select any object of their interest without having to view information about the objects which they did not want to view.

Figure 5.4. The interface for object selection in the FC

Figure 5.5. The first page after the user clicks on available objects in the GT

Figure 5.6 illustrates the interface for the guided tour for each exhibit; the left picture shows the top side of the page with two navigation buttons ('Back' and 'Next') as before, and the right picture shows the bottom part with the link to the next object.

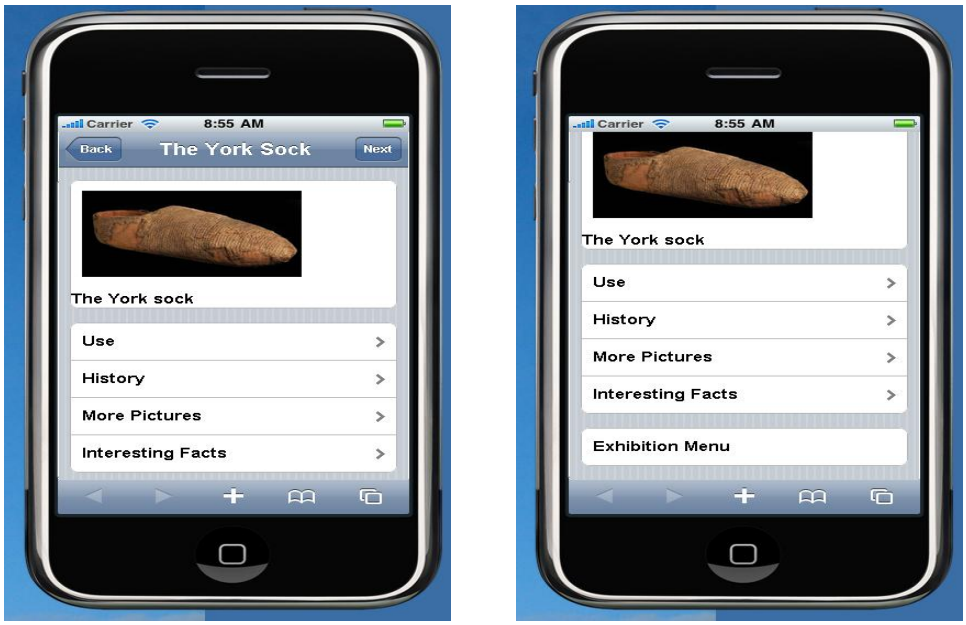


Figure 5.6. GT interface for exhibits

Figure 5.7. FC interface for exhibits

Figure 5.7 show the interface for the FC with only one navigation button in the picture on the top left ('Back') but with the same navigation link on the bottom part.

Figure 5.8. Interface for both FC and GT exploration showing detailed information about the exhibit

Figure 5.8 shows the interface of both versions of the tour when the visitors click on the link. The interface for the GT is on the left and the interface for the FC is on the right. The interface for the GT has two navigation options, the 'Back' button at the top and the link to next section at the bottom, whilst the FC only has the 'Back' button. Visitors who used this version had to go back to select which topics or sections they wanted, but the visitors who used the guided tour needed to click on the link at the bottom to go to the next section.

Figure 5.9 shows the interface of the guide for both versions showing the 'more pictures' page with more choices of pictures to be selected. Both versions of the guides had the same interface. Once the visitors selected a picture, they were directed to a bigger picture, as shown in Figure 5.10. These had different interfaces; the GT is on the left whilst the FC is on the right.

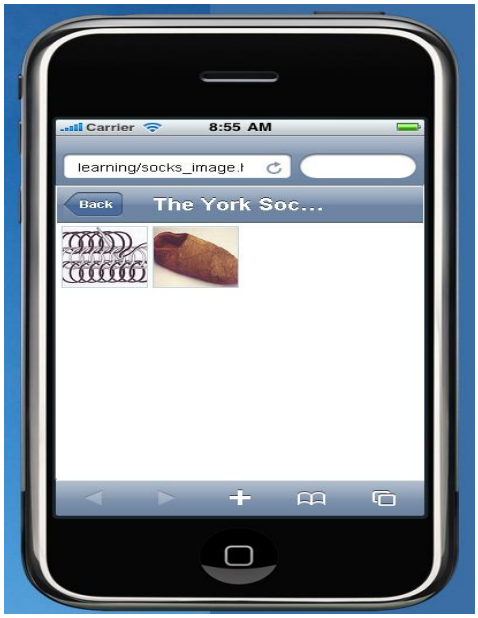


Figure 5.9. Interface for 'more pictures' for both versions

Figure 5.10. Interface for larger picture on both versions

Figure 5.11 shows the final two pages for both versions of the tour; the GT is on the left whilst the FC is on the right. Users were directed to the 'Acknowledgement' page after they clicked on the 'end of TOUR' link. Then, they needed to follow the next instruction and complete the questionnaire at the reception table. The link 'Exit' directed them away from the tour guide web-app to a different website, which was that of the Department of Computer Science at the University of York.

Figure 5.11. The final two pages of the mobile guides for both versions

5.3.4 Research Instruments

5.3.4.1 Multimedia Guide Scale (MMGS)

The scale for this study was taken from my previous study (study 2) with minor changes. One item was removed as it was not related to this study. The item that was removed for this study was 'I found it difficult to hear the material on the audioguide'. The construction and validation of the questionnaire items were discussed in Chapter 4. The questions were close-ended and measured on a Likert scale ranging from 1 'strongly disagree', 2 'disagree', 3 'neutral', 4 'agree', to 5 'strongly agree' (Likert, 1932).

The questionnaire for this particular study can be found as Appendix J.

5.3.4.2 Procedure

The Interaction Laboratory was divided for this study into four different rooms which each had a different exhibition on display. The rooms were: 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 Centre were placed in these rooms with appropriate captions and labels. Each room contained four objects with two, three or four photographs of each object (*see* Figure 5.12). Participants were also provided with a floor plan of the exhibition space which showed the location of the exhibit groups (*see* Appendix K for the floor plan).

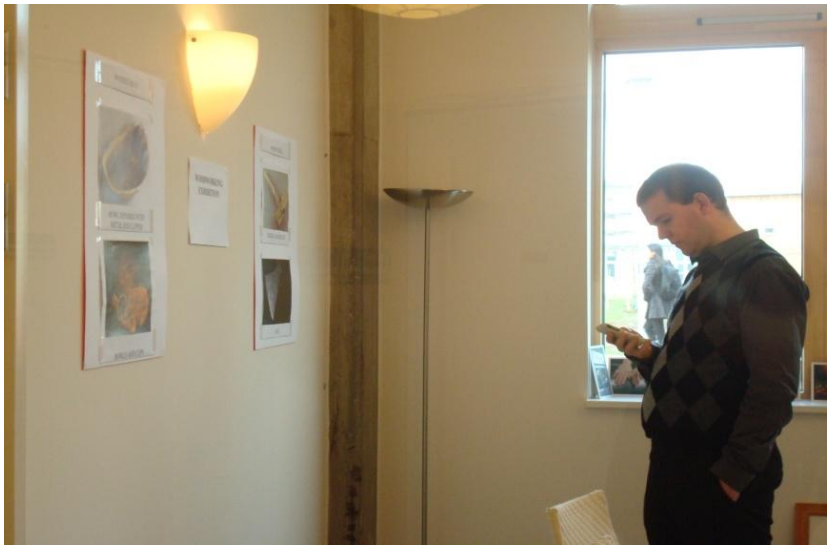


Figure 5.12. Room with photographs of objects

Participants for this study were asked to go to the Interaction Laboratory in the Computer Science Department in the University of York. Participants were run individually but more than one active participant was in the exhibition area at any one time (*see* Figure 5.13). It took between fifteen and thirty minutes for each session. Participants were randomly assigned either a FC or a GTby the instructor by dividing the participants into two different groups.

Figure 5.13. Room with more than one active participant

Below is the chronological sequence of the study:

1. **Briefing session:** When participants arrived, they were asked to gather at the main entrance and then listen to instructions from the instructor. They were asked to bring their own iPhone before the study.
2. **Signing the information consent form:** Participants were asked if they had any questions, and then requested to read and fill out the consent form; they were informed that they could withdraw from the study at any time (*see* Appendix L).
3. **Reading the instruction:** Participants were then asked to read the instructions on the instruction sheet (*see* Appendix M).
4. **Interaction with the iPhone web-app:** Participants were asked to browse the web-app using the iPhone given the URL. They were asked to use the iPhone as a mobile guide just as they would in an exhibition with real objects on display.
5. **Mobile guide tour:** Participants toured the exhibition using the tour guide format assigned to them (FC or GT).
6. **Questionnaire:** Participants were asked to complete the questionnaire provided.
7. **Debriefing session:** The debriefing session then took place; the experimenter explained the purpose of the study and answered any questions which the participants had. The experimenter thanked the participants for their contributions to the study and they were each given a gift voucher worth £10.

5.4 Results

5.4.1. The descriptive features of the sample

There were sixteen participants in this study with an average age of 34.9 (SD=10.1). Twelve of them were male and four were female.

5.4.2. Correlations between the three components of the MMGS

To analyse the results of the study of the two versions of the Multimedia Guide, I took the answers to the MMGS and calculated the mean rating for each of the responses to the questions on each of the components. The results are shown in Figure 5.14, below. A two-way analysis of variance (2-way ANOVA for the FC and GT) carried out on these scores showed that there were significant differences between the scores on the three components ($F = 27.54$, $df = 2, 28$, $p < 0.001$), and a significant difference between FC and GT ($F = 4.53$, $df = 1, 14$, $p < 0.05$). 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 dependent on the different components. Thus it shows in Figure 5.14 that scores were higher for the guided tour on the General Usability component and particularly on the Learnability and Control component, whereas for the Quality of Interaction component, scores were higher for the FC guide.

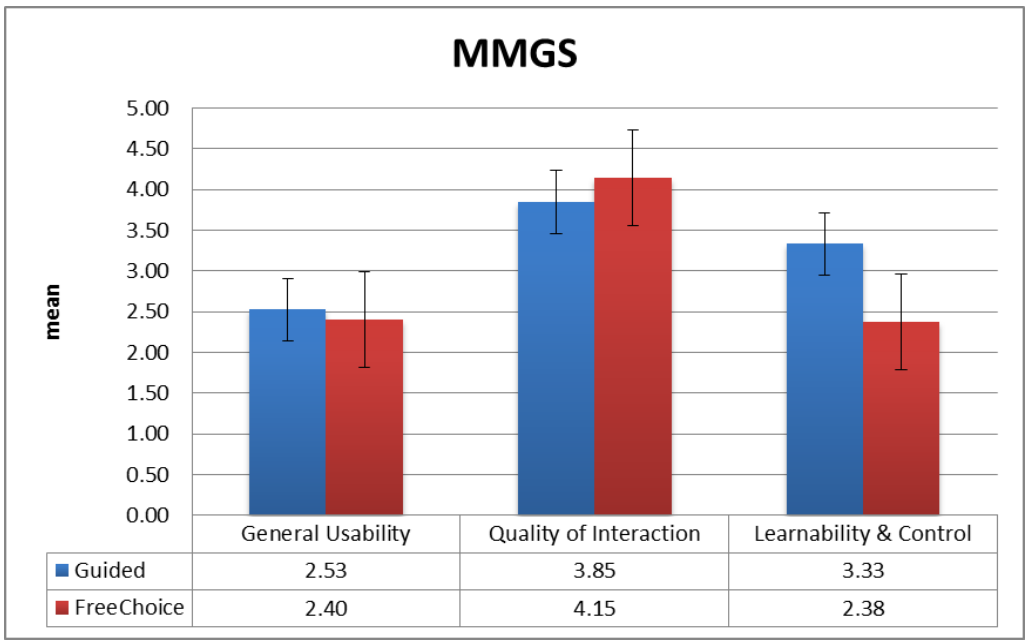


Figure 5.14. Mean scores for the three components of the MMGS for participants using the GT and those using the FC guide

5.4.3 Post-Hoc Analysis

A further analysis was then made of the data. This was carried out because I needed further analysis to see the differences 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)

4: Non-native speaker using free choice tour (NNS-FC)

The post-hoc analysis results shown in Table 5.1 revealed that there was a significant difference between the native-speaker group using the FC and the non-native-speaker group who used the GT. These results are highlighted bold in the Table 5.1.

Multiple Comparisons							
						95% Confidence Interval	
	(I) group	*(J) group*	*Mean Difference (I-J)*	*Std. Error*	*Sig.*	*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							

Table 5.1. Post-Hoc tests of differences on MMGS between native and non native speakers on Guided Tour (GT) and Free Choice (FC) conditions

5.5 Discussion

I have successfully used my MMGS in a preliminary evaluation of two versions of a mobile guide for a simulation of the Jorvik Viking Centre in York. I found that there were significance differences across the three different components (General Usability, Quality of Interaction, and Learnability and Control). These components are important in measuring the visitors' experience when using mobile guides in a cultural space and are of considerable interest to those who develop guides and to the personnel responsible for cultural spaces.

One of the interesting findings from this study is that only the Quality of Interaction component was viewed more positively by FC users in comparison to GT users, although FC users were given more freedom of interaction. An overall finding shows that the GT was viewed more positively than the FC. This may be because the GT 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 which I have also explored in the previous chapter.

5.5.1 Quality of Interaction

It is undeniable that one of the important measures of visitors' experience when using mobile guides in a cultural space is the quality of interaction between the users and the mobile guides. Visitors are said to have a more meaningful experience when they can easily use the mobile guide provided without having to learn and re-learn the new technology. Previous studies have shown the importance of minimizing the learning for using a multimedia guide in a museum. Participants found out that the multimedia guide in this study was easy to learn and this had a positive impact on their learning experiences (Gay & Spinazze, 2002). In addition, the quality of interaction also refers to the ability of the guides to respond to the user's actions. A good multimedia guide should not become a barrier between the visitors and the exhibits. This happens when the interaction between the user and the technology is natural and 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 visitors to retrieve as much information as possible when needed (Schilit, Adam & Want, 1994; Aoki & Woodruff, 2000).

5.5.2 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 or GT. 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 or GT will improve visitors' experiences as they know which guides work better for them.

It is interesting that the mean rating from the GT users was slightly higher than that from the FC users. It is important to study why the mean rating for GT is higher than FC, given that FC users' are free to choose what, which and how to learn. This freedom of choice given to FC users' should produce a higher mean rating than GT users. Previous study highlighted that context can influence the museum learning experience and later proposed the contextual model of learning (Falk and Storksdieck, 2005). This model emphasis on the several contexts such as personal, socio-cultural and physical context. 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.

5.5.3 Learnability and Control

The mean rating from the GT users was higher than that from the FC users. This is an interesting result for the researchers to study in depth because the FC users should have more control of the guide and should therefore learn better compared with the GT users. The use of a FC should give users more control and wider choice over what they wanted to view within the exhibition and not restrict their usage. Importantly, one of the reasons why GT users are more in control is because they only follow a set path through the guide material, and thus they required less learning and increased their control of the guide. This would best suit users who come to the museum with some knowledge about the exhibits. Previous studies have found that participants were drawn into the mobile guides and that this hindered them from interacting with the exhibits, thus they were losing control in the environment (Semper & Spasojevic, 2002). The same study found that visitors who did not have any experience with mobile guide technologies were struggling to use the device, hence the need for designing mobile 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.

5.6 Conclusions

It can be concluded that the MMGS will be a useful tool to allow researchers and museum staff to measure visitor reactions to their multimedia guides, including to different versions of mobile guides. It is definitely not the only measure the usability of mobile guides that should be taken, but it does provide an efficient and easy way to make a quantitative measurement of visitors' experience with a mobile guide. This can then be complemented with other measures, such as more qualitative information about the visitor experience, such as open-ended questions, delivered either in writing or in person.

I have used the MMGS to begin to explore the possibilities of personalizing mobile guides for different visitors. Some museum visitors may prefer to use a mobile 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 my research was to add recommendations of other exhibits that would be of interest to the visitor, based on the exhibits which they have already chosen to visit and possibly the amount of time they have spent visiting each exhibit. This will add further personalization and individuality to mobile guides.

CHAPTER 6

Study 4: Exploration of visitors' experiences in historic churches: the development of the Church Experience Scale (CES)

6.1 Introduction

This study is one of the stages in this research programme. This study is similar to study 2. The main difference between study 2 (described in Chapter 4) and this study (study 4) is their focus; study 2 focused on visitors' experiences in museums, whereas study 4 focuses on visitors' experiences in historic churches. In addition, study 2 was carried out using a web survey whilst this study was carried out with participants immediately after their visit to a historic church in York.

Churches have become one of the centres of tourism in recent decades and this can be shown by the increasing numbers of visitors to such venues. These churches attract nearly two millions visitors a year in the UK (CCT, 2011). Many of the churches which attract significant numbers of visitors are primarily historic churches, meaning they have some "historic, architectural or

cultural significance" (CCT, 2011). Most of these churches are under the management of the Churches Conservation Trust (CCT)[7].

This study mainly focuses on historic churches, both active and non-active churches. A church is considered to be an active church if it serves as a regular place of worship, whilst inactive churches do not have regular services. Some inactive churches do have a few services in a year but do not exceed the number of services that can be considered as defining an active church. There are three churches of interest in this study, all within the city of York: Holy Trinity in Goodramgate (an inactive church), Holy Trinity in Micklegate (an active church) and All Saints in North Street (an active church). All three churches in this study are medieval churches. The inactive church in this study only holds three services a year but it is open to visitors every day, whilst the active churches hold services of worship several times a week and are closed to visitors during the services (although visitors who wish to are welcome to attend the services as worshippers).

Holy Trinity Micklegate is one of the many active medieval churches in York. This church has been a place of worship for more than 900 years and was once part of a monastery. The church was founded in 1066 before the Norman conquest (HTM, 2011). Figure 6.1 is a picture of the church.

Figure 6.1. Holy Trinity Micklegate, York

[7] The Churches Conservation Trust (CCT) is an organization that helps with the extensive repairs and maintenance necessary in English parish churches, mainly because of their 1000 years of history or architecture.

As an active church, it attracts many regular visitors for the services, but at the same time tries to attract more tourists to the church. This church is one of many that have exhibitions within the church's walls and is equipped with technology (for example, a touch screen display, interactive kiosks and closed-circuit television or CCTV). Figure 6.2 show the technology (an interactive kiosk) installed in the church, whilst Figure 6.3 shows the touch screen technology at the church.

Figure 6.2. Interactive kiosk technology for visitors to Holy Trinity Micklegate

Figure 6.3. Touch screen technology for visitors to Holy Trinity Micklegate

Holy Trinity Micklegate church is currently holding *The Monks of Micklegate*, an interactive exhibition, as well as other display panels about the history of this medieval church in York. This can be seen in Figure 6.4.

Figure 6.4. Exhibition in Holy Trinity Micklegate

All Saints Church in North Street is another Anglican Church that has been a place of worship for about 1100 years, but the current building is mainly of fourteenth- and fifteenth-century construction. Figure 6.5 shows the church's interior.

Figure 6.5. All Saints Church, North Street, York

All Saints North Street is known throughout the world for some of the most beautiful stained glass windows in the British Isles, including the famous "Pricke of Conscience" Window (ASNS, 2011). Examples of the stained glass windows in this church can be seen as Figures 6.6 to 6.8. Figure 6.6 shows the Pricke of Conscience Window, whilst Figures 6.7 and 6.8 show other examples of stained glasses windows to be seen in this church.

Figure 6.6. Stained glass known as the Pricke of Conscience Window

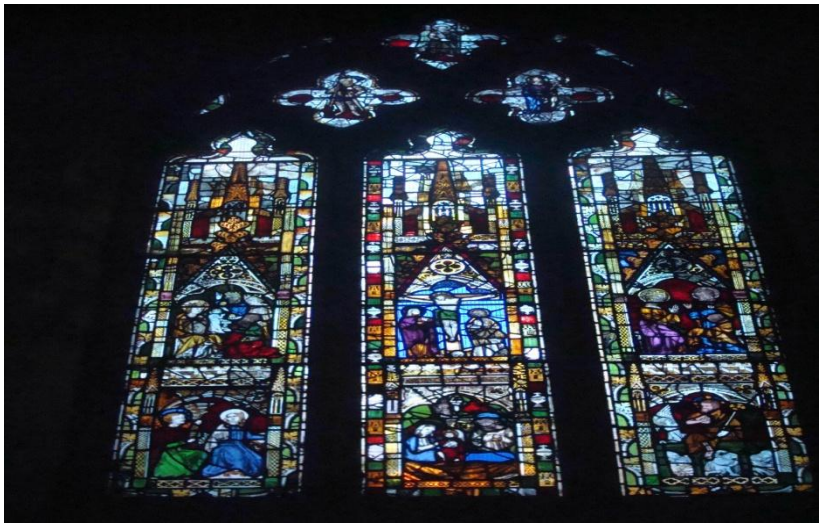


Figure 6.7. One example of a stained glass window in All Saints North Street

Figure 6.8. Another example of stained glass window in All saints North Street

Holy Trinity Church in Goodramgate is the most visited church of all three churches in this study. Unlike the first two churches, this church is not an active church. It has been operated by the Churches Conservation Trust after it became redundant (no longer an active parish church holding regular services) in the 1970s. Figure 6.9 shows a picture of Holy Trinity Goodramgate in York.

Figure 6.9. Holy Trinity Goodramgate, York

Figure 6.10. Inside Holy Trinity Goodramgate, York

Unlike the other churches in this study, Holy Trinity Goodramgate has no running water, gas or electricity and uses candles to light the church. This can be seen in Figure 6.10 which shows the church environment with candles lit. This makes the church damp especially during the winter, but at the same time visitors can smell the original building inside the church. The building dates

back to the fifteenth century, but the foundation of a church on this site can be traced back to the twelfth century (White, 2011).

This church is also one of the few churches in England that still have the rare seventeenth-century box pews. The box pews (enclosed wooden compartments with small doors for access) in this church can be seen in Figure 6.11. This church is one of the many historic churches that have a genuinely medieval feel about them and this can be best experienced during the cold winter days when it is gloomy and dark. Visitors can experience what it was like many centuries ago.

Figure 6.11. The seventeenth-century box pews at Holy Trinity Goodramgate, York

Similar to other cultural spaces (for example museums, heritage sites, art galleries and many others), historic churches also have various artefacts on display. This is one of the features that could attract more visitors to historic churches. This feature has transformed historic churches and visitors will benefit from this. Figure 6.12 shows examples of artefacts on display at one of the churches in this study. These artefacts are well presented with relevant information.

Figure 6.12. Artefacts on display at Holy Trinity Micklegate, York

6.2 Objectives

The objective of this study is to design and develop a short instrument to measure visitors' experience in historic churches because I felt that the visitor experience in historic churches had potentially sufficiently different aspects. Although the nature of these two cultural spaces (museums and churches) shares some similar features, there may well be components that are not measured in the MES, particularly the spiritual aspect of historic churches.

6.3 Method

6.3.1 Respondents

The intention for this study was to recruit as many respondents (historic church visitors) as possible, ideally more than 225 respondents, as a Principal Components Analysis (PCA) would be conducted on the results. The size of the sample is particularly important when administering a preliminary questionnaire to ensure that the number of responses is appropriate for psychometric analysis.

There were 272 respondents. The respondents' ages ranged from teens to the 80s. The respondents came from diverse demographic backgrounds (for example, various places or countries, age groups and genders). It is essential to have a range of respondents in this kind of study. The variety of the respondents in this study will give more dimensions to this study by providing more data and different aspects for consideration.

6.3.2 Design

As the nature of Studies 2 and 4 are similar, here I will describe how the design of this study varied from that used in Study 2. In contrast to Study 2, this study was conducted actually in historic churches. Immediately after they had made a visit to a church, respondents were asked to answer a set of questions to elicit their views on their visit. The questionnaires were administered to the respondents at all three historic churches in York. The historic churches which were involved in this study were Holy Trinity Church Goodramgate, Holy Trinity Micklegate and All Saints North Street.

Respondents were also asked a short set of demographic questions, such as their age, gender, nationality, and whether they were making the visit alone or with others. One issue of importance was whether to ask respondents their religious affiliation, which might have been relevant to their experience of a historic church. After some debate, it was decided that this was a particularly sensitive question and as many people would be visiting historic churches for tourist rather than religious purposes, it was preferable to forgo this information.

6.3.3 Questionnaire

The questionnaire construction also followed a similar design to that used for Study 2. One additional theme was developed, experiences that might be particularly relevant to a historic church (Church Experience). A pool of 65 possible statements was initially gathered and the same procedures for eliminating the questions as was used in Study 2 were undertaken. The initial statements are available as Appendix O. The final choices consisted of 45 statements and these are available as Appendix P. The complete questionnaire administered to the respondents (including questions about participants' demographics) can be found as Appendix Q.

6.3.4 Procedure

Before visitors left the church, they were approached and given a brief explanation about the study by one of the researchers. They were asked whether they would like to help with the research by completing the questionnaire about their experience of the church visit. To encourage participation, a prize draw for Amazon gift vouchers was offered to all respondents. This study was carried out over two weeks in the three different historic churches in York. The data collection was made possible with the help of the following people (Both my PhD supervisors: Prof. Helen Petrie and Dr Christopher Power; Fellow PhD students: Andre Freire,

Dave Swallow, Frank Soboczenski and Tanya Barrat; and undergraduate student: Shasha Zaffa). These people help the student to distribute the questionnaire to the church's visitors for several days in these three different historic churches. Figure 6.13 below shows a picture of visitors in one of the churches, whilst Figure 6.14 shows one respondent answering the questionnaire after a visit.

Respondents were asked to answer the questions and give their views on their particular church visit. Respondents were advised that completing the questionnaire would take at most ten minutes. They were also asked to answer short questions about the church (the churches needed some feedback on some aspects such as temperature, security, pamphlets) as well as some standard demographic information after completing their questionnaire. The short questions for the churches are not included in this report.

Figure 6.13. Visitors at Holy Trinity Goodramgate

Figure 6.14. One of the visitors answering the questionnaire after a visit

6.4 Results

6.4.1 Reliability analysis

A reliability analysis was performed on the 45 items in the questionnaire and the results in Table 6.1 show that the items are highly related to each other with values of .924. With the Cronbach's alpha values of .924, the items were good for further analysis.

Table 6.1. Reliability test for the questionnaire items

Reliability Statistics	
Cronbach's Alpha	*N of Items*
.924	45

6.4.2 Principal Components Analysis (PCA)

Table 6.2 shows the results of both the KMO test and Bartlett's Test of Sphericity. The table shows that the KMO value was relatively high at 0.92, compared with the minimum or acceptable value of 0.6 for the data to be reliable. Bartlett's Test of Sphericity also showed a significant value ($p<0.05$), thus allowing me to carry out a PCA.

Table 6.2. Result of both the KMO test and Bartlett's Test of Sphericity

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.920
Bartlett's Test of Sphericity	Approx. Chi-Square	5612.161
	Df	990
	Sig.	.000

6.4.2.1 Church Experience Scale (CES)

A PCA was performed on the 45 statements about church experience to see how they correlated to each other. Five components emerged from the PCA:

- ***Emotional Connection and Spiritual Experiences*** with the church and its features;
- ***Knowledge and Learning*** gained from understanding and information discoveries;
- ***Enjoyment, Intellectual Stimulation and Curiosity*** from the interaction with the church and its features;
- ***Immersion*** in the church and its features;
- ***Information overload*** with the amount of information about the church.

Factor loadings for each component are shown in Table 6.3 (only statements with a factor loading over 0.6 are listed).

Table 6.3. The five components on the Church Experience Scale and their factor loadings

Emotional and Spiritual Experiences (CES-ESE)		***Enjoyment, Intellectual Stimulation and Curiosity (CES-ESI)***	
I felt spiritually involved with the church and its features	0.76	The church and its features held my attention	0.77
I felt connected with the church and its features	0.73	I felt engaged with the church and its features	0.75
I felt emotionally involved with the church and its features	0.69	I felt focused on the church and its features	0.69
I felt moved in the church	0.69	My visit to the church aroused my curiosity and interest	0.69
The church had a spiritual atmosphere	0.63	I enjoyed my experience at the church	0.68
My sense of being in the church was stronger than my sense of being in the rest of the world	0.61	I enjoyed visiting the church	0.65
Immersion (CES-I)		***Information overload (CES-IO)***	
I still felt in touch with the real world while visiting the church (*reversed relationship*)	0.74	I was overwhelmed by the amount of information provided about the church and its features (*reversed relationship*)	0.65
I felt detached from the outside world while visiting the church	0.63		
During my visit everyday thoughts and concerns were still very much on my mind (*reversed relationship*)	0.62		
Knowledge and Learning (CES-KL)			
I have developed an increased interest in something I knew little about before my visit			0.73
I felt that I learnt new information from my visit to the church			0.63
I have developed a new interest as a result of my visit			0.63
I have gained knowledge as a result of my visit			0.60

6.4.2.2 Initial use of the CES for validation

As an initial use of the CES to provide a validation, I compared the experience of respondents who had made a church visit to an active (39 respondents) and a non-active church (233 respondents). There was a significant difference in mean scores across all five components between these two groups ($F_{1, 270} = 4.52$, $p < .05$). There was also a significant difference between the five factors ($F = 220.5$, $df = 4, 1080$, $p < 0.001$). There was no interaction between the group and factor variables.

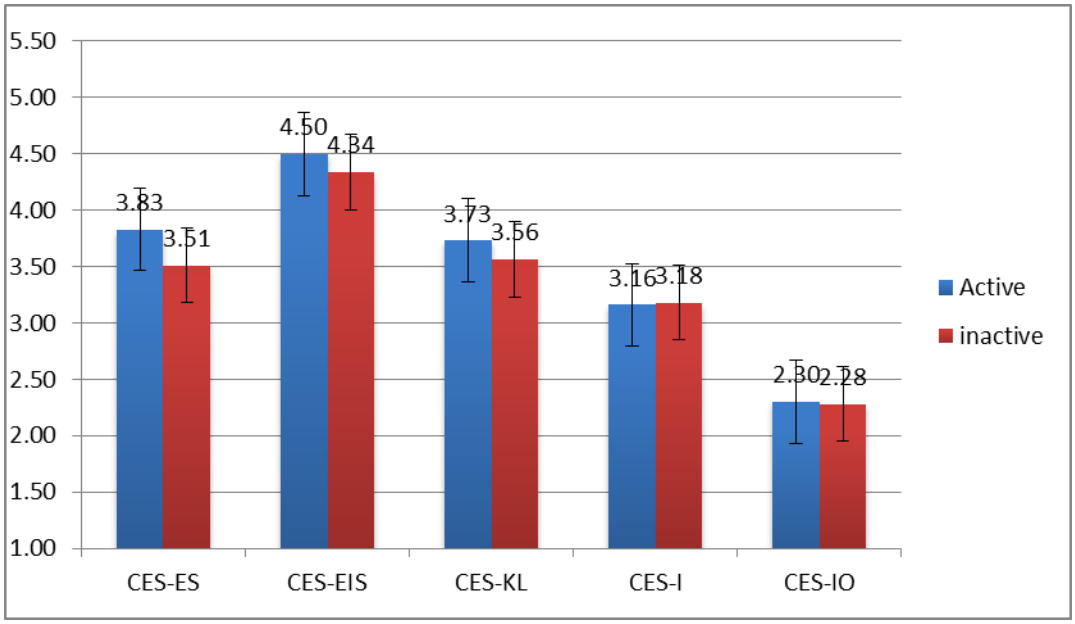


Figure 6.15. Mean scores on the five components of the CES for participants who had visited active or inactive churches

Figure 6.15 shows the mean scores on the five components for the active and inactive churches. This shows that scores on four components were higher (more positive) with the active churches, whilst one component shows a slightly higher significant score with the inactive church. The only component that shows a slightly higher significant value for the inactive church was immersion. Although this difference between active and inactive churches is relatively small, it does give an impact to this study. Arguably, the church settings and environments can make a difference in the sense of immersion felt by visitors and give them a feeling of being easily detached from the real world. On the other hand, there were three components which showed a significant difference between these churches, as was expected – as well as the fourth component which only shows a relatively small difference.

6.5 Discussion

The outcomes of this study on the development of a scale to measure visitor experience in historic churches have shown interesting and useful results. I have developed a CES with five components (Emotional/Spiritual Experience; Enjoyment, Intellectual Stimulation/Curiosity; Knowledge/Learning; Immersion; and Information Overload).

6.5.1 Church Experience Scale (CES)

The CES was successfully used to compare visitors' experience in historic churches with active or inactive churches. The discussion will now focus on the five main components identified in this study, through which it will provide a basic understanding of visitors' experiences within cultural spaces, primarily in this case historic churches. The five components of Emotional/Spiritual Experience (CES-ES); Enjoyment, Intellectual Stimulation/Curiosity (CES-EIS); Knowledge/Learning (CES-KL); Immersion (CES-I) and Information Overload (CES-IO) are meaningful, informative and seem to be useful to many researchers and practitioners to help them to understand visitors' experiences in churches.

6.5.1.1 Emotional and Spiritual Experience (CES-ES)

Emotional and spiritual experience is one of the components that showed a significant difference between visitors to active and inactive churches. These results do show that the emotional and spiritual experience had more of an impact in active churches where these churches have a designated area and time for worship, whilst inactive churches have merely preserved their features to be marvelled at and experienced.

6.5.1.2 Knowledge and Learning (CES-KL)

The results from the CES showed that active churches produced significantly higher scores on the knowledge and learning component, this may well be because one active church in this study had an ongoing exhibition in addition to various other features similar to the inactive church.

I might have expected this kind of result due to what has been offered by these churches. Unlike other public spaces, such as museums that have a similar predilection for providing information by means of an exhibition (temporary or permanent collections either technology oriented or not) to their visitors, the churches have different ways of attracting their visitors. Some churches might have a special feature, artefacts or exhibitions that draw significant numbers of visitors but

might lack information. During this study, it was found that Holy Trinity Goodramgate (an inactive church) attracted a significantly higher number of visitors compared with the other two churches (active churches).

Arguably, visitors expect to learn and gain some knowledge from their church visit and this is one of their motivations for visiting such cultural places. Furthermore, visitors enjoyed visiting historic churches because it enhances their knowledge about the history and the features that particular churches offer, and at the same time they would like to know more about the church and its features after their visit.

6.5.1.3 Enjoyment and Intellectual Stimulation/Curiosity (CES-EIS)

Cultural spaces such as historic churches strive to find good ways to engage their visitors with intellectual stimulation/curiosity within the church walls. Obviously, this is one of main goals of visiting cultural spaces. In order to achieve this goal, cultural spaces strive to present information about a church and its features in such ways that it is easy for visitors to understand and to need the least amount of effort to understand any underlying messages. This can be done by having an interactive exhibition with or without using technology.

The results from the CES showed that active churches produced significantly higher scores on the enjoyment and intellectual stimulation/curiosity component, this may well be because one active church in this study had an ongoing exhibition in addition to various other features similar to the inactive church. Overall, result showed that CES-EIS component are significantly higher than other CES components, both active and inactive churches.

6.5.1.4 Information Overload (CES-IO)

Clearly, cultural spaces such as historic churches also strive to be places that impart to their visitors more than just clearly presented information. To achieve this, cultural spaces explore the way information or exhibitions are presented as well as the amount of information provided. In addition, the visitors should not be saddled with vast amounts of information. Historic churches should be places that are able to develop visitors' curiosity and sense of wonder as well as places of worship; more than simply a place for knowledge dissemination or diversion from daily activities. Hence, churches and their information features should be carefully designed such that they are able to attract visitors' attention and, at the same time, to keep them engaged. In

addition, information presentation should be moderate, not too lengthy that it might bore visitors nor too little that it fails to communicate with the visitors themselves.

The results from the CES showed that visitors in the active church are were more overwhelmed with the amount of information given to them compared to the visitors in the inactive church. In addition, CES-IO component are significantly lower than other CES components, both active and inactive churches.

6.5.1.5 Immersion (CES-I)

Cultural spaces such as historic churches should be a place for visitors to experience a sense of immersion. Historic churches should be able to detach visitors' minds from everyday thoughts and cause time to pass without them being aware. In addition, historic churches should be a place to experience a past medieval time because the churches' features are well preserved (and sometimes still used for their original purpose).

The result from immersion component (CES-I) shows that inactive church has a higher score on immersion component than active church, although the different are relatively small. Visitors in inactive church are more immersed into the church and its features than the visitors in the active churches. This could be because the inactive churches' features are well preserved and have the feeling of medieval times. This means that the inactive church environments are able to provide a more meaningful, enjoyable experience for visitors and this view is supported by Russell (1994). This result also in accordance with one of the different level of visitor experience proposed by Packer (2008), which emphasize on the attributes of the settings that visitors value (for example, layout, ambience, signage, and many others).

6.6 Conclusions

There are various ways to provide visitors' needs and expectations within cultural spaces. They should be a place that not only imparts information to visitors, but is also able to stimulate intellectual involvement. They should also offer a sense of immersion and engagement, whilst enabling visitors to have a spiritual and emotional connection with the church and its features. The results from this study show that the development of a scale to measure visitors' experience of historic churches and their features can be used with cultural space venues other than museums, as was demonstrated in Chapter 7.

The CES scale is a contribution to the body of knowledge in museum studies and human computer interaction and should be useful to researchers and practitioners in other related fields. The five components of Emotional/Spiritual Experience; Enjoyment, Intellectual Stimulation/Curiosity; Knowledge/Learning; Immersion and Information Overload which comprise the CES can be used as a simple way of measuring to what extent a particular historic church, or exhibition or use of technology creates a meaningful experience for visitors. I have developed a good visitors' experience scale on which I have found good scores on the Knowledge and Learning, Spiritual and Emotional Experience, Immersion as well as Enjoyment and Intellectual Stimulations/Curiosity components. Furthermore, this scale can be easily adopted for use in Mosques, Synagogues, Sikh and Buddhists temples and other spiritual places.

CHAPTER 7

Study 5: Evaluation of visitor experience with an iPhone mobile guide in historic church

7.1 Introduction

This study is the final stage in this research programme. This study used the CES developed in Study 4 to evaluate an iPhone mobile guide for a historic church. The study was conducted in the church itself, Holy Trinity Stratford, to create the most realistic and appropriate setting for the evaluation.

Holy Trinity Church in Stratford-upon-Avon is one of many active medieval churches in the UK. This church has been a place of worship for more than 800 years: a church was built on the site by the Saxons as part of a monastery in 713, but the present church dates from 1210. This church was built in stages over the centuries. The oldest parts of the church are the tower, the transepts and the nave pillars. Figure 7.1 is a picture of the exterior of the church.

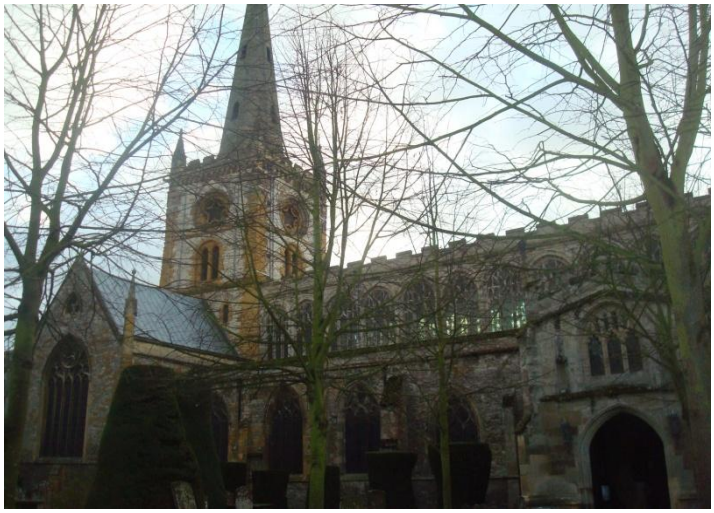


Figure 7.1. Holy Trinity Church, Stratford-upon-Avon

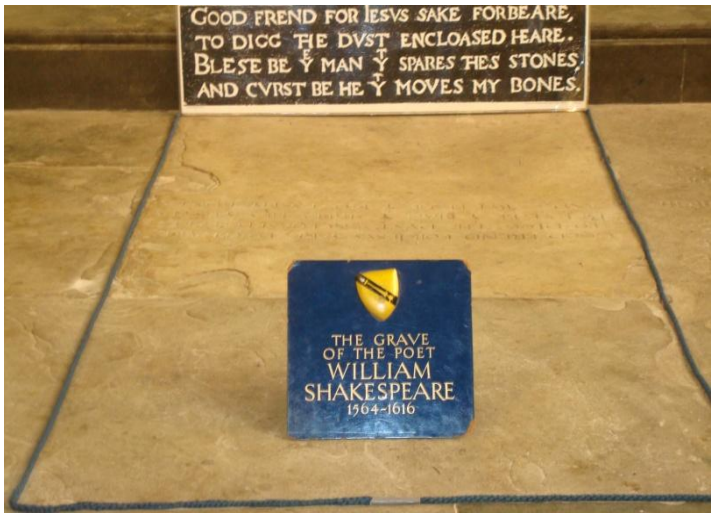


Figure 7.2. William Shakespeare's grave

As an active church, it attracts many regular visitors as worshippers at the regular services, but at the same time it attracts many more tourists to visit the church itself. According to the church's verger (an administrative officer), it is estimated that about 250,000 visitors visit this church every year, and the number are growing fast. One of the main attractions to this church is the link with the famous playwright William Shakespeare: the church contains the graves of Shakespeare and members of his family; Shakespeare was baptized here and worshipped here both as a child and when he returned to Stratford-upon-Avon in his later life. Figure 7.2 shows William Shakespeare's grave and its famous inscription.

This church is aiming to create interesting experiences for visitors by introducing new technology. The church has worked in collaboration with the Centre of Christianity and Culture at the University of York and developed an iPhone mobile guide for the church. Figure 7.3 shows the home screen of the iPhone app which acts as a mobile guide for visitors to the church, and Figure 7.4 shows a visitor (and participant in this study) using the iPhone guide in the church. In this chapter, the term iPhone guide will be preferred for the sake of brevity and consistency.

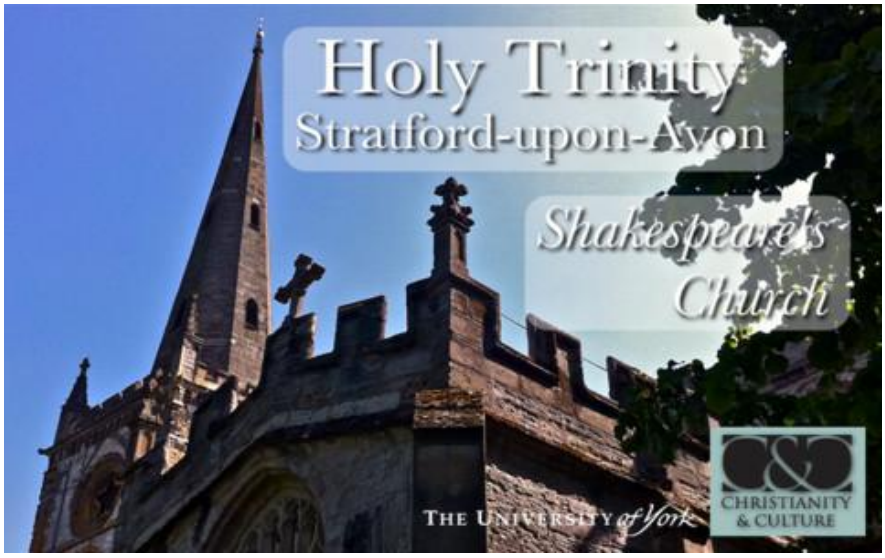


Figure 7.3. iPhone app for Holy Trinity Stratford home screen

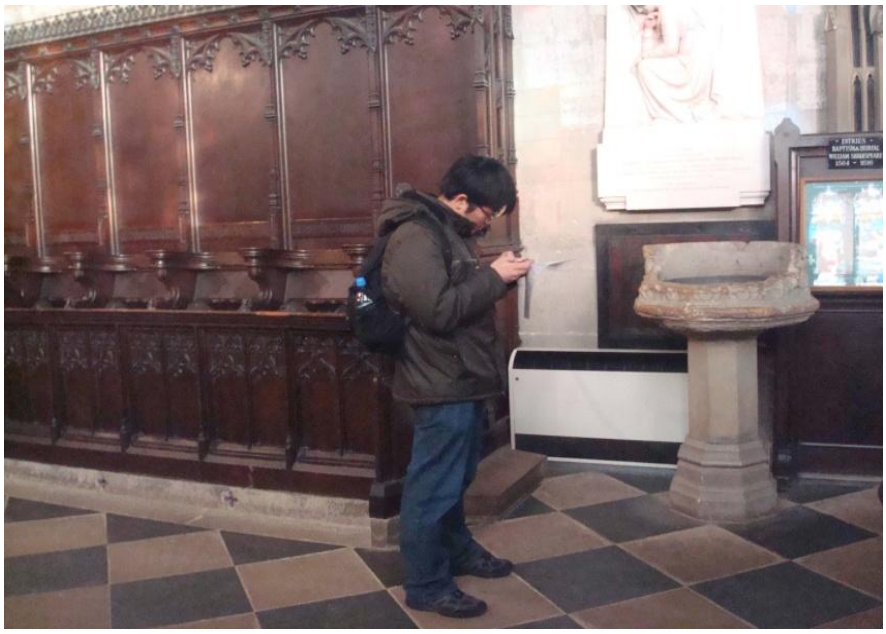


Figure 7.4. A participant using the iPhone guide in the church

Figure 7.5. Stained glass windows in Holy Trinity Stratford

In addition to this iPhone guide, Holy Trinity Stratford also provides various display panels about Shakespeare in one corner of the church, as well as pamphlets. In addition to the Shakespearean attractions in this church, there are various church features and artefacts that have historic interest. Some of these features and artefacts can be seen in Figures 7.5 and 7.6.

Figure 7.5 shows one of many stained glass windows in the church; this is the west window of the church. The first organ was installed in the fifteenth century but the one shown in Figure 7.6 is an eighteenth-century organ which was originally located over the entrance to the chancel.

Figure 7.6. Eighteenth-century organ in Holy Trinity Stratford

7.2 Objectives

The objective of this study was to use the CES and MMGS to evaluate the iPhone guide in this historic church. In particular, I was interested in comparing visitors' experience using two different tours on the iPhone guide, a guided tour and a free-choice tour. I was interested to find out more about the sense of engagement, immersion and interaction with the iPhone guides. I also intend to validate my CES and MMGS with answers to semi-structured interview. In addition, I also use heuristic evaluation to evaluate the iPhone guide.

7.3 Method

7.3.1 Participants

There were 59 participants; 19 in the control group (CG), 21 in the free-choice (FC) group and 19 in the guided tour (GT) group. Participants came from diverse demographic backgrounds, for example a wide range of countries (including Thailand, Korea, the UK, Australia, Canada, China and New Zealand); education or work backgrounds; age groups and genders. In addition, the participants in this study were a mix of iPhone users and non-users, including non-smartphone users.

7.3.2 The iPhone Guide to Holy Trinity Church, Stratford-upon-Avon

The iPhone guide to Holy Trinity Church, Stratford-upon-Avon, was developed by the Centre of Christianity and Culture at the University of York. I was not involved in the development of the iPhone guide, so the design rationale is not described here. It has a number of components, all of which can be accessed from the main menu, shown in Figure 7.7. The user then moves to a plan of the church (*see* Figure 7.8) or to a scrollable photographic rendering a part of the church (*see* Figure 7.9), each of which contains tappable point-of-interest markers. These point-of-interest markers then lead to screens which have text on the left and a photograph of the point of interest on the right. Figure 7.10 shows the screen for the Shakespeare Memorial, with the beginning of the text visible. The iPhone guide can be configured to provide either a free-choice (FC) tour of the point-of-interest markers or a guided tour (GT) through the points of interest.

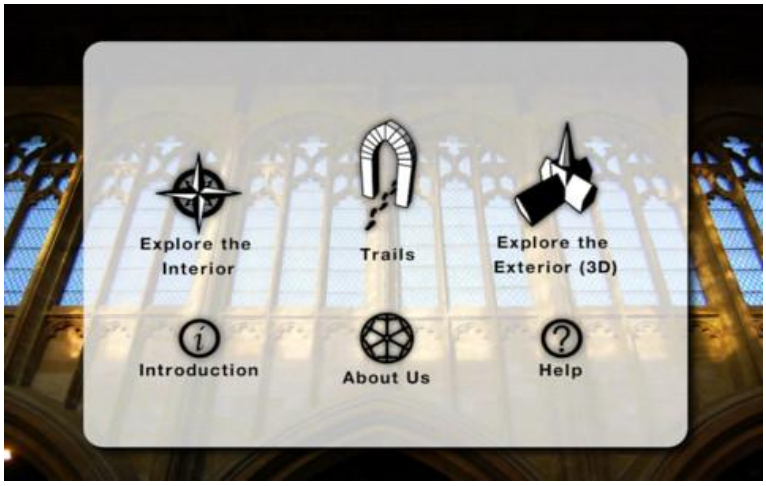


Figure 7.7. Main menu for the iPhone guide to Holy Trinity, Stratford

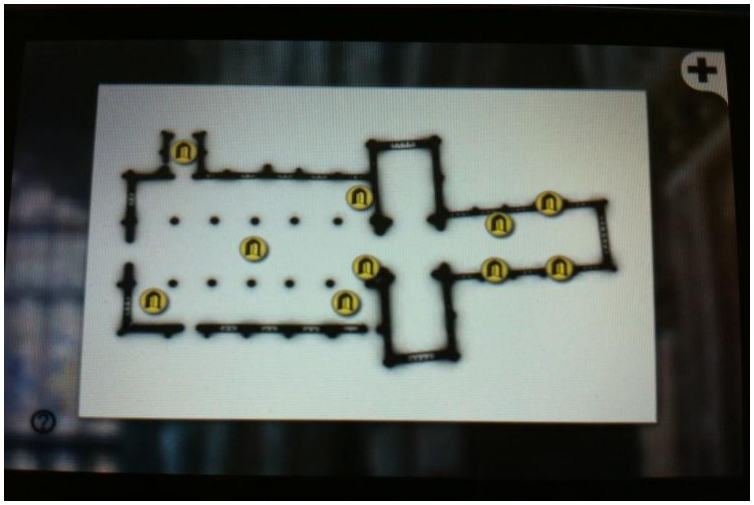


Figure 7.8. Plan of Holy Trinity Stratford in the iPhone app

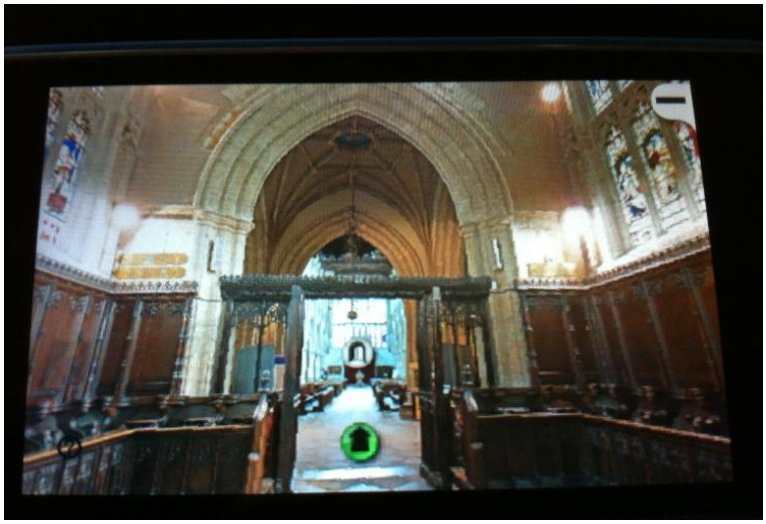


Figure 7.9. Scrollable photographic rendering of the interior of Holy Trinity Church, Stratford

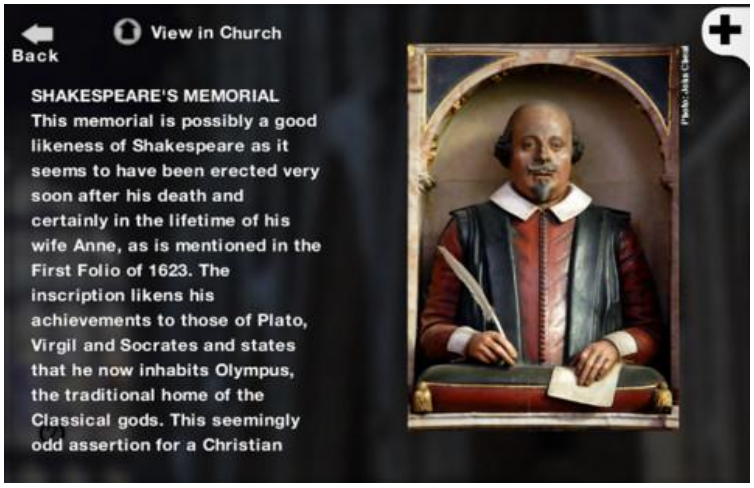


Figure 7.10. Point-of-interest screen: Shakespeare's Memorial

7.3.3 Design

The participants in this study were assigned into three different groups, one which used the FC guide; one was the CG and the third used the GT. There was random assignment to the FC and GT groups, but participants who were not familiar with the iPhone were assigned to the CG. This may have created a slight bias, but was part of the constraints of conducting research in a realistic setting – participants would not have been willing to spend time learning how to use the iPhone simply to take part in the study. In addition, it would not have been possible to provide them with enough training to make them comparable with the participants who used the iPhone, so there would still have been a bias.

Participants spent as long as they wished using the iPhone guide, and moved around the church and viewed the church and its features with the help of the iPhone guide. Participants in the CG spent as long as they wished visiting the church with a paper pamphlet currently provided by the church.

The main data collection methodology for this study was the CES instrument and a semi-structured interview. The participants were given the CES to elicit their views on their church experience and MMGS which covered a range of aspects of their experience with the iPhone guide (excluding the CG), including usability, user experience and engagement with the church FC). They were interviewed and their demographic information were collected during the interview. After they had completed the questionnaire, they were interviewed by the research team to gain more information about their experiences with or without the iPhone guides and most importantly to validate the CES with the answers to the interviews questions.

7.3.4 Methodology for heuristic evaluation

It was important to perform various types of evaluation of the iPhone guide before it could be used in the church. Two types of evaluation were conducted, one using questionnaire and interview carried out at the church with visitors at the end of their church visit, and the other an heuristic evaluation carried out by four evaluators before the mobile guide could be used at the church. The evaluators for heuristic evaluation are PhD supervisors (Prof Helen Petrie, Dr Christopher Power), the author and a fellow PhD student (Dave Swallow).

The heuristic evaluation was carried out on the iPhone guide before it was tested at the church. It was hoped that the usability problems identified at this stage could be addressed by the Centre of Christianity and Culture at the University of York and I hoped that some improvements would be made to the app before the evaluation at the church but unfortunately this was not possible.

This evaluation was carried out by four evaluators who had knowledge of the user interface and they evaluated the usability aspects of the iPhone guide using Nielsen's heuristics (Nielsen, 1994).

7.3.5 Questionnaire

The questionnaire construction followed similar steps to those described for studies 2 and 4. Two themes were developed: 'Visitors' experience of an historic church' (Church Experience) and 'Visitors' experience of an historic church using the iPhone guide'. I have used the CES and the MMGS. The final questionnaire is available as Appendix S.

7.3.6 Interview Questions

The questions for the short semi-structured interview were constructed to validate the statements in the questionnaire as well as to obtain more information about participants' experience in the church, with or without the iPhone guide. The interviews took place after participants had completed the CES and MMGS. The interview questions, including questions about participants' demographics, can be found as Appendix T.

7.3.7 Procedure

When visitors arrived at the church, they were approached and asked if they would like to participate in the study. The study was briefly explained to them by one of the researchers. If they were interested, they were assigned to one of the three groups CG, FC or GT. To

encourage participation, a £10 M&S gift voucher was offered to all respondents, as well as free entry to the chapel in which Shakespeare's grave is located (*note:* Admission to the main part of the church is free, but visitors are asked to contribute £2 to visit the Choir, where Shakespeare is buried). The study was carried out over two days at Holy Trinity Church, Stratford-upon-Avon. Participants were run individually or in a group if they came in a group. In addition, there was more than one active participant/group in the exhibition area at any one time (*see* Figure 7.11). Participants were advised that there was no limit on the time that they could spend in the church.

Figure 7.11. More than one active participant in the church

Below is the chronological order of the elements of the study:

1. **Briefing Session:** When visitors expressed interest in participating in the study, they were asked to listen to instructions from a team member and were loaned a pre-loaded tour on the iPhone (not applicable to the CG).
2. **Demonstration Session:** Participants in the GT and FC tours were given a demonstration of how to use the iPhone guide. Participants were also given a one-page set of instructions to take with them to explain the use of the iPhone guide, if needed. Figure 7.12 shows the short demonstrations on how to use the iPhone guide as a mobile guide being given by one of the research team's members to the participants.
3. **Reading the Instructions:** They were then asked to read the instructions from the instruction sheet (*see* Appendix U).
4. **Interaction with the iPhone guide:** Participants were asked to use the iPhone guide as their tour guide while they were in the church.

5. **Church tour:** Participants toured the church using the guide format assigned to them.
6. **Questionnaire:** At the end of their tour, they were asked to complete the CES and MMGS provided.
7. **Interview Session:** They were then interviewed by a team member to gain more information about their experiences in the church. The research team member answered any questions which the participants had. The research team member thanked participants for their contribution to the study and each participant was given a gift voucher worth £10.

Figure 7.12. A researcher demonstrating how to use the iPhone as a mobile guide

Figure 7.13 below shows a picture of visitors in the church, whilst Figure 7.14 shows participants answering the questionnaire after their visit. Figure 7.15 shows participants being interviewed by one of the team members.

In this study, the data collection procedure was made possible with helps of the following people: Both my PhD Supervisors (Prof Helen Petrie, Dr Christopher Power). They both helped out in recruiting, interviewing, demonstrating on how to use the iPhone' app and disseminating questionnaire to the participants.

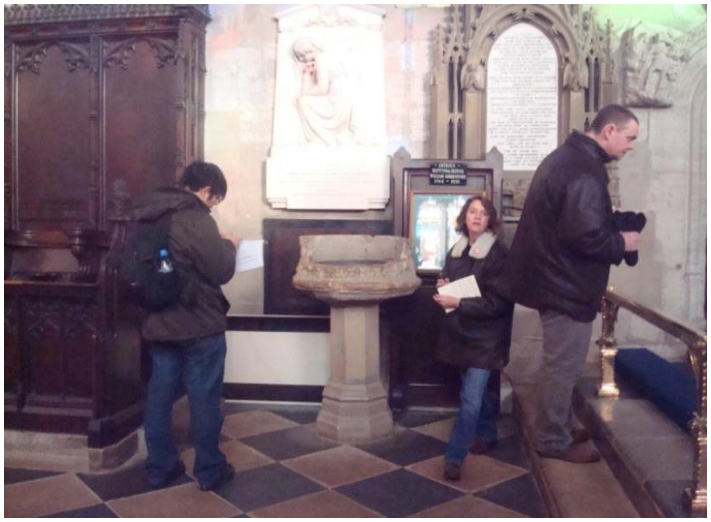


Figure 7.13. Visitors in Holy Trinity Stratford-upon-Avon

Figure 7.14. Participants answering the questionnaire after their visit

Figure 7.15. Participants being interviewed

7.4 Results

7.4.1 Preliminary evaluation of the iPhone Guide: Heuristic evaluation

After careful analysis of the iPhone guide by heuristic evaluation, there were a number of issues raised by the evaluators with regard to usability. The results of this evaluation can be found in Appendix R. This evaluation was intended to highlight any usability problems with the iPhone guide, but unfortunately it was not possible to redesign the guide on the basis of the evaluation.

The evaluators used Nielsen's severity rating scale to rate the usability problems. According to Nielsen (1994), there are three factors which contribute to the severity of a usability problem:

1. The ***frequency*** with which a problem will occur: will users encounter it often or rarely?
2. The ***impact*** of the problem: is it difficult or easy to overcome?
3. The ***persistence*** of the problem: is it 'one time only' and the user will know what to do next, or will users will be repeatedly annoyed by it?

Nielsen proposed a 4 point rating scale to evaluate the severity of a problem: 1 = a 'cosmetic problem', the user will be mildly frustrated and it would be nice to fix, 2 = a 'minor problem', users will be frustrated/have difficulty continuing to their goal, could be fixed, 3 = a 'major problem', users will be very frustrated/having difficulty continuing to their goal, should be fixed, and 4 = a 'catastrophic problem', users will not be able to continue to their goal, must be fixed (Nielsen, 1994).

39 usability problems were identified in the evaluation. The problems and their mean severities can be seen in Table 7.1, below. These problems were classified and grouped based on the nature of the usability issue. There are seven groups of usability problems identified: icon/button (size, shape, colour, etc), text (size, colour, amount of text, etc), scrolling, help content, navigation, contents blocks layering upon each other and inconsistencies with iPhone conventions.

Table 7.1. Usability problems in the iPhone guide with mean severity, grouped on the basis of their nature

No	Problem	Mean severity
	Group 1: Icon/Button (size, shape, colour, etc)	
1	button "view in church" too small	2.5
2	icon looks like trash can	1.25
3	"view in church" label is unclear	2
4	help icon too small	3
5	help icon hardly visible due to poor contrast with the background	3
6	what is the + icon for? Usually adding something (current use not consistent with iPhone conventions)	3
7	purpose of icons in the menu not clear	2.25
8	purpose of black arrow on green background icon unclear	1.25
9	colour coding of point of interest icons (green/yellow) unclear	2
10	The inkwell icon does not look as if it is an icon, no-one realized it would navigate to somewhere else or where that would be	3
11	inconsistency between "The Shakespeare Trail" and text under inkwell picture which is "Shakespeare's church"	1.75
	Group 2: Text (size, colour, amount of text)	
1	Text too small	2.5
2	too much information in one go, unstructured and difficult to read	2.25
	Group 3: Scrolling	
1	no indication that the text scrolls	2
2	scrollling not consistent with other iPhone apps	1.5
3	up/down scrolling is directly mapped (look up, move finger up) whereas the left/right scrolling is inverted (look right, move finger left)	3
	Group 4: Help Content	
1	Instructions talk about a back button, but there is no back button on the map panel	2.75
2	Wording of help message assumes the user will find things easy, this isn't necessary so	2
3	when you access help from the in exterior view, the church spins as you scroll the help	2

	Group 5: Navigation	
1	no back button - no way back	3.5
2	if you open the menu, then tap on the map, menu closes,but + sign does not return, a minus sign remains	3
3	if I return to the map view, no indication of which points of interest I've visited (although this is indicated in the in church view)	2.5
4	if I return to the map view from in church view, a background view remains, but no indication of where that is on the map	1.75
5	from map view, cannot go back to the previous point of interest that I was looking at	3
6	no indication that you can move around	3
7	transition action disorienting, not clear where I've gone	3
8	how can I "undo" /go back from the transition?	3
9	tapping an area of the church exterior opens description panel, tapping the area again does not close it, despite the highlighting being removed	3
10	it is possible to slip off the time slider without any interruption to the church spinning	3
11	no markers on the time slider	2
12	if you come into the exterior view from a trail, you cannot return to the trail you were on	3.5
	Group 6: Contents blocks layering upon each other	
1	background showing through, obscuring text	2.5
2	when you access help from the in church view, the church view moves as you scroll the help	2
3	help button is behind text and can only be activated with difficulty	2.25
4	when you access text from the exterior view, the church spins as you scroll the text, so you lose the aspect of the church you are reading about	2.75
5	as you move the time slider, the church spins as well, so you can not see particular changes (and spin is another gesture)	2.75
		5
	Group 7: Inconsistencies with iPhone conventions	
1	when you have the map view from the "explore the interior" the icons look very similar to the icons on the map view in the trails (they do have different symbols but they are very difficult to see) but you are taken to a panaromic view not a text/picture panel - inconsistent behaviour of the app	2.5

2	Cannot re-size text with pinch zoom - inconsistent with iPhone conventions	2.25
3	instructions are using open/close (a window metaphor), whereas the buttons in the app itself are using a web metaphor (not using the iPhone gestures and metaphor)	3.25

7.4.2 Analysis of CES and iPhone Guide conditions

To examine the interaction between the three iPhone Guide groups (CG, FC and GT) of respondents on the five components in the CES, a two-way repeated measures ANOVA was carried out. There was a significant difference in mean scores across the five CES components ($F = 64.11$, $df = 4, 224$, $p < 0.000$). There was also a significant interaction between the groups and the CES factor variables ($F = 3.27$, $df = 8, 108$, $p < 0.02$). In addition, there was no significant difference between the three groups ($F_{2,56} = 1.20$, $p=0.30$, n.s).

A post-hoc comparison using the LSD test was carried out to see the interaction between the five components of the CES and the three iPhone guide conditions (CG, GT and GC) with each other. The results of this test indicated that there was a significant difference between CES-KL-GT with all groups for CES-ES, CES-I and CES-IO. There was also a significant difference between CES-KL-FC with all groups for CES-IO, whilst there was a significant difference between CES-KL-CG with only two groups in the Enjoyment, Intellectual Stimulation and Curiosity component; CES-EIS-FC and CES-EIS-GT.

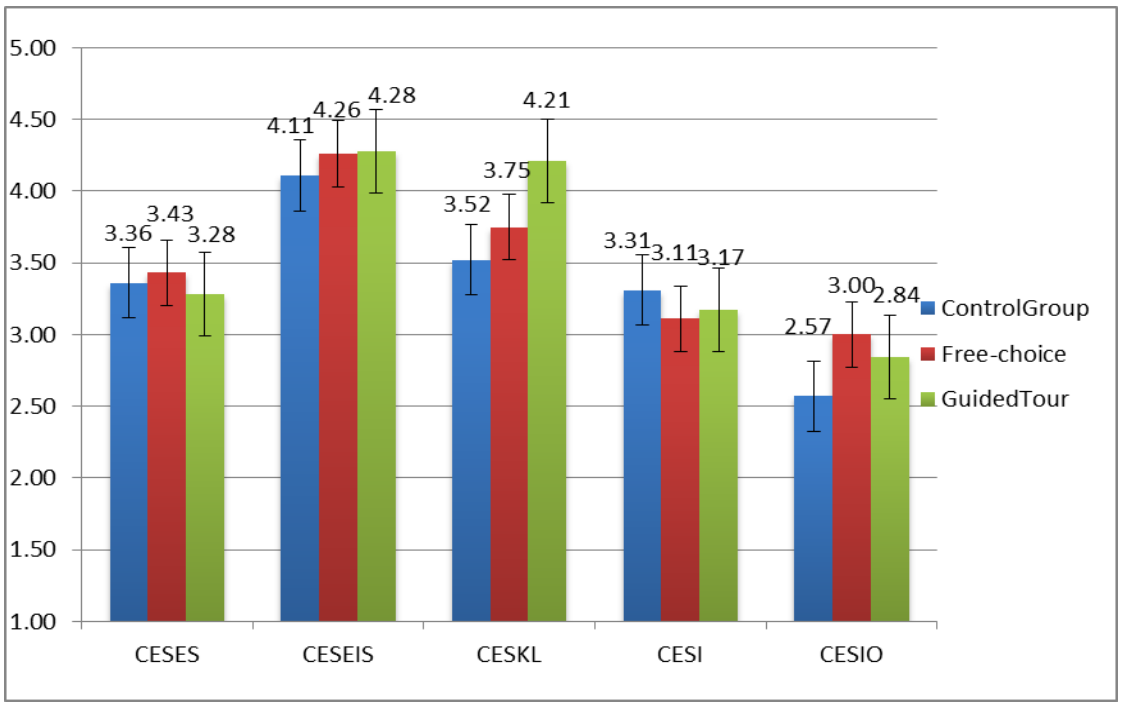


Figure 7.16. Mean scores on the five components of CES for the three different groups

Figure 7.16 shows the mean ratings for the five components on the CES, for participants in the GT, FC and CG conditions. The figure shows that the mean ratings for the Emotional and Spiritual Experience (CES-ESE), the Enjoyment, Intellectual Stimulation and Curiosity (CES-EIS), Immersion (CES-I) and Knowledge and Learning (CES-KL) components were all above the midpoint of the 5 point rating scale; only the Information Overload (IO) component had mean ratings below the midpoint. Table 7.2 shows whether the mean ratings of the components were significantly above the midpoint or not.

Table 7.2. Tests of significance for deviation of mean ratings on the five CES components from the midpoint of the rating scale

	GT df = 19	FC df = 20	CG df = 18
CES-ESE	t = 1.70 n.s.	4.11 $p < 0.001$	2.66 $p < 0.01$
CES-EIS	t = 11.11 $p < 0.001$	14.96 $p < 0.001$	12.88 $p < 0.001$
CES-I	t = 2.54 $p < 0.05$	1.05 n.s.	12.88 $p < 0.001$
CES-IO	t = 0.65 n.s	0.00 n.s.	3.68 $p < 0.05$
CES-KL	t = 10.37 $p < 0.001$	6.55 $p < 0.001$	2.39 $p < 0.05$

Mean scores for three components, Knowledge and Learning (CES-KL); Immersive (CES-I); and Enjoyment, Intellectual Stimulation and Curiosity (CES-EIS), were higher in the GT than in the FC group. In addition, scores on CES-KL component were significantly higher or more positive for the GT group than for the other two groups. This clearly shows that the participants in the GT group gained more knowledge and learned more about the church's features than those in the other two groups.

The only component for which the CG showed a higher score than the other two groups was (CES-I). It can be concluded that the use of iPhone guides distracted the visitors from having an immersion experience.

The post-hoc test also showed that there was a significant difference between CES-IO-GT with all groups for CES-EIS and with only two groups in the Knowledge and Learning component; CES-KL-FC and CES-KL-GT. There was a significant difference between CES-IO-FC with all groups for CES-EIS but only two groups in the Knowledge and Learning component; CES-KL; CES-KL-FC and CES-KL-GT. On the other hand, there were significant differences between CES-IO-CG with all groups for CES-KL, CES-ES and CES-EIS but only one group in the Immersion component, which was CES-I-CG. Participants who used the iPhone guide had the same effect with the Information Overload component, so there was no significant difference between these two groups (FC and GT).

The post-hoc test also showed that there was a significant difference between both CES-I-GT and CES-I-FC with all groups in CES-EIS, but with only one group in the Knowledge and Learning component, CES-KL-GT. On the other hand, there was a significant difference between CES-I-CG with all groups in the CES-EIS component and with one group for the Information Overload (CES-IO-CG) and the Knowledge and Learning components (CES-KL-GT). Participants who used the iPhone guide had the same effects for the Immersion component, hence there was no significant difference between these two groups (FC and GT).

Surprisingly, the mean scores on the Information Overload (CES-IO) component were relatively high for the FC compared with the other two groups. This shows that participants in the FC group were given too much information on their iPhone guide. I had expected that participants in the GT group would be overwhelmed when they had to follow the pre-defined tour which might not match their interest, but the result shows that this was not the case.

The mean scores for the Emotional and Spiritual Experience (CES-ES) component were significantly higher for the FC group than for the other two groups.

Only one component shows relatively small differences between the mean scores for the three different groups. The CES-EIS components do not differ much, especially between the GT and FC groups.

The post-hoc test also showed that there was a significant difference between both CES-EIS-GT and CES-EIS-FC with all groups in CES-ES, CES-I and CES-IO, but with only one group in the Knowledge and Learning component, CES-KL-CG. On the other hand, there was a significant

difference between CES-EIS-CG with all groups in CES-IO and CES-I as well as two groups in the Emotional and Spiritual Experience component, CES-ES-CG and CES-ES-GT. The use of iPhone guides had the same effect on the participants for the Enjoyment, Intellectual Stimulation and Curiosity component, thus there was no significant difference between these two groups (FC and GT).

For the CES-ES, there was no difference at all between participants who used the iPhone guide and those who did not. However, for the CES-EIS component, participants who used the iPhone guide had higher mean scores than those who did not. For the CES-I component, participants who did not use the iPhone guide had slightly higher scores. Finally, for both the CES-IO and the CES-KL components, participants who used the iPhone guide had higher scores. The largest difference between the two conditions was on the last component, CES-KL.

The post-hoc test also showed that there was a significant difference between both CES-ES-GT and CES-ES-CG with all groups in CES-EIS, but with only one group in the Knowledge and Learning component, CES-KL-GT and the Information Overload component, CES-IO-CG. On the other hand, there was a significant difference between CES-ES-FC with two groups in the CES-EIS component, CES-EIS-FC and CES-EIS-GT, as well as one group for both the Information Overload (CES-IO-CG) and the Knowledge and Learning components (CES-KL-GT). Participants in the CG had the same effect as those in GT for the Emotional and Spiritual Experience component.

7.4.3 Analysis of CES with age and gender

To investigate the interaction between the five components of CES with different age groups and the three different groups of participants (CG, FC and GT) a further two way analysis of variance was undertaken, with age group as one of the variables (groups: 20 – 30 years, 31 – 40 years, over 40 years). There was no significant difference in the mean scores of all five CES components across the age groups ($F_{2, 35} = 0.58$, n.s) and the three different groups of participants, ($F_{2, 35} = 1.28$, n.s). There was also no significant interaction between the five CES factors and the age groups ($F = 0.83$, $df = 8, 62$, n.s).

Another test was carried out to see the relationship between the five components of CES with gender and three different groups of participants (CG, FC and GT). There was a significant difference between the genders ($F_{4, 50} = 1.01$, $p < 0.002$). There was no significant interaction difference in the mean scores of all five CES components with genders and the three different groups of participants, ($F_{2, 50} = 1.28$, n.s). The average overall means for men and women for the five components of CES are shown in Figure 7.17.

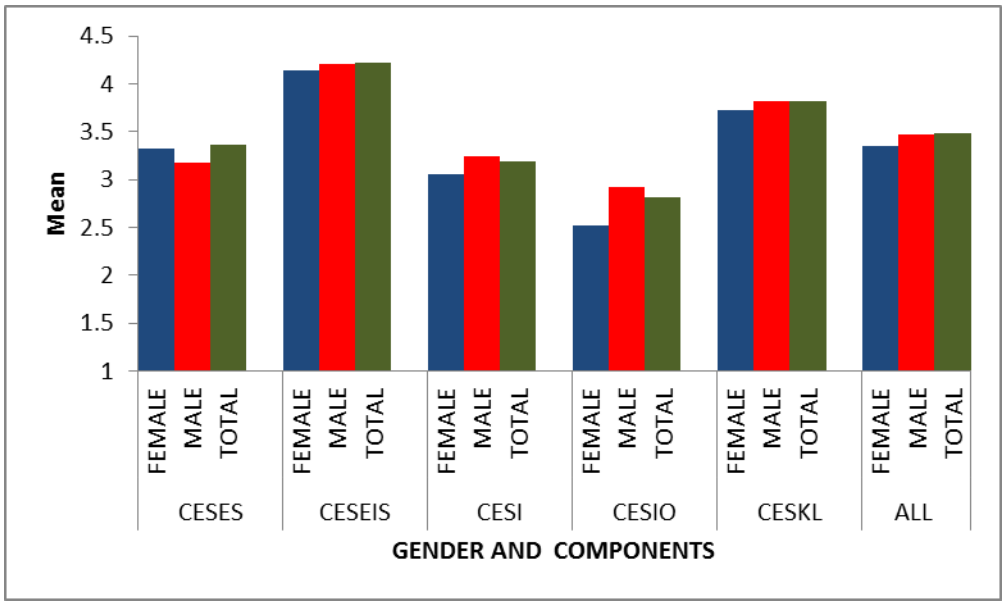


Figure 7.17. Mean scores on the five components of CES by gender

7.4.4 Analysis of Multimedia Guide Scale (MMGS) and iPhone Guide conditions

To examine the interaction between the three iPhone Guide groups (CG, FC and GT) of respondents with the three components in the MMGS Two-way repeated measures ANOVA was carried out. There was no significant difference in mean scores across all three components between these three groups, ($F_{1, 38} = 0.005$, $p=0.94$, n.s). There was a significant difference between the three factors ($F_{2, 37} = 66.58$, $p< 0.000$). There was no interaction between the group and factor variables ($F = 0.93$, $df = 2, 37$, n.s).

Figure 7.18 shows the mean scores between participants in the FC and the GT groups. It shows that the differences in the mean scores for all three components are relatively small.

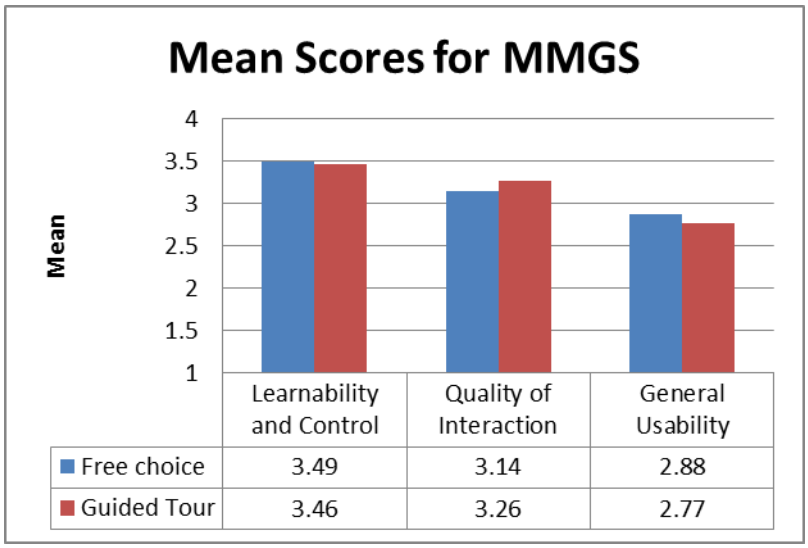


Figure 7.18. Mean scores for MMGS on FC and GT iPhone Guide conditions

A similar test was carried to see the interaction between the three components of MMGS with the three different age groups and the three iPhone Guide conditions. There was a significant difference between the age groups ($F_{2, 25} = 3.45$, $p < 0.05$). There was no significant interaction in the mean scores of all three MMGS components with the age groups and the three different groups of participants, ($F_{2, 25} = 0.03$, n.s). There was also no significant correlation between MMGS factors and the age groups ($F = 2.04$, $df = 4, 50$, n.s). Finally, there was no significant interaction between MMGS with the age groups and the different groups of participants ($F=0.82$, $df = 2, 50$, n.s).

7.4.5 Effect on visit length on visitor experience

A One-way ANOVA was carried out to see whether the length of time spent on the visit of the church had a significant effect on the participants' experience. There was a significant effect of time on the participants across the three iPhone Guide conditions ($F_{2, 56} = 6.63$, $p < .005$).

Participants in the CG spent a mean of 13 minutes and 30 seconds on their visit (standard deviation = 6 minutes and 30 seconds) and the iPhone guides users spent a mean of 20 minutes and 3 seconds on their visit (standard deviation = 8 minutes and 24 seconds). Figure 7.19 shows the mean scores for iPhone guides users and non-guide users.

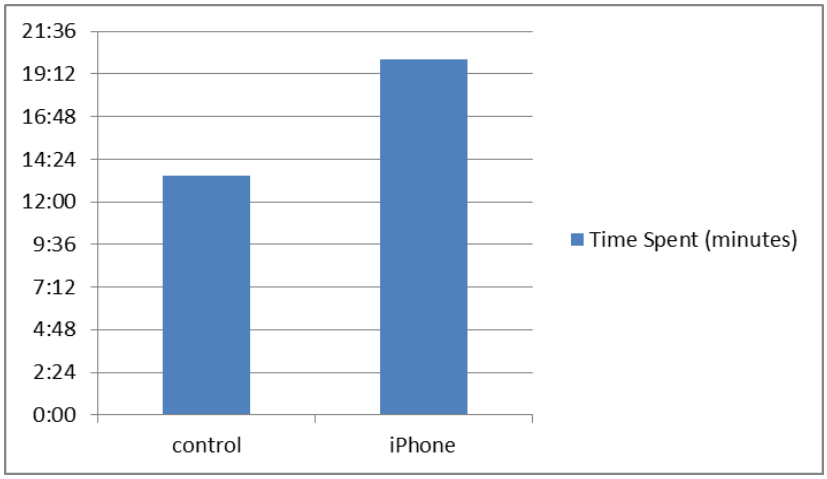


Figure 7.19. Time spent for iPhone Guide users and non-guide users

A Least Significant Difference (LSD) post-hoc analysis showed that the two iPhone guide groups (FC and GT) were not significantly different from each other in time spent, but the GT users spent significantly longer in the church than the CG users. Thus, using an iPhone guide significantly increased the time spent on the church visit, and in the case of the GT users, it nearly doubled the time spent on the visit.

There was no significant difference between the other groups. The results of this LSD post-hoc analysis are shown as Appendix V.

7.4.6 Relationship between CES and MMGS components with time spent

Correlations between the five components of the CES and time spent on church visit were calculated to explore the relationships between these components. The correlation (Pearson coefficients) matrix is shown in Table 7.3.

Table 7.3. Correlation between time and the five components of the CES

Correlations

		TIME	CESES	CESEIS	CESI	CESIO	CESKL
TIME	Pearson Correlation	1	-.105	.333**	-.302*	-.113	.161
	Sig. (2-tailed)		.430	.010	.020	.393	.223
	N	59	59	59	59	59	59
CESES	Pearson Correlation	-.105	1	.441**	-.163	.177	.333**
	Sig. (2-tailed)	.430		.000	.218	.180	.010
	N	59	59	59	59	59	59
CESEIS	Pearson Correlation	.333**	.441**	1	-.212	.166	.546**
	Sig. (2-tailed)	.010	.000		.108	.210	.000
	N	59	59	59	59	59	59
CESI	Pearson Correlation	-.302*	-.163	-.212	1	.374**	-.059
	Sig. (2-tailed)	.020	.218	.108		.004	.659
	N	59	59	59	59	59	59
CESIO	Pearson Correlation	-.113	.177	.166	.374**	1	.205
	Sig. (2-tailed)	.393	.180	.210	.004		.120
	N	59	59	59	59	59	59
CESKL	Pearson Correlation	.161	.333**	.546**	-.059	.205	1
	Sig. (2-tailed)	.223	.010	.000	.659	.120	
	N	59	59	59	59	59	59

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The values given in Table 7.3 show a number of significant relationships within the data, both positively correlated relationships and inverse relationships. For example, there is a positive correlation between time and the CES-EIS component, r = 0.33, df = p < .001, whilst there is an inverse relationship between time and the CES-I component, r = 0.30, p <.005. It can be concluded that time spent on church visit has a positive effect on Enjoyment and Intellectual Stimulation/Curiosity. Time spent on church visit has a negative impact on level of immersion in visitors, for example more time spent in churches decreased level of immersion.

In addition, there is a positive correlation between the CES-EIS component and the CES-ES component, r = 0.44, p < .001 and with the CES-KL component, r= 0.54, p< .001. It can be concluded that there is an association between visitors' Enjoyment and Intellectual Stimulation/Curiosity with Emotional and Spiritual Experiences as well as Knowledge and Learning.

Furthermore, there is a positive correlation between the CES-I component and the CES-IO component, r = 0.37, p< .001. There is also a positive correlation between the CES-ES component and the CES-KL component, r = 0.33, p≤ .001. It can be concluded that there is an association between visitors' level of Immersion with the Information Overload. Furthermore,

there is an association between Emotional and Spritual Experiences with the Information Overload.

A similar correlation between the three components of the MMGS and time spent on church visit was calculated to explore the relationships between these components. The correlation (Pearson coefficients) matrix is shown in Table 7.4, below. This shows that there are no significant correlation between the three MMGS components and time spent on the church visit.

Table 7.4. Correlation between time spent on church visit and the three components of the MMGS

Correlations

		TIME	MMGSGU	MMGSLC	MMGSQol
TIME	Pearson Correlation	1	-.207	.128	-.215
	Sig. (2-tailed)		.200	.432	.184
	N	59	40	40	40
MMGSGU	Pearson Correlation	-.207	1	.193	.124
	Sig. (2-tailed)	.200		.233	.444
	N	40	40	40	40
MMGSLC	Pearson Correlation	.128	.193	1	.019
	Sig. (2-tailed)	.432	.233		.909
	N	40	40	40	40
MMGSQol	Pearson Correlation	-.215	.124	.019	1
	Sig. (2-tailed)	.184	.444	.909	
	N	40	40	40	40

Another correlations analysis was undertaken to find the correlation relationship between time spent on church visit, participant age and gender in this study. The correlation (Pearson coefficients) matrix is shown in Table 7.5. Interestingly, there is no correlation at all between time spent and gender, time spent and age or age and gender in this study.

Table 7.5. Correlations between time spent, gender and age

Correlations

		TIME	GENDER	AGE
TIME	Pearson Correlation	1	.033	-.158
	Sig. (2-tailed)		.831	.306
	N	59	45	44
GENDER	Pearson Correlation	.033	1	.183
	Sig. (2-tailed)	.831		.246
	N	45	45	42
AGE	Pearson Correlation	-.158	.183	1
	Sig. (2-tailed)	.306	.246	
	N	44	42	44

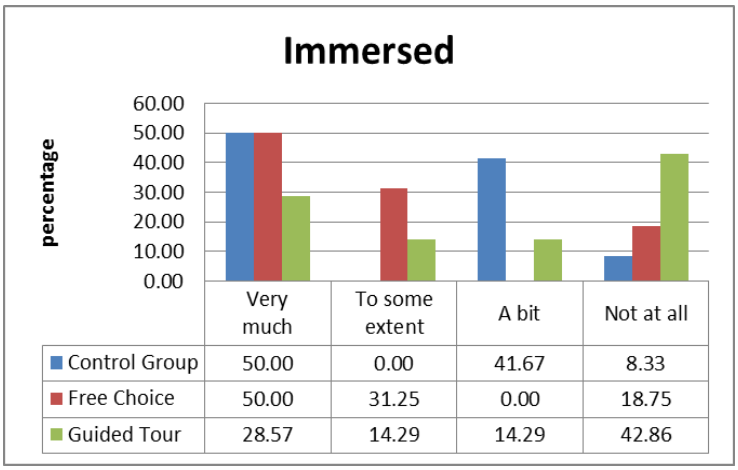
7.4.7 Validating CES with semi-structured interview

Participants in this study were asked to complete both the CES and a series of open-ended questions that addressed the same issues so I could validate the scales of the CES with the answers to these questions. However, using this data to validate the components of the CES proved more difficult than I expected. Participants often gave vague answers, or clearly the 'expected' answer, and were confused as to why they were being asked about the issues that they had just addressed in the CES itself (of course, they were not told until the debriefing that this was for validation purposes). Nonetheless, it was possible to deduce some useful information from this exercise. Participants' open-ended questions were divided into whether they appeared to agree 'very much', 'to some extent', 'a bit' or 'not very much' with the question.

A number of questions were asked during the short interview to gain more information from participants about their experiences in the historic church.

1. ***Immersion in the church***

   Participants were asked if they had felt immersed during their visit and were not thinking about their every-day life.



	Very much	To some extent	A bit	Not at all
Control Group	50.00	0.00	41.67	8.33
Free Choice	50.00	31.25	0.00	18.75
Guided Tour	28.57	14.29	14.29	42.86

Figure 7.20. Answers on different levels of immersion felt by three iPhone Guide conditions

Figure 7.20 shows that there were significant numbers of participants in the FC group (81.25%) who felt so immersed in the church that the rest of their life and concerns dropped away, whilst only 57.14% of participants in the GT group felt the same. Furthermore, this also shows that 50% of the participants in the FC group felt very much immersed compared with the participants in the GT group.

It can be concluded that the participants in the FC group were more immersed in the church and its features than those in the GT group. On the other hand, these figures also show that the CG participants were overall more significantly immersed than the other two groups (FC and GT).

Importantly, this result validates the analysis of the scales for the CES-I component which shows that the CG participants were more immersed than the other groups.

2. *Information provided*

Participants were asked if the amount of information provided on the iPhone guide is sufficient to them.

Figure 7.21 shows that the information provided on the iPhone guides (GT and FC) was sufficient for the participants. This implies that participants in the GT group were more satisfied with the amount of information provided than those in the FC group. This could be because the participants in the FC group only selected features in the church which were of interest to them and they might have prior knowledge about these features.

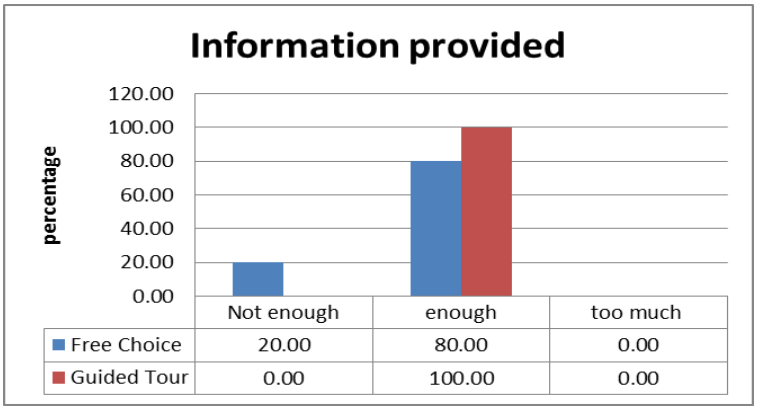


Figure 7.21. Answers for information provided by the iPhone guide for FC and GT groups

3. *Did your visit to the church hold your attention and engage you completely?*

Participants were asked if the church and its features able to hold their attention and engaged them completely. Result showed that levels of engagement between participants in this study were varied. The results are shown in Figure 7.22. All the participants in all three groups were engaged with the church and its exhibits but with different levels of

engagement. Most of the participants (85.7%) in GT were deeply engaged with the church and its exhibits, whilst only 65.22% and 76.92 were in FC and CG respectively. Clearly, participants in the GT group were more engaged with the church and its features than those in the other two groups.

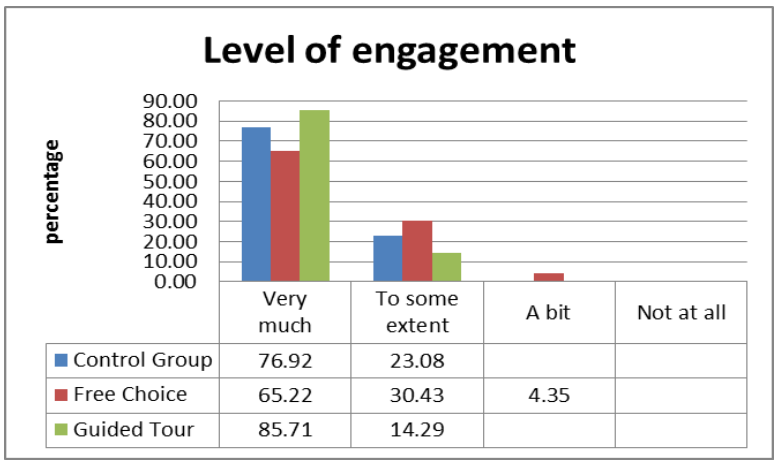


Figure 7.22. Answer for different levels of engagement between three iPhone Guide conditions

4. Stimulate your curiosity and interest

Participants were asked if the church and its features able to stimulate their curiosity and interest. Results showed that the church and its features had different impacts on the participants in different groups. Figure 7.23 shows how the church's features had a different impact on the level of curiosity and interest for participants in the GT and FC groups. Overall, the results show that the church and its features had less impact on the participants' curiosity and interest in the CG. On the other hand, participants in the GT said that church and its features had a deep impact on them. This result validates the CES-EIS component in the CES scale analysis.

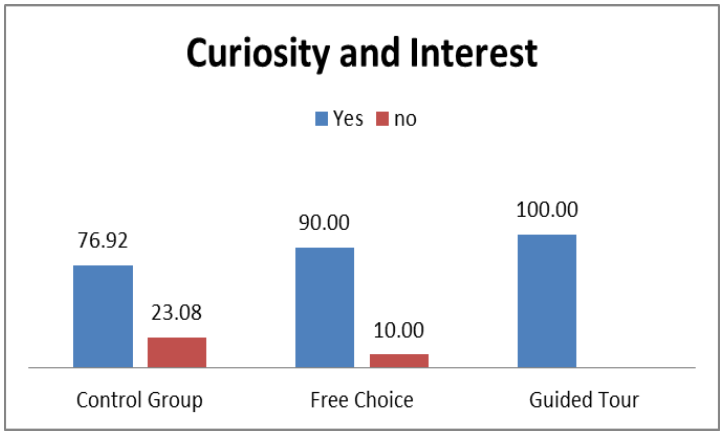


Figure 7.23. Answers on curiosity and interest for three iPhone Guide conditions

5. Participants enjoyed their visit to the church

Participants were asked if they enjoyed their visit to the church. Figure 7.24 shows the level of enjoyment that participants had during their visit to the historic church. Overall, the participants in the FC and GT groups enjoyed their visit to the church more than the CG. Participants in the CG did not enjoy their visits as much as the visitors with the iPhone guide. It can be concluded that the introduction of technology in this cultural space had an impact on visitors' enjoyment.

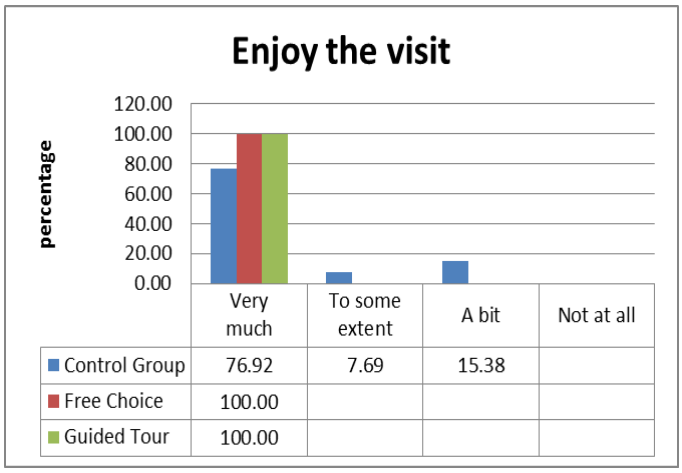
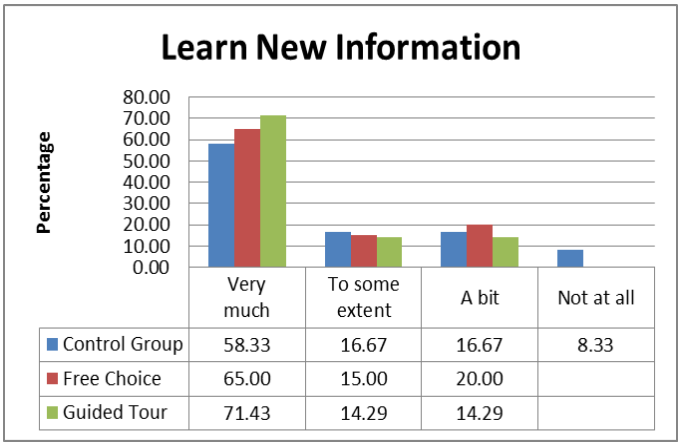


Figure 7.24. Answer for different level of enjoyment between three iPhone Guide conditions

6. Did you learn new information from your visit?

Participants were asked if they learnt new information as a result from their visit. Figure 7.25 clearly shows that visitors in the GT group were learning more new information than those in the other two groups during their visit. This result validates the CES result

analysis, particularly the CES-KL component. A total of 8.33 % of the participants in the CG did not learn any new information. The use of an iPhone guide has an impact on learning new information as the iPhone guide may provide a good amount of information about the church and its features.

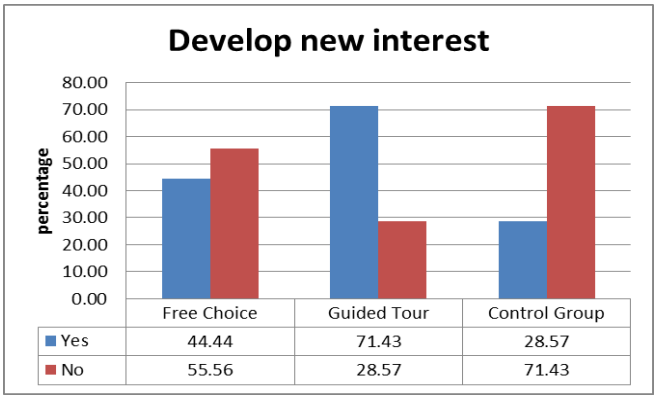


	Very much	To some extent	A bit	Not at all
Control Group	58.33	16.67	16.67	8.33
Free Choice	65.00	15.00	20.00	
Guided Tour	71.43	14.29	14.29	

Figure 7.25. Answer for levels of learning new information between three iPhone Guide conditions

7. *Develop new interest*

Participants were asked whether new interest developed after their visit to the church. Figure 7.26 shows the percentage of participants in each group who said that they had developed a new interest as a result of their visit to the church. Overall, participants in the study agreed that they would develop a new interest as a result of their visit to the historic church, but this response came mainly from participants in GT. Interestingly, most participants in CG thought that they were not developing a new interest as a result of their visit.



	Free Choice	Guided Tour	Control Group
Yes	44.44	71.43	28.57
No	55.56	28.57	71.43

Figure 7.26. Answer for new interests developed after the visit by three iPhone Guide conditions

8. *Spiritual or tourist experience*

Participants were asked if they had a spiritual experience, tourist or both during their visit. Participants in this study did not feel that they had had a spiritual experience on its own, but they did feel that they had had either a tourist experience or both a spiritual and a tourist experience at the same time. Participants in the GT showed a significant number of tourist experience responses but scored less on both the spiritual-and-tourist experience response than those in the FC. The results can be seen in Figure 7.27.

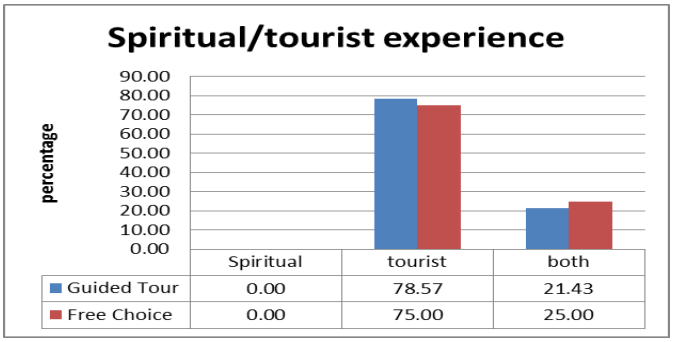


Figure 7.27. Answer for different types of experiences participants with iPhone Guide had during their visit

9. *Emotional engagement*

Participants were asked if they had an emotional engagement during the visit to the church. Figure 7.28 shows the different levels of engagement for participants in each group. It is interesting to see that the participants in this study had varied levels of emotional engagement across three different groups, but that participants with the iPhone guide (GT and FC) were more engaged than the CG. Many participants in CG did not feel that they had had an emotional experience. Clearly the use of the iPhone guide had a major impact on the emotional engagement for the church visitors.

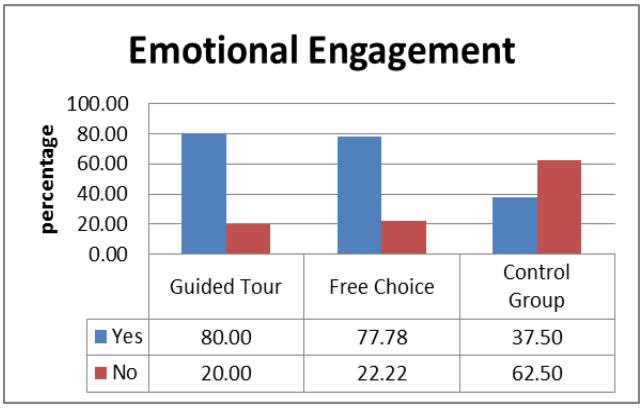


Figure 7.28. Answer on different levels of emotional engagement between three iPhone Guide conditions

10. iPhone: easy to use

Participants with the iPhone Guide were asked if the guide is easy to use. Figure 7.29 shows the scores for ease of use for the iPhone guide between the FC and the GT. Participants in GT were very comfortable when using the iPhone guide because they only followed a navigation in a sequential order. This result follows the same pattern as the Quality of Interaction component of the MMGS.

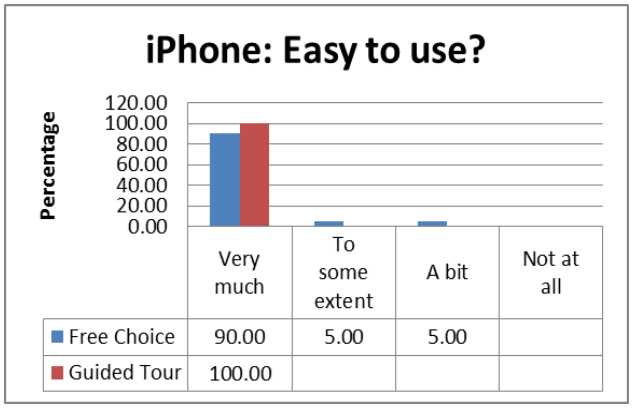


Figure 7.29. Answer for Ease of use for the iPhone Guide (FC and GT groups)

11. iPhone: easy to control

Participants with the iPhone Guide were asked if the guide is easy to control. Figure 7.30 shows whether participants found it easy to control the iPhone guide. Most participants in the FC felt that the iPhone guide was easy to control. Importantly, this result also validates the previous analysis of the MMGS, particularly the Learnability and Control component.

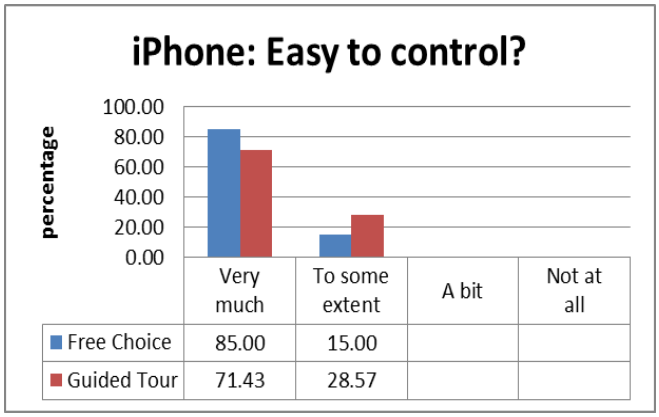


Figure 7.30. Answer for Ease of control of the iPhone Guide (FC and GT groups)

12. Did you have to learn and remember how to use the iPhone guide?

Participants with the iPhone Guide were asked if they have to learn and remember how to use the iPhone guide. Figure 7.31 shows the percentage of participants' views on whether they had to learn and remember the iPhone function to operate the iPhone guide. This result shows that most participants (GT and FC) in this study felt that the iPhone app on the iPhone guide was easy to learn and they did not have to remember any shortcuts or functions to operate it. Clearly the use of an iPhone guide is not a major issue for visitors to cultural spaces. This result is the same as that for the MMGS analysis general usability component.

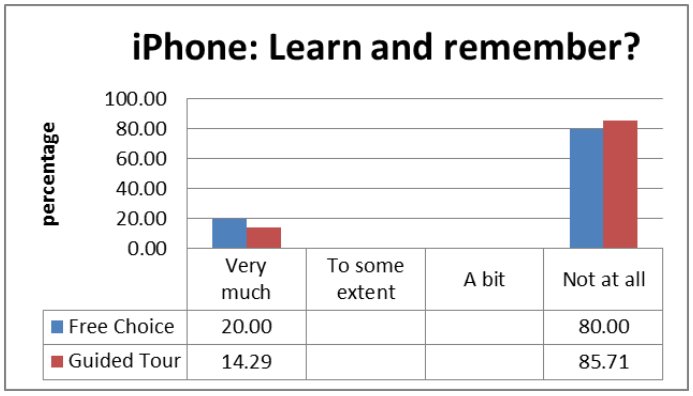


Figure 7.31. Answer for learning and remembering iPhone Guide functions (FC and GT groups)

7.5 Discussion

The study set out to measure the visitor experience in an historic church with an iPhone Guide and to validate two of the measures developed in this research programme to measure that experience, the CES and the MMGS.

7.5.1 Church Experience Scale (CES)

The different components of the CES were successfully used to compare visitors' experiences in an historic church across three different groups (CG, FC and GT) with or without the iPhone guide.

7.5.1.1 Information Overload (CES-IO)

The results clearly show that information overload is the one component that should be explored further. Initially, I had assumed that participants in the FC group would have low scores compared with those in the GT group because they were able to choose points of interest

in the church to suit their own interests. Interestingly, the results show that the mean score for participants in the FC group is 3 out of 5, which is significantly higher than the GT group. However, a previous study has shown that for users to be able to personalise the information according to their interest was considered important because they are able to reduce information overload or redundancy (Oppermann & Specht, 1999).

Even though the results from this study show that introducing an FC tour into cultural spaces, particularly historic churches, can make the visitors in the cultural spaces feel more overwhelmed by the amount of information on the mobile guides, proper guidelines for designing the content of mobile guides in order to reduce information overload could overcome this issue. Katz *et al.* (2006) discussed how to design a mobile guide for an exhibition and further added that the amount of information on the guides should convey the right information and engage visitors with the exhibition as well as the guides. On the other hand, another study focused on designing interfaces for the PDA to reduce information overload when visitors actively use a mobile guide in a museum (Jaên, Mocholî, Esteve, Bosch & Canós, 2005). The importance of designing and presenting the right amount of information to the user in cultural spaces can be clearly seen in the findings of previous research. For example *"the contents of the presentations must be condensed, yet understandable by the greatest possible number of visitors whose interest the museums wishes to capture"* (Kuflik *et al.*, 2011).

In addition, the results show that the scores from the CG were lower than those from the other two groups. Another question arises about whether the information available for the CG is sufficient for visitors, or should they be able to opt to use the mobile guide tour offered by the historic church.

7.5.1.2 Knowledge and Learning (CES-KL)

The results from CES showed that scores on the CES-KL component were significantly higher or more positive for the GT group than the FC or the CG. This clearly shows that the participants in the GT group acquired more knowledge and learned more than those in the other two groups. It is true in this context that when visitors are using a guided tour, they most probably do not know what they might learn throughout their visit, so they will have more knowledge after leaving the church compared with the FC group. It is also clear that participants in the FC group were able to select what to see and how much information they would like to have, thus shaping their own learning experiences. On the other hand, participants in the GT

group learned more because they just followed points of interest given by the mobile guide. Previous analysts have classified visitors into four different groups; Browsers, Followers, Searchers and Researchers (Morris, Hargreaves & McIntyre, 2004). Following this classification, I can describe the participants in this study, particularly in the GT group, as Followers because Followers only follow what has been provided to them and usually will be happy with the use of mobile guides provided by the cultural spaces. Followers are the type of visitors that are *"keen to feel that they have learned something by the end of their visit"* (Morris, Hargreaves & McIntyre, 2004). The amount of knowledge that visitors learned in the FC group was not as much as the visitors in the GT group, but they probably already had more knowledge about specific points of interest/exhibition/exhibits. Cultural spaces such as museums support free-choice learning by providing an avenue for visitors to enforce concrete learning as well as providing them with a meaningful and unique experience that suits their needs or interests (Falk & Dierking, 2000).

It is important to address that I did not control the amount of information given to the participants (FC, GT and CG). The variation of participants with prior knowledge in this study might have some effect on the results. However, from this study, it can be concluded participants' perception of learning for CG (participants with no iPhone guides) have less knowledge than the other two groups (FC or GT). Previous studies have shown that visitors with mobile guides in cultural spaces, for example museums, have more knowledge after the visit (*see* Vavoula *et al.*, 2009; Boehner, Gay & Larkin, 2005; Naismith, Sharples & Ting, 2005). Participants' perception of learning in are less than the GT group, but providing a free-choice tour option is the way that visitors to cultural spaces should follow because they usually have in mind what they want to visit and they have prior knowledge about or interest in some particular exhibit/church features, so providing them with this option will help them. *See*, for example, studies by Vavoula *et al.* (2009), Falk and Storksdieck (2005) and Tsybulskaya and Camhi (2009) about the importance of prior knowledge or 'entrance narratives' when visiting cultural spaces. Doering (1999) acknowledged the importance of entrance narratives and personal experiences, emotions and memories as one of the entrance narrative components (Doering, 1999). McDonald (1992) also discussed how exhibits have 'implicit messages' which lie in visitors' minds before their visit, and museums are able to enforce this knowledge by presenting it in a meaningful way or with the aid of technology (Macdonald, 1992).

The importance of free-choice learning with mobile guides, be it conventional mobile guides on mobile phones or apps on smartphones, can be related to previous research. The focus on information access and richness for museums' mobile guides in the past should be shifted into 'exploration and discovery', where the design of the mobile guide is focused on personal exploration and information discovery, not information retrieval and retention (Wakkary *et al.*, 2009).

7.5.1.3 Immersion (CES-I)

The results from the CES immersion component make me wonder if the use of mobile guides, particularly multimedia guides, in cultural spaces has a big impact on the immersion component. The mean scores show that there was a significant difference (a more positive impact) between the CG and the other two groups (FC and GT). The CG group was more immersed in the church and its features than the FC and GT group. However, previous studies have show that the introduction of mobile guides is more engaging and interesting to the visitors in cultural spaces, particularly information presentation and engagement as well as learning (for example, Vavoula *et al.*, 2009; Boehner, Gay & Larkin, 2005; Naismith, Sharples & Ting, 2005). Furthermore, the differences in level of immersion in this study were significantly high, especially between participants with the iPhone guides. It can be concluded that the sense and level of immersion in the church and its features, or in other places of interest in cultural spaces, vary between visitors and may be influenced by a range of factors such as prior knowledge, motivation, interest, technology, time spent in the exhibit and so on.

It is important for cultural spaces such as historic churches to find ways to enable their visitors to have a sense of immersion during their visit with or without the use of technology. Although the results from this study show that participants in the CG were more immersed than the other two groups, something could be done to ensure that the integration of mobile guide technology could have a sense of flow between the churches' features and the mobile guide. Many would agree that historic churches should be able to detach a visitor's mind from everyday thoughts and to allow time to pass without them knowing as a result of being immersed in the church and its features.

7.5.1.4 Emotional and spiritual experience (CES-ES)

Although it would not be surprising if visitors to an historic church had emotional and/or spiritual experiences, they have generally come to a church as tourists. Most visitors in this study left the church simply as a tourist and only a small percentage left the church with both spiritual and tourist experiences. However, a number of participants remarked that they were surprised how emotional the experience of visiting the church had been. So visitors to cultural spaces such as churches do have emotional experiences even if they are not expecting them, and I should be designing technologies, particularly mobile guides, that do not hinder those experiences.

Clearly, the main objective of cultural spaces is to be places that impart knowledge to their visitors, but this role should be changed and moved from being a place where information is provided and distributed to being a place which is able to integrate various aspects such as a sense of wonder, emotional and spiritual experience, joy and many feelings beyond mere knowledge or an entertaining diversion. Interestingly, the participants in the FC group had more emotional and spiritual experiences than those in the other two groups. Clearly, the ability to choose which church features to see, or the sequences of viewing features/objects during the visit, has an impact on visitors. Participants in the GT had fewer emotional and spiritual experiences as they only followed the one guided tour which was provided, hence they had less emotional connection and spiritual experience. A GPS-based walking route called Rituals that connects religious monuments was developed mainly to give personal (spiritual) and emotional experiences to participants (Van Dijk, Kerstens & Kresin, 2009).

Previous studies (for example, Davis, 1995) have discussed the importance of designing an exhibit or exhibition such that it can capture the emotion, stimulate an emotional response or enable visitors to become emotionally involved with the exhibits. Doering (1999) classified the spiritual experiences that visitors had during their visit into introspective experience, one of four types of satisfying experience in museums.

Falk and Gillespie (2009) found an interesting result about the role of emotions in a free-choice learning environment. They conducted their study in the Science Centre by comparing visitors who visited the *Goose Bump* exhibition and other visitors (control group). They found that the *Goose Bump* exhibition visitors had a significantly higher level of enjoyment (*valence*) than general Science Centre visitors. They further added that there was a significant relationship between emotional arousal and cognition. Importantly, they suggested that "Goose Bump *can not only create*

elevated emotions amongst visitors but that this arousal might result in long-term positive changes in visitors' cognitive attitude and behaviour" (Falk & Gillespie, 2009, p.128). That study showed that a well-designed exhibition has a significant impact on visitors' emotions thus enhancing their experience during their visit. In one of her examples, Casey (2005) explained the importance of designing exhibits that are able to engage visitors. She further wrote *"Holocaust Museum … Engaging viewer through dramaturgical sequences of short narratives … active exhibits … passive exhibits … These staging techniques … emphasizing the emotional rather than intellectual tenor of the place"* (Casey, 2005, p.84).

7.5.1.5 Enjoyment and Intellectual Stimulation/Curiosity (CES-EIS)

The use of a mobile guide in cultural spaces such as historic churches has a big impact on the enjoyment and intellectual stimulation/curiosity of visitors. On the other hand, the difference between participants' enjoyment and intellectual stimulation/curiosity was relatively small in this current study between participants in the FC and the GT. However, mean scores for participants who used the iPhone in this study were higher than for visitors without the guide.

Generally, cultural spaces such as museums, historic churches and art galleries should be able to trigger alternative ways of learning in an informal environment by stimulating the senses, arousing curiosity and promoting curiosity (Clarke *et al.*, 2002). Importantly, this can be achieved by putting carefully designed information onto a mobile guide. As a result, historic churches should be able to find good ways to engage their visitors through intellectual stimulation/curiosity by presenting information on the guide that is able to promote these functions. Previous studies have concluded that the smartphone has the ability to be exploited to present information in meaningful ways and at the same time enhance visitor experiences (Föckler *et al.*, 2005). Zancanaro, Stock and Alfaro (2003) addressed the importance of designing good contents and presenting them in a meaningful way, and suggested that the automatic guide (guided tour) "can reduce the interference with the enjoyment and the learning experience of an exhibit" (Zancanaro, Stock & Alfaro, 2003).

However, Perry (1992) said that there are six components which intrinsically are able to motivate museum experience: curiosity, confidence, challenge, control, play and communication. She also further discussed how to design exhibits that motivate. One of the questions she asked was "how do I pique the visitor's curiosity?" (Perry, 1992). It is important to note that *"After individual curiosity is aroused, the exhibit must engage sustained interest in order for learning to take place … the object one*

finds and the experience one enjoys, while possibly inspiring awe and a sense of discovery, should not feel disconnected from one's own life" (Csikszentmihalyi & Hermanson, 1999, p.153-154). Doering (1999) also added that *"museum visitors engage in active, creative, intellectual and emotional processes that include remembering, imagining and revering objects, taking objects as symbols, and using objects to tell stories to others"* (p.81). Previous studies have found that incorporating challenges or short quizzes is one way of increasing participation or interaction with the mobile guide, and that younger users enjoy it (Naismith & Smith, 2006). Bellotti, Berta, de Gloria and Margarone (2002) also found that enjoyability is related to user age when using a mobile guide tour, as well as highly correlated with the usefulness and quality of the contents of the technology. Hence, there is a need to design mobile guides that are able to instigate visitors' intellectual stimulation or curiosity.

7.5.2 Multimedia Guide Scale (MMGS)

7.5.2.1 General Usability

Cultural institutions are interested in finding ways to significantly attract their visitors to use mobile guides at cultural spaces. One of the problems that has stopped visitors from using these guide is that they have to learn and re-learn how to operate different types of mobile guide for different cultural spaces. This problem can be easily overcome if cultural spaces start to adopt the 'bring your own device' concept by which visitors are able to use their own devices as a mobile guide tour. This reduces the usability issues faced when visitors have to learn and re-learn how to use a new mobile guide. Furthermore, the design and navigation on the mobile guides should be simple enough to accommodate different types of visitor who have different needs, experiences and interests. The use of smartphones or other mobile guides in cultural spaces should improve the user experience with the cultural spaces, be it cognitive, psychomotor, attitude, emotion or other type of experience that such places could offer when visitors are using such mobile guides.

Obviously, the use of these mobile guides in cultural spaces is one of the ways that the cultural spaces can use to significantly improve their visitors' experiences and at the same time level up with other entertainment avenues which are always able to attract more visitors with the technologies which they use. This type of technology (smartphones, apps or mobile guides) offers visitors to cultural spaces new ways of experiencing various aspects of cultural spaces. An evaluation of mobile guides in Tate Modern found that older visitors had difficulties in using the mobile guide compared with the younger visitors (Proctor & Tellis, 2003). That study also found that 45% of the respondents found it difficult to use the mobile guide. This implies that

technologies should be designed to accommodate different types of visitor and interest. Colazzo, Garzotto and Paulinni (2005) identified various issues and problems with mobile guide technology faced by cultural institutions, including the design, interaction, contents and inter-operability. They further discussed how to overcome these usability issues toward designing a good mobile guide for use in places of cultural heritage.

7.5.2.2 Learnability and Control

With the advancement of technology, cultural spaces have begun to adapt every technology that they can get hold of to improve visitors' experience, be it mobile, handheld, display or many other formats. Importantly, these technologies should not become a barrier between the visitors and the exhibits, or distract them from interacting with other visitors and other exhibits. Visitors should be in control of the technology and it should be easy to learn and to operate. Previous studies have found that participants were drawn into the mobile guides and this hindered them from interacting with the exhibits, thus they were losing control of the environment and the technology (Semper & Spasojevic, 2002). They also found that visitors who had no experience with mobile guides or touch screen devices struggled to use the mobile guide, hence the need for designing mobile guides that are easy to learn and control. Furthermore, this problem can be solved by allowing visitors to use/bring their own devices and download the contents of the mobile guides into their own devices. Proctor and Tellis (2003) found that it is important to design the interface or buttons clearly so that users do not miss a prompt or press the wrong button; and importantly to incorporate something that is intuitive in the design.

7.5.2.3 Quality of interaction with the iPhone Guide

Arguably, quality of interaction with a mobile guide is important for users to have a meaningful experience when using such systems in cultural spaces. We can measure user experience (UX) in cultural spaces by looking at the quality of interaction with the mobile guide. Previous studies have shown that it is important for visitors to interact with the mobile guide when viewing the exhibit and to know the amount of information they could learn by using the mobile guide (Semper & Spasojevic, 2002). Improving the quality of interaction between the users and the smartphone/mobile guide in cultural spaces is getting easier with the advancement of technology. Importantly, many research studies have been carried out to ensure that interaction between user and the mobile guide are seamless and natural. For example, the use of a system that employs context-awareness which can eliminate unnecessary information but at the same

time enable the user to retrieve as much information as possible when needed (Schilit, Adam & Want 1994; Aoki & Woodruff, 2000).

7.5.3 Effect on visit length to visitors' experiences in cultural space

The results of the current study show an interesting pattern. First, the use of the iPhone guide significantly increased the time that visitors spent in the church by nearly 50%, from a mean of 13 minutes and 30 seconds to just over 20 minutes. Inevitably, this gives visitors more opportunity to experience the church, to learn about its history and features. This finding aligns with those of previous studies. For example, Kuflik *et al.* (2011) found that the average time which visitors spent in a museum without a mobile guide tour was 4 minutes and 58 seconds, whilst with a mobile guide tour, they spend on average 20 minutes and 41 seconds, and the difference in their learning showed after the visit. Manning and Sims (2004) also found that visitors with mobile guides not only spend more time in an exhibition but showed a significant learning outcome from their visit.

7.6 Conclusions

This study has investigated the use of an iPhone guide in an historic church associated with William Shakespeare on the experience of visitors to the church. The study used the Church Experience Scale (CES) developed to investigate whether technological innovations such as mobile guide tours deployed via a smartphone app enhanced or detracted from the cultural experience provided by a historically and culturally significant church.

The iPhone guide has been proven successful in engaging visitors by extending the time which visitors spent during their visit to this historic church. On the other hand, the results on the visitor experience show that there was no difference between iPhone guide users and non-users in their emotional and spiritual experience of the church. While the use of the iPhone guide did not enhance the experience, neither did it interfere with any emotional or spiritual experience that visitors might have. In the interviews, the great majority of participants said that they were expecting to have a purely tourist experience in the church, and they were not expecting to have any kind of emotional or spiritual experience, even those visitors who felt closely connected with Shakespeare. This study has shown that introducing an iPhone guide in an historic church has interesting effects, both positive and possibly negative, on visitor experience. Developers and deployers of mobile guides in cultural spaces need to be able to measure such effects, to be able to make sensible decisions, for example, on the amount of information to provide to visitors

versus information overload. The Church Experience Scale (CES) based on the earlier Museum Experience Scale (MES) provides a simple yet effective way of measuring these effects.

CHAPTER 8

Conclusions

Technology has become more diverse than one could imagine and understanding how this technology affects users has become important. Technology is being used more and more frequently in museums and other cultural spaces. Mobile guides have now been used in cultural spaces for some decades. Science museums and centres have used interactive displays but technologies are now reaching more traditional cultural spaces such as providing smartphone guides for historic churches. To understand the impact of technologies on the visitor experience of cultural spaces, we need not only to evaluate the user experience with the technology, but also to understand the effect of the technology on the visitor's experience of the cultural spaces.

Generally, this programme of research has sought to understand the use of mobile guide technologies in cultural spaces, particularly the use of the free-choice versus guided tours in developing tour guides and information presentation. This research has explored the use of the free-choice learning concept as opposed to the traditional ways by which information has been

presented on a tour guide (i.e. the guided tour) and how these two approaches have an impact on their users' experiences in cultural spaces.

This chapter briefly summarizes the research programme as a whole and revisits the important findings

Throughout this process, I have conducted five different studies: an initial exploration of methods for studying the effects of mobile technologies in cultural spaces; the development of a Museum Experience Scale (MES) and a Multimedia Guides Scale (MMGS); mobile technology in cultural spaces – a multimedia guide application using an iPhone; the development of a Church Experience Scale (CES); and a comparison of visitors' experiences in an historic church using iPhone guides. Throughout these studies, I have gathered substantial amounts of interesting results to help me understand better these two approaches as well as understanding the users' action and reaction towards the use of mobile guide technology in cultural spaces. In addition, I have also gained a better understanding of different users' behaviour and experiences when using mobile guide technology, especially the difference between the FC group and the GT group.

Although the results from the first study did not yield much understanding of the users' experiences in two different sets of a virtual museum (FC and GT), it did present a good opportunity to further explore this area. I reflected on what went wrong with the procedures or measurements to better equip me for the next study.

Subsequently, I successfully developed a simple way to measure users' experience in cultural spaces, particularly in a museum, in the second study. In this study, I developed the MES which provide ways of measuring visitor experience and the MMGS to measure vistiors' experience with mobile guide or other technology. This study was a good start for me to explore further the visitors' experiences in cultural spaces, especially the differences between the FC and GT experiences with the use of mobile guide technologies. This study also provided me with a better understanding of users' experiences in cultural spaces, particularly museums, and what the effects are of using mobile guides for the visitors. In addition, I was able to acquire initial results to understand the interaction between the visitors and the guides.

The results of Study 2 gave me a direction for what I should do next. As a result, I devised a pilot study (Study 3) to design and develop a web-app that could be used in the main study to compare two different guide conditions (FC and GT). I developed two different designs of the web-app to be used with an iPhone. I used the scales developed in Study 2 to evaluate the differences between two groups of participants who experienced the two versions of the web-app. Although the study was conducted in the Interaction Laboratory in the Department of Computer Science at the University of York, it was designed such that it had the same features as a museum exhibition (except for the real artefacts). The results from this study showed very interesting findings from these two groups when using the web-app and told me what to expect in the main study (a large-scale evaluation in a real cultural space).

When I was ready to start to plan the main study with museums, there were unforeseen circumstances that stopped me from pursuing the main study with the museums. After months of searching for another venue, I was approached by the Centre of Christianity and Culture at the University of York to evaluate their iPhone app developed for Holy Trinity Church in Stratford-upon-Avon. I then revised my MES and decided to run another study to create a scale for measuring visitors' experiences in churches, particularly historic churches. So the CES was formulated in Study 4 after successfully gathering data from three different churches (active and inactive churches) in York.

The main study (Study 5) was formulated from the outcomes of the previous studies and was conducted at Holy Trinity Church in Stratford-upon-Avon and proved to be successful in measuring visitors' experiences from different groups (FC, GT and CG) using the mobile guide (an iPhone guide).

In brief, these are the important results from the research that have been found:

1. The design and development of contents (for example, text, images, navigations and information presentation) for FC and GT tours are important (*see* Chapter 3 for details).
2. The development of the Museum Experience Scale (MES) and the Multimedia Guide Scale (MMGS), *see* Chapter 4 for details.
3. The development of the Church Experience Scale (CES) as described in detail in Chapter 6.

4. Engagement is a major factor in comparing visitors' experiences with a mobile guide or without (*see* Chapter 4 for details).
5. Gender and native speaker status do not have a significant impact on visitors' experiences in the museum as a whole (*see* Chapter 4 for details), but there was a significant difference between the native-speaker group who used the FC and the non-native speaker group who use the GT *see* Chapter 5 for details).
6. There was no effect on different groups of participants in terms of gender with the mobile guides (*see* Chapter 7 for details).
7. GT users had better learnability and control as well as general usability of the mobile guides using a iPhone app/web app (*see* Chapters 5 and 7 for details).
8. FC users had a better quality of interaction with the mobile guides (*see* Chapters 5 and 7 for details).
9. There was a significant difference between three groups of participants (FC, GT and CG) but in depth analysis using a post-hoc test showed that the difference was only between CG and GT (*see* Chapter 7 for details).

8.1 Research Questions

The following research questions were asked at the beginning of the research programme and I shall address now what has been done to answer these questions.

8.1.1 Research Question 1:

What are the main features of visitors' experience in cultural spaces?

The studies have successfully developed appropriate scales in the Museum Experience Scale (MES) and the Church Experience Scale CES) which are able to measure the main features of visitors' experiences in cultural spaces. The components identified in each of these scales are important in evaluating how the mobile guides used in cultural spaces are able to enhance visitors' experiences. I found that visitors' experiences in a museum are linked to these components of MES:

- ***Engagement*** with exhibitions or exhibits;
- ***Knowledge/Learning*** gained from understanding and information discoveries;
- ***Meaningful Experiences*** from the interaction with the exhibitions/exhibits or other visitors;
- ***Emotional Connection*** with the contexts and contents of the exhibits/exhibitions.

On the other hand, I also found that visitors' experiences in historic churches can be described as follows:

- ***Emotional Connection and Spiritual Experiences*** with the church and its features;
- ***Knowledge and Learning*** gained from understanding and information discoveries;
- ***Enjoyment, Intellectual Stimulation and Curiosity*** from the interaction with the church and its features;
- ***Immersion*** in the church and its features;
- ***Information Overload*** with the amount of information about the church.

I had to establish two different scales for both museums and historic churches because the natures of these cultural spaces are not the same, although they do share some features or have the same presumed aim of providing a meaningful experience to their visitors using various techniques.

8.1.2 Research Question 2:

What are the main features of visitors' experience in cultural spaces with mobile guides?

Some of the features that support visitors' experience in cultural spaces discovered from this study are:

1. ***General usability*** of the mobile guide, whether the functionality is appropriate, whether it was helpful;
2. ***Learnability and control****,* whether the guide was easy to learn to use and whether the user felt in control;
3. ***Interaction with the guide***, how the interaction and feedback given by the guide to the users' action can shape their learning curve;
4. ***Information provided*** on the guide, whether the amount of information provided is sufficient and appropriate for different types of visitor.

Furthermore, it cannot be concluded which components of the MMGS played major roles in shaping visitors' experiences between these two groups (FC tour and GT) because the differences are dependent on the individual components. Arguably, the major differences in visitors' experience in cultural spaces between FC visitors and GT visitors lie in the visitors themselves. The tour guides (either FC or GT) act as a mechanism or an aid to the user to better understand the subject matter (for example, museum exhibits, exhibitions, church features, and many more). The mobile guides offer visitors different ways of experiencing cultural spaces, but what makes them different are motivation, previous knowledge and time spent, as well as other factors that may influence the interaction between visitors and the mobile guides, as well as with the exhibits/exhibition.

Interestingly, the results from Studies 3 and 5 were consistent. For example, the quality of interaction is the only component in which the FC group felt a positive impact as opposed to the other group, whilst the other two components showed different results. On the other hand, the

results from both studies show that the GT visitors had a better understanding of the general usability of the mobile guide (for example, how to navigate using the guide, or the ease of use); and to control the mobile guide as well as learn about the mobile guide and the information presented (for example, visitors were able to be in control of the mobile guide and felt that the information was presented in a meaningful way and was easy to understand). Practically, this is true because visitors in the GT have to follow the tour in strict sequence, which helps them to understand the control of the mobile guide better, and the learning curve is slightly more straightforward compared with the FC visitors.

8.1.3 Research Question 3:

How did the usability of the mobile guide affect visitors' experience in cultural spaces?

It is important to note that the use of a mobile guide in a cultural space should help the users to learn more about the exhibits and at the same time give a meaningful experience to the users. This research programme has clearly shown that the usability aspects of mobile guides which affected visitors' experience in cultural spaces are:

1. ***Ease of use*** of the mobile guide;
2. ***Ease of control***, or the level at which users are in control of the guide;
3. ***Easy to learn and remember functions*** of the mobile guides, thus avoiding the users having to remember different functions to operate the mobile guides, which could affect their experience of their visit.

8.1.4 Research Question 4:

What are the implications of the use of mobile guides on visitors' experience in cultural spaces?

It has been clearly shown from this programme of research that the use of mobile guide technology in cultural spaces gives a significant impact to both the cultural spaces and their visitors. Generally, the results from Study 2 (measuring visitors' experiences in a museum: the development of the MES and the MMGS) clearly show that the means from visitors with mobile guides were higher (more positive) than those from visitors without a mobile guides in the museum. Thus, the introduction of mobile guides into cultural spaces gives a positive impact to

the visitors' experiences. The participants in Study 2 were more actively engaged (with the exhibition/exhibits or the mobile guides) than the visitors without the mobile guides. Although the other three components of the MES did not show a significant difference, the use of mobile guides did not distract visitors from having an emotional connection with the exhibits and the exhibition or from gaining new knowledge/learning new things about the exhibits/exhibitions. The most important thing is that the use of mobile guides did not prohibit the visitors from having a meaningful interaction with the exhibition/exhibits or with other visitors. In addition, participants with the mobile guides spent significantly more time on their visit than visitors without the mobile guides (*see* Study 5 for more details). Furthermore, the results from Study 5 also show a significant difference between visitors with the mobile guides and visitors without the mobile guides over the knowledge and learning components. This shows that the mobile guides effectively addressed visitors' cognitive and intellectual needs. However, there was a price to pay for this increased learning and knowledge: the participants who used the mobile guide experienced greater information overload.

8.1.5 Research Questions 5:

What are the implications of the use of guided tour or free-choice mobile guides in cultural spaces for the visitors' learning?

The results from Study 5 (comparing the visitors' experiences in an historic church using iPhone guides) show that the use of mobile guide technology in cultural spaces (in this case an historic church) had a substantial impact on the visitors, particularly in the knowledge and learning component. Visitors in both groups (FC and GT) gained more knowledge than visitors who did not use the guide (CG). Visitors in these two groups gained knowledge by their own information discoveries as well as by understanding what had been provided to them through the iPhone guide.

It was interesting that the participants who used the iPhone guide produced higher scores on the Enjoyment, Intellectual Stimulation and Curiosity component (CES-EIS), although the difference from participants who did not use an iPhone guide was very small. There was a much larger difference on the Knowledge/Learning (CES-KL) component. Both of these differences show that the iPhone guide effectively addressed visitors' cognitive and intellectual needs. However, again there was a price to pay for this increased intellectual stimulation and consequent enjoyment, learning and knowledge. The participants who used the iPhone guide experienced

more information overload and less immersion. The latter effect may also have been because the participants were concentrating on the information on the iPhone guide and not looking at the church and its features quite as closely or as much as those who did not use the iPhone guide.

8.2 Comparison with previous research: highlights

This study has successfully achieved its aim of measuring visitors' experiences in cultural spaces with or without mobile guides. The outcome from this study will complement previous studies made by other researchers.

I have summarized that visitors' experiences in cultural spaces can be best described using the CES (for visitors to historic churches), the MES (for museum visitors) and the MMGS (for visitors to cultural spaces who use mobile guides during their visit). The CES has five main components:

1. ***Emotional Connection and Spiritual Experiences*** with the church and its features;
2. ***Knowledge and Learning*** gained from understanding and information discoveries;
3. ***Enjoyment, Intellectual Stimulation and Curiosity*** from the interaction with the church and its features;
4. ***Immersion*** in the church and its features;
5. ***Information overload*** with the amount of information about the church.

The MES has four main components:

1. ***Engagement*** with exhibitions or exhibits;
2. ***Knowledge/Learning*** gained from understanding and information discoveries;
3. ***Meaningful Experiences*** from the interaction with the exhibitions/exhibits or other visitors;
4. ***Emotional Connection*** with the contexts and contents of the exhibits/exhibitions.

MMGS components:

1. ***General Usability*** of the multimedia or audioguide, whether the functionality is appropriate, whether it was helpful;
2. ***Learnability and Control,*** whether the guide was easy to learn to use and whether the user felt in control;
3. ***Interaction with the guide***, how the interaction and feedback given by the guide to the users' action can shape their learning curve;

4. ***Information provided*** on the guide, whether the amount of information provided is sufficient and appropriate for different types of visitor.

The main difference between this study and Pallud & Monod (2010) is the technologies used in the research. For example, this study focuses on the mobile guide, whilst Pallud & Monod (2010) include several technologies available in museum such as audio guides, interactive kiosks, computers, etc. It is not clear that their framework could be extended to measure visitors' experiences with mobile guides.

The experiences described by Pekarik, Doerings and Karns (1999) in their study are from their extensive data collection by conducting in-depth interviews, surveys and comments from visitors about the museum. On the other hand, Packer (2008) explored visitors' experience in museums which were not related to learning outcomes, but proposed three levels of visitors' experiences: the attribute of the settings that visitors valued; the experience that they gained; and the benefits that they derived from the visit.

It is important to highlight that some of the previous studies on visitors' experiences in cultural spaces does not focus on the technology but the visitors' experience in general (for example, Packer, 2008; Doerings, 1999; Pekarik, Doerings & Karns, 1999).

8.3 Future Work

Future work in this field could explore visitor experience in a number of other historic churches which have different resonances from Holy Trinity Church in Stratford-upon-Avon. Because of its connection with Shakespeare, Holy Trinity is perhaps seen by visitors as being of particular historic importance. Another church that has a significant history and could be pursued in the future is Coventry Cathedral, which has a much more emotional and spiritual resonance for visitors, because of its connection with the bombing during World War and many visitors will have first-hand experience of the loss of life and the fear which this created, which is felt more strongly than it is in a church with a historical connection to events of several centuries ago.

This study has been about investigating visitors' experiences in churches, spiritual spaces for Christians and with particular resonances for those living in traditionally Christian countries, even if they are not themselves Christian. Of course, there are places of cultural, historic and spiritual importance for other religions and belief structures, from Buddhism to Zoroastrianism.

I believe that the Church Experience Scale (CES), in spite of its name, would be appropriate for measuring visitor experience in any place of religious and spiritual significance, and I would welcome the opportunity to test this hypothesis.

I would also be interested in conducting a follow up research using MES in real settings as I did not had a chance to test the MES in real settings of use. In addition, I would like to conduct another study with MMGS that explore the effect of using mobile guides in real situations.

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Appendix A

Study 1: Questionnaire

Introduction

Thank you for agreeing to take part in our study.

The purpose of distributing this questionnaire is to obtain your view on the virtual museum. This virtual museum is specially designed for the purpose of gathering your value comments about their information presentations, layout, design, and other comments that related to learning about museum exhibitions using virtual museum website. The information given will be used for academic purposes only and will be treated as confidential. As this research is a part of PhD study, we value every comment and information you have provided and your co-operation are greatly appreciated. If you have any queries do not hesitate to ask us.

As a respondent of this study, we would like you to follow the instructions below before you begin.

1. Please browse the website given by clicking on the link or navigation button provided.
2. There is no right way of doing the navigation and browsing, please do the usual way you browse the web.
3. You should gather as much as information you can about the museum exhibitions on this web because you will be asked about the contents of the website.
4. Please answer the questionnaires given after you have done the browsing and navigating the website.
5. This questionnaire is divided into three sections, namely Section A, questions to gather information about your experiences with this website and Section B to get your general opinion/views about museum or galleries and Section C to gain your demographic information.

Section A: Questions about your experience with the museum website

1. I felt engaged with the website

Strongly Disagree Disagree Neutral Agree Strongly Agree

2. The website held my attention

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. I found it is easy to navigate the website

Strongly Disagree Disagree Neutral Agree Strongly Agree

4. The page layout was consistent throughout the website

Strongly Disagree Disagree Neutral Agree Strongly Agree

5. The graphics on the website were boring

Strongly Disagree Disagree Neutral Agree Strongly Agree

6. I enjoyed the layout of the website

Strongly Disagree Disagree Neutral Agree Strongly Agree

7. There was too much text on each page of the website

Strongly Disagree Disagree Neutral Agree Strongly Agree

8. I got bored with the contents of the website

Strongly Disagree Disagree Neutral Agree Strongly Agree

9. The information about the museum exhibits on the website was clear

Strongly Disagree Disagree Neutral Agree Strongly Agree

10. I was overwhelmed by the amount of information on the website

Strongly Disagree Disagree Neutral Agree Strongly Agree

11. The website provided me with intellectual stimulation about the exhibits

Strongly Disagree Disagree Neutral Agree Strongly Agree

12. Having looked at the website, I was still interested to know more about the exhibits

Strongly Disagree Disagree Neutral Agree Strongly Agree

13. The design of the website motivated me to learn about the exhibits

Strongly Disagree Disagree Neutral Agree Strongly Agree

14. I felt I was able to learn independently about the exhibits from the website

Strongly Disagree Disagree Neutral Agree Strongly Agree

15. What was the most memorable aspect of using the website?

---

16. What was the worst aspect of using the website?

---

17. What would you change about the website?

Section B:

18. Have you visited any museums/art galleries/heritage sites (country houses, cathedrals, monuments etc) in the last year? Yes [ ] No [ ]

    a. If yes, approximately how many such sites have you visited in the last year?

    ---

    b. If yes, which museum/art gallery/heritage site made the most impression on you?

    ---

19. What kinds of things do you find most interesting when visiting museums/art galleries/heritage sites?

---

20. Do you ever use the audio/multimedia guides provided by museums/art galleries/heritage sites? Yes [ ] No [ ]

    a. If yes, can you remember an audio guide that you thought was particularly interesting? What was it that made it so interesting?

---

b. If yes, what do you like about these guides?

---

c. If no, why are not interested in these guides?

SECTION C: Demographic

21. Your age: ----------

22. Your gender: ----------

23. Occupation: ----------

Appendix B

Study 1: Informed Consent Form

Initial exploration of methods for studying the effects of mobile technologies in cultural spaces

[Introduction to the project: The purpose of distributing this questionnaire is to obtain your view on the virtual museum. This virtual museum is specially designed for the purpose of gathering your value comments about their information presentations, layout, design, and other comments that related to learning about museum exhibitions using virtual museum website. The information given will be used for academic purposes only and will be treated as confidential. As this research is a part of PhD study, we value every comment and information you have provided and your co-operation are greatly appreciated].

Before you participate in this study, please complete Section A, printing your name in the first space and then sign at the end. Once the study is over and you have been debriefed, you will be asked to initial the three statements in Section B, to indicate your agreement.

Section A

I, _____, voluntarily give my consent to participate in this study for the Cultural Spaces: Examine Free Choice Learning with Technology Integrations in Museums Project. I have been informed about, and feel that I understand the basic nature of the project. I understand that I may withdraw from the interview/focus group at any time without prejudice. I also understand that my information is confidential.
Only Mohd Kamal Othman and Prof Helen Petrie will have access to the data collected today in its original format and it will only be shared with other project members in an anonymous format.

_____ _____

Signature of Research Participant Date

Section B

Please initial each of the following statements when the study has been completed and you have been debriefed.

I have been adequately debriefed	Your initials:
I was not forced to complete the study.	Your initials:
All my questions have been answered	Your initials:

Appendix C

Study 1: Instructions

Introduction

Thank you for agreeing to take part in our study.

The purpose of distributing this questionnaire is to obtain your view on the virtual museum. This virtual museum is specially designed for the purpose of gathering your value comments about their information presentations, layout, design, and other comments that related to learning about museum exhibitions using virtual museum website. The information given will be used for academic purposes only and will be treated as confidential. As this research is a part of PhD study, we value every comment and information you have provided and your co-operation are greatly appreciated. If you have any queries do not hesitate to ask us.

As a participant of this study, we would like you to follow the instructions below before you begin.

1. Please browse the website given by clicking on the link or navigation button provided.
2. There is no right way of doing the navigation and browsing, please do the usual way you browse the web.
3. You should gather as much as information you can about the museum exhibitions on this web because you will be asked about the contents of the website.
4. Please answer the questionnaires given after you have done the browsing and navigating the website.
5. This questionnaire is divided into three sections, namely Section A, a short quiz about the contents of the website, Section B to gather information about your experiences with this website and Section C to get your general opinion/views about museum or galleries.

Appendix D

Study 1: Qualitative Data for the Study

Participant number 1:

Q15: Simple, almost linear design

Q16: Some frustration about not being able to go further. i.e when saw interesting pictures and not able to click on it and find out more.

Q17: Make more interactivity. Make it more linked, better or bigger images.

Q18: YES.

a. 6 times
b. Byland Abbey

Q19: A sense of history: what it must have been like in its time

Q20: YES

a. The Vatican
b. The guide gave (easy) access to deeper information I would not otherwise have accessed.
c. –

Q21: 53

Q22: Male

Q23: Lecturer

Participant number 2:

Q15: The layout and font was very good

Q16: Toolbar was not fixed.

Q17: Introduced navigation on the left hand.

Q18: YES.

a. 3 times
b. Natural History Museum

Q19: paintings

Q20: NO

c. it takes more time to read and look etc

Q21: 29

Q22: Female

Q23: Lab Technician

Participant number 3:

Q15: Being able to see the pictures of the museum objects

Q16: There was at some extend difficult to know whether the content had or not more pages.

Q17: I would show the museum itself, the pictures of it.

Q18: YES.

a. 10 times
b. British Museum

Q19: The gallery that have visual impact on visitors. Put them to interact with history

Q20: YES

a. Sigmund Freud Museum in Vienna Austria as explained his life based on the pictures and the rooms of his original house
b. They can tell you interesting facts. You always learn something different from them.
c. –

Q21: 31

Q22: Female

Q23: MA student

Participant number 4:

Q15: It was very clear, both graphical and textual and very easy to navigate

Q16: text was quite large, Figures were without detail. The buttons took too much space. Button at top should have remained frozen while you read through so you don't have to scroll back to the top to navigate to other pages.

Q17: The button at the top would remain frozen. Text would be smaller. Some contact info, timing and fares.

Q18: YES.

a. 5-6 times
b. British museum

Q19: the main themes covered by them (i.e. Egyptian, medieval ages, Islamic art, oriental, etc)

Q20: YES

a. Dot remember
b. -

c. –

Q21: 35

Q22: Male

Q23: PhD student

Participant number 5:

Q15: able to learn about wars, hunting, etc

Q16: Next button sometimes hidden. You have to scroll down to see them.

Q17: add search facility by text and date (year). More navigation button to the top.

Q18: NO.

Q19: history

Q20: YES

a. York minster, it described about exhibition in a interesting manner.

b. -

c. –

Q21: 36

Q22: Male

Q23: Senior software developer

Participant number 6:

Q15: Reading in depth more about the history from different country around the globe

Q16: It was a lot of information to take in for a short time scale. I would like longer time to research more.

Q17: I can't think of anything to change. I was pleased with the clear layout and well presented images

Q18: YES.

a. 1 times

Q19: Pottery painting artists by Alan Turner

Q20: YES

a. It was easy to understand the artefacts and take note at a slow pace

Q21: 25

Q22: Male

Q23: Sales assistant

Participant number 7:

Q15: clear, easy use, very useful and important information and images

Q16: none.

Q17: maybe add little more images.

Q18: NO.

Q19: History, old item's age

Q20: NO

c. never had interest in it. Nothing ever caught my attention

Q21: 32

Q22: Male

Q23: Aux Nurse

Participant number 8:

Q15: History

Q16: information about exhibition and tournament gallery were happened.

Q17: divide the long text paragraphs in different sub sections, like different part of the museum. Better quality and size of the graphics in relation to text

Q18: YES.

a. 6 times
b. Durham (minster), castle museum york

Q19: jewellery, crokery of specific eras

Q20: NO

Q21: 29

Q22: Female

Q23: Student

Participant number 9:

Q15: the pieces on display although they could have put more pictures from various angles.

Q16: there was very little detail about the objects.

Q17: More details about the objects. More pictures from different angles to give a better feel of the objects on display

Q18: YES.

a. More than 10
b. Museum in Prague, knaresborough

Q19: almost everything that is on display although I am not really intrigued by reptiles, a lot of geological rocks

Q20: YES

a. The Whitby abbey audio guide. It was nicely told in a very easy and comprehendible way.
b. The enactment of the characters that were being talked about. The only problem was the device had to be held to the ear which made it a little cumbersome
c. –

Q21: 24

Q22: Female

Q23: Student

Participant number 10:

Q15: the picture were big banner that were somewhat distracting

Q16: lacks of links to the texts to take me more information on artefacts

Q17: more links leading to info about artefacts.

Q18: YES.

a. 8 times
b. Experiment music seattle

Q19: Interactive exhibits where I can experience how to use objects

Q20: YES

a. The one at Riveaux Abbey had scenes that played at each site that helped build atmosphere
b. The can provide more info than is on players
c. –

Q21: 33

Q22: Male

Q23: Lecturer

Participant number 11:

Q15: the way the website was navigated

Q16: the unclear photos.

Q17: the images, better to see them in a large size.

Q18: YES.

a. 1 times
b. All- gallery, history, modern, etc

Q19: the galleries, history, story

Q20: NO

Q21: 22

Q22: Female

Q23: Undergraduate student

Participant number 12:

Q15: Easy to navigate

Q16: pages were boring, wanted something more interactive.

Q17: more colours, pictures. Would make it more accessible to a range of audiences

Q18: YES.

a. 3-4 times
b. Fountain Abbey

Q19: interactive images- I don't like to be lectured, I want to be engaged

Q20: YES

a. The V&A museum in London. Videos on different countries and cultures
b. Made exhibits more accessible. Find learning audibly easier than large texts
c. –

Q21: 23

Q22: female

Q23: Teaching assistant

Study 2: Table of Possible Questions for Engagement with Museums Questionnaire (Initial Pool)

Question	Source	Measures
1. I felt engaged with the museum exhibition		Engagement directly
2. The museum exhibition held my attention	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q1)	Measures attention directly
3. I felt focused on the exhibition	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q2)	Measures attention
4. I prefer text-based to graphics-based supporting material at museum exhibitions	From MLA GLO document	Measures Enjoyment, Creativity & Inspiration in GLO How does this measure enjoyment, creativity and inspiration?
5. I found it was easy to move around the exhibition	From MLA GLO document	Measures Action & Behaviour in GLO
6. There was too much text associated with the artefacts in the exhibition	From MLA GLO document	Measures Enjoyment, Creativity & Inspiration in GLO How does this measure enjoyment, creativity and inspiration?
7. The graphics associated with the artefacts were boring	From MLA GLO document	Measures attitudes & Values in GLO
8. I prefer graphical (images or pictures) materials to explain artefacts in an exhbition	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q9)	Measures attitudes & Values in GLO

9. I enjoyed my experience at the museum	From MLA GLO document	Measures Enjoyment & Inspiration in GLO
10. The contents on displays clearly explain the information about museum exhibits	From MLA GLO document	Measures knowledge & understanding in GLO
11. I got bored with the design of the exhibition	From MLA GLO document	Measures attitudes & Values in GLO
12. The information provided about artefacts in the exhibition was clear	From MLA GLO document	Measures knowledge & understanding in GLO
13. I was overwhelmed by the amount of information provided for the exhibition	From MLA GLO document	Measures knowledge & understanding in GLO
14. After visiting the exhibition, I was still interested to know more about the topic of the exhibition	From MLA GLO document	Measures knowledge & understanding in GLO
15. The exhibition was intellectually stimulating	From MLA GLO document	Measures knowledge & understanding in GLO
16. The design of the exhibitions motivated me to learn about the exhibits	From MLA GLO document	Measures attitudes & Values in GLO
17. My museum visit aroused my curiosity and interest	From MLA GLO document	Measures Enjoyment & Inspiration in GLO
18. I would prefer using the audio/multimedia guides provided		Measures skills in GLO
19. The audio/multimedia guides provided were complicated to use	From MLA GLO document	Measures skills in GLO
20. The information given by the audioguide was too lengthy	From MLA GLO document	Measures Enjoyment & Inspiration in GLO
21. I would prefer moving around exhibitions without any audio/multimedia guides	From MLA GLO document	Measures Action & Behavior in GLO
22. I was annoyed with the way	From MLA GLO document	Measures Enjoyment &

information were presented on audio/multimedia		Inspiration in GLO
23. I like to move around freely in an exhibition without having to follow a specific sequences	From MLA GLO document	Measures Action & Behavior in GLO
24. I did not feel any emotional attachment to the exhibition.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q2)	Measures emotions
25. I was interested in seeing how the game's events would progress.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q3)	
26. It did not interest me to know what would happen next in the game.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q4)	
27. I did not find myself to become so caught up with the game that I wanted to speak to directly to the game.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q8)	
28. I sometimes found myself to become so involved with the game that I wanted to speak to the game directly.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q7)	
29. I did not like the graphics and imagery associated with the exhibition.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q10)	
30. I enjoyed visiting the exhibition.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q11)	
31. Visiting the exhbition was not fun.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire	

	(App A/Q12)	
32. The controls of the audioguide were not easy to use.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q13)	Measures skills, usability
33. The controls of the audioguide were difficult to understand.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q14)	Measures skills, usability
34. I became unaware that I was even using any controls on the audioguide	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q15)	Measures flow, immersion
35. The audio/multimedia guides' controls were not invisible to me.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q16)	Measures Behaviors
36. I felt myself to be directly travelling through the game according to my own volition.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q17)	
37. I did not feel as if I was moving through the game according to my own will.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q18)	
38. It was as if I could interact with the world of the game as if I was in the real world.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q19)	
39. Interacting with the world of the game did not feel as real to me as it would be in the real world	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q20)	
40. I was unaware of what was happening around me.	Adapted from Jennett *et al.*, (2008) immersion in games	

	questionnaire (App A/Q21)	
41. I was aware of surroundings.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q22)	
42. I felt detached from the outside world.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q23)	
43. I still felt attached to the real world.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q24)	
44. At the time the game was my only concern.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q25)	
45. Everyday thoughts and concerns were still very much on my mind.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q26)	
46. I did not feel the urge at any point to stop playing and see what was going on around me.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q27)	
47. I was interested to know what might be happening around me.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q28)	
48. I did not feel like I was in the real world but the game world.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q29)	
49. I still felt as if I was in the real world whilst playing.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire	

	(App A/Q30)	
50. To me it felt like only a very short amount of time had passed.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q31)	
51. When playing the game time appeared to go by very slowly.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q32)	
52. How immersed did you feel?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q33)	
53. How much effort did you put into playing the game?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q3)	
54. Did you feel that you were trying you best?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q4)	
55. To what extent did you lose track of time?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q5)	
56. To what extent did you feel consciously aware of being in the real world whilst playing?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q6)	
57. To what extent did you forget about your everyday concerns?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q7)	
58. To what extent were you aware of yourself in your surroundings?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q8)	

59. To what extent did you notice events taking place around you?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q9)	
60. Did you feel the urge at any point to stop playing and see what was happening around you?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q10)	
61. To what extent did you feel that you were interacting with the game environment?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q11)	
62. To what extent did you feel as though you were separated from your real-world environment?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q12)	
63. To what extent did you feel that the game was something you were experiencing, rather than something you were just doing?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q13)	
64. To what extent was your sense of being in the game environment stronger than your sense of being in the real world?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q14)	
65. At any point did you find yourself become so involved that you were unaware you were even using controls?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q15)	
66. To what extent did you feel as though you were moving through the game according to you own will?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q16)	
67. To what extent did you find the audio/multimedia guides challenging?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire	Measures Skills

	(App B/Q17)	
68. Were there any times during the game in which you just wanted to give up?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q18)	
69. To what extent did you feel motivated while playing?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q19)	
70. To what extent did you find the audio/multimedia guides easy to use?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q20)	Measures Skills
71. To what extent did you feel like you were making progress towards the end of the game?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q21)	
72. How well do you think you performed in the game?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q22)	
73. To what extent did you feel emotionally attached to the game?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q23)	
74. To what extent were you interested in seeing how the game's events would progress?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q24)	
75. How much did you want to "win" the game?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q25)	
76. Were you in suspense about whether or not you would win or lose the game?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q26)	

77. At any point did you find yourself become so involved that you wanted to speak to the game directly?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q27)	
78. To what extent did you enjoy the graphics and the imagery?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q28)	Measures Enjoyment & Inspiration
79. How much would you say you enjoyed playing the game?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q29)	Measures Enjoyment & Inspiration
80. When interrupted, were you disappointed that the game was over?	Adapted from J Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q30)	
81. Would you like to use the audio/multimedia tours guide again?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q31)	Measures Enjoyment & Inspiration
82. My visit was very interesting	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Enjoyment, Creativity & Inspiration
83. My visit was inspiring!	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Enjoyment, Creativity & Inspiration
84. I discovered some new information about exhibits	Adapted from MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures knowledge & understanding in GLO
85. I learned how to do use audio/multimedia guides	Adapted from MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Skills
86. I learnt some things that made me change my mind	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Attitudes & Values
87. My feelings and emotions were engaged	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Attitudes & Values
88. Some things were hard to	MLA website- Generic Learning	Measures knowledge &

understand	Outcomes (GLO) Exit Survey	understanding in GLO
89. The audio/multimedia guides were disappointing	Adapted from MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Attitudes & Values
90. I felt that I learnt some new information about artefacts in museums	Adapted from MLA website- question Bank	Measures knowledge & understanding in GLO
91. I have developed an increased interest in something I knew little about before coming here	MLA website- question Bank	Measures knowledge & understanding in GLO
92. I could make sense of most of the things we saw and did at the museum / archive / library	MLA website- question Bank	Measures knowledge & understanding in GLO
93. I have gained knowledge that I can use or have used in my work as a result of my visit(s) here	MLA website- question Bank	Measures knowledge & understanding in GLO
94. Museums / archives / libraries are more interesting than I thought	MLA website- question Bank	Measures Attitudes & Values
95. I've left the museum/archive/library more interested in the subject/theme than when I came	MLA website- question Bank	Measures Attitudes & Values
96. I have developed a new interest during my visit(s) here	MLA website- question Bank	Measures Action, Behaviour and Progression
97. I can use the knowledge I learnt here when I visit other similar places	MLA website- question Bank	Measures Action, Behaviour and Progression
98. I intend to come again	MLA website- question Bank	Measures Action, Behaviour and Progression

99. I achieved my intentions	MLA website- question Bank	Measures Action, Behaviour and Progression
100. I am thinking about starting some training or a college course as a result of my experience here	MLA website- question Bank	Measures Action, Behaviour and Progression
101. Visiting has given me lots of ideas for things I could do	MLA website- question Bank	Measures Action, Behaviour and Progression
102. The visit has made me want to find out more	MLA website- question Bank	Measures Action, Behaviour and Progression
103. I am planning to join a special interest group as a result of my experience here	MLA website- question Bank	Measures Action, Behaviour and Progression
104. Using the handheld device does not require much training.	Naismith and Smith questionnaires items (statement a)	Measures usability
105. It was easy at a glance to see what the options were for each screen.	Naismith and Smith questionnaires items (statement b)	Measures usability
106. It was difficult to select the option I wanted with the touch screen.	Naismith and Smith questionnaires items (statement c)	Measures satisfaction
107. I felt that I was in control of the device.	Naismith and Smith questionnaires items (statement d)	Measures satisfaction
108. The device responded too slowly.	Naismith and Smith questionnaires items (statement e)	Measures usability
109. I found it difficult to read the text on the screen.	Naismith and Smith questionnaires items (statement f)	Measures usability
110. The device helped me to navigate around the museum.	Naismith and Smith questionnaires items (statement g)	Measures efficiency, satisfaction
111. I felt self conscious using the device.	Naismith and Smith questionnaires items	Measures satisfaction

	(statement h)	
112.The way that the device presented information was clear and understandable.	Naismith and Smith questionnaires items (statement i)	Measures efficiency
113.It was difficult for me to determine where I was in the museum	Naismith and Smith questionnaires items (statement j)	Measures satisfaction
114.I would recommend the device to other visitors.	Naismith and Smith questionnaires items (statement k)	Measures satisfaction
115.Using the guide would improve my museum visits	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Perceived Usefulness (PU)
116.Using the guide would make my museum visits easier	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Perceived Usefulness (PU)
117.The guide was useful during the visit	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Perceived Usefulness (PU)
118.I intend to use the guide in the future	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Intention to use – IU
119.I predict that I would use the guide	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Intention to use – IU
120.Learning to operate the guide would be easy for me	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Ease to use – PEU
121.I found it difficult to get guide do what I wanted it to do	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis,	Measures Ease to use – PEU

	1989)	
122.My interaction with guide was clear and understandable	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Ease to use – PEU
123.Time seemed to go by very quickly while I was using the guide	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures Time Distortion (TD)
124.While I was using the guide, I tended to lose track of time	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures Time Distortion (TD)
125.I consider myself knowledgeable about the right usage of the guide	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures skills
126.How would you rate your skill at using the guide, compared to other services supporting museum visit ? (much better/much worse; seven point Likert scale)	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures skills
127.How would you rate your skill at using the guide, compared to the first time you used a cellular phone? (much better/much worse; seven point Likert scale)	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures skills
128.Using the guide challenged me	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures challenge
129.I find that using the guide stretches my capabilities to the limits	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures challenge

130.Using the guide provided a good test of my skills	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures challenge
131.How much did the guide challenge you, compared to other things you can do into the museum?	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures challenge
132.I forgot about my immediate surroundings when I was using the guide	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures Presence
133.After using the guide, I felt like I come back to the "real world" after a journey	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures Presence
134.I was so involved by the presentation that I forgot the real world	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures Presence
135.Using the guide made me forget where I was	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Novak et. al, 2000)	Measures Presence
136.The guide clearly conveyed the effect of my action	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales	Measures feedback
137.Whenever it proposed follow-ups, the guide signaled it	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales	Measures feedback
138.It was clear to me when the guide was taking the initiative to autonomously propose contents	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales	Measures feedback
139.Seeing the real things is most satisfying aspect of my museum visits	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
140.Seeing rare thing give me a	Adapted from Pekarik, Zoering &	Measure object experiences

sense of wonder about the exhibition	Karns (1999)	
141.I was overwhelmed with the aesthetic/beauty aspect of the artefacts	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
142.I always wanted to own such artefacts	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
143.My museum enriched my professional development	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
144.I have gained more knowledge after my museums visit	Adapted from Pekarik, Zoering & Karns (1999)	Measure cognitive experiences
145.My museums visit enriched my knowledge and understanding about specific artefacts	Adapted from Pekarik, Zoering & Karns (1999)	Measure cognitive experiences
146.Seeing the exhibitions enabled me to imagines other places in time	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
147.I am able to reflect the significant of the objects and their meaning	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
148.The exhibitions enabled me to reminisce my past	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
149.I feel connected spiritually with the artefacts	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
150.I feel connected with the exhibition's artefacts	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
151.I like to spend time with family and friends	Adapted from Pekarik, Zoering & Karns (1999)	Measure social experiences
152.I like to see my children learn a new things in museums	Adapted from Pekarik, Zoering & Karns (1999)	Measure social experiences

Appendix F

Study 2: Final Questions for Engagement with Museums Questionnaire

Questions about the Museum/Exhibition Experience (37 Questions)

	Question	Source	Measures
1.	I felt engaged with the museum exhibition		Engagement directly
2.	The museum exhibition held my attention	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q1)	Measures attention directly
3.	I enjoyed visiting the exhibition.	Adapted Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q11)	Measures Enjoyment & Inspiration
4.	Visiting the exhbition was fun.	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q12)	Measures Enjoyment & Inspiration
5.	To what extent did you feel that the exhibition was something you were experiencing, rather than something you were just visiting?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q13)	Involvement
6.	My sense of being in the exhibition was stronger than my sense of being in the real world?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q14)	Immersion
7.	To what extent were you interested in seeing how the exhibition would progress?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q24)	Measures cognitive involvement and effort
8.	The exhibition enabled me to reminisce about my past	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences

9.	I was unaware of what was happening around me.	Adapted Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q21)	Measures immersion/flow
10.	To what extent did you lose track of time?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q5)	Measures flow
11.	I felt focused on the exhibition	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q2)	Measures attention
GLO – KNOWLEDGE AND UNDERSTTANDING			
12.	After visiting the exhibition, I was still interested to know more about the topic of the exhibition	From MLA GLO document	Measures knowledge & understanding in GLO
13.	I discovered new information from the exhibits	Adapted from MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures knowledge & understanding in GLO
14.	I could make sense of most of the things I saw and did at the exhibition	MLA website- question Bank	Measures knowledge & understanding in GLO
15.	I have gained knowledge that I can use or have used in my work as a result of my visit	MLA website- question Bank	Measures knowledge & understanding in GLO
GLO – ACTION, PROGRESSION AND BEHAVIOUR			
16.	I found it was easy to move around the exhibition	From MLA GLO document	Measures Action & Behavior in GLO
17.	I would make another visit to that exhibition	MLA website- question Bank	Measures Action, Behaviour and Progression
GLO – ENJOYMENT INSPIRATION AND CREATIVITY			
18.	My visit to the exhibition was	MLA website- Generic	Measures Enjoyment,

	very interesting	Learning Outcomes (GLO) Exit Survey	Creativity & Inspiration
19.	My visit to the exhibition was inspiring.	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Enjoyment, Creativity & Inspiration
QUESTIONS ABOUT THE EXHIBITS			
GENERAL QUESTIONS – THAT ASK DIRECTLY ABOUT IMMERSION, ENGAGEMENT ETC			
20.	To what extent did you feel that you were interacting with the exhibits?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q11)	Measures immersion
21.	To what extent did you feel emotionally involved with the exhibition?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q23)	Emotional response
22.	Some things were hard to understand	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures knowledge & understanding in GLO
23.	Seeing the real objects was most satisfying aspect of my visit to the exhibition	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
24.	Seeing rare things gave me a sense of wonder about the exhibition	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
25.	I was overwhelmed with the aesthetic/beauty aspect of the exhibits	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
26.	I wanted to own exhibits like those I saw	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
27.	My visit to the exhibition enriched my professional development	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
28.	I have gained more knowledge about the exhibition topic after my visit	Adapted from Pekarik, Zoering & Karns (1999)	Measure cognitive experiences
29.	My museums visit enriched my	Adapted from Pekarik,	Measure cognitive

	knowledge and understanding about specific exhibits	Zoering & Karns (1999)	experiences
30.	Seeing the exhibition enabled me to imagine other places in time	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
31.	During my visit I was able to reflect on the significance of the exhibits and their meaning	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
32.	I feel connected with the exhibits	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
LABELS, INFORMATION ABOUT EXHIBITS			
33.	I prefer text-based to graphics-based supporting material at museum exhibitions	From MLA GLO document	Measures Enjoyment, Creativity & Inspiration in GLO How does this measure enjoyment, creativity and inspiration?
34.	The information provided about artefacts in the exhibition was clear	From MLA GLO document	Measures knowledge & understanding in GLO
35.	I was overwhelmed by the amount of information provided for the exhibition	From MLA GLO document	Measures knowledge & understanding in GLO
36.	I did not like the graphics and imagery associated with the exhibition.	Adapted from Jennett et al immersion in games questionnaire (App A/Q10)	Measures emotions
37.	How much effort did you put into thinking about the exhibition?	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App B/Q3)	Measure cognitive involvement/effort

QUESTIONS ABOUT THE AUDIO/MULTIMEDIA GUIDE (20 Questions)

	Question	Source	Measures
GENERAL QUESTIONS – THAT ASK DIRECTLY ABOUT IMMERSION, ENGAGEMENT ETC			
38.	The information given by the audioguide was too lengthy	From MLA GLO document	Measures Enjoyment & Inspiration in GLO
39.	I became unaware that I was even using any controls on the audioguide	Adapted from Jennett *et al.*, (2008) immersion in games questionnaire (App A/Q15)	Measures flow, immersion
40.	It was difficult to determine where I was in the exhibition with the audio guide	Naismith and Smith questionnaires items (statement j)	Measures usability
41.	I predict that I would use an audio guide again	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Intention to use – IU
USABILITY – overall ease of use			
42.	The audio/multimedia guides was complicated to use	From MLA GLO document	Measures skills in GLO
43.	I felt self conscious using the audioguide.	Naismith and Smith questionnaires items (statement h)	Measures user acceptance
44.	Learning to operate the audio guide was easy	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Ease to use – PEU (Usability – learnability ISO)
45.	I found it difficult to get the audio guide do what I wanted it to do	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Ease to use – PEU (Usability – ease of use ISO)

USABILITY – efficiency/effectiveness			
46.	The audioguide helped me to navigate around the exhibition.	Naismith and Smith questionnaires items (statement g)	Measures efficiency
47.	The audio guide responded too slowly.	Naismith and Smith questionnaires items (statement e)	Measures usability
USABILITY - learnability			
48.	The controls of the audioguide were difficult to understand.	Adapted from Jennett *et al*., (2008) immersion in games questionnaire (App A/Q14)	Measures skills, usability
49.	Using the audioguide does not require much training.	Naismith and Smith questionnaires items (statement a)	Measures usability (learnability)
USABILITY – memorability- recognition rather than recall			
50.	It was difficult to select the option I wanted with the audio guide.	Naismith and Smith questionnaires items (statement c)	Measures usability
USABILITY - satisfaction			
51.	Using the audio guide enhanced my exhibition visit	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales (Originally adapted from Davis, 1989)	Measures Perceived Usefulness (PU)
USABILITY – User control and freedom			
52.	The audioguide was a distraction	Helen	Measures extent to which the technology interferes with experience of the exhibiton
53.	I felt that I was in control of the	Naismith and Smith	Measures usability

	audio guide.	questionnaires items (statement d)	
USABILITY – Visibility			
54.	I found it difficult to read the text on the screen of the audio guide.	Naismith and Smith questionnaires items (statement f)	Measures usability
USABILITY – Aesthetic and minimalist design			
55.	The audio guide presented information in an understandable manner.	Naismith and Smith questionnaires items (statement i)	Measures usability
USABILITY – provide feedback			
56.	The guide clearly provided feedback about my actions	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales	Measures feedback
57.	It was clear to me when the audio guide was taking the initiative to offer me information	Pianesi, Graziola, Zancanaro and Goren-Bar questionnaires scales	Measures feedback

Appendix G

Study 2: Full set of Questionnaires

Introduction

We are interested in finding out how people experience museums, art galleries, historic houses, archeological sites, indeed any cultural or historic venue. To make this questionnaire easier to follow, we will use the word “museum” throughout, but you can take this to refer to any of the above venues. We will also use the word "exhibition" to the part(s) of the museum that you visited, whether it was part of the permanent collection or a special, temporary exhibition. Finally we will use the word "exhibit" to refer to the objects, aspects of architecture etc that you looked at during your visit. We would like you to answer the questions in relate to a recent visit (within the last six months) you have made to a museum.

You will be asked for some brief information about the practicalities of that visit and then questions about what you felt and experienced during the visit. If you used an audioguide during the visit, there will be a separate set of questions to answer about your experience of the audioguide. An audioguide is any small device that you carry around the exhibition that provides you with more information about the exhibition, via an audio commentary, sometimes music, and sometimes images or text on its screen.

The main questionnaire should take approximately 10 minutes to complete, and the audioguide questionnaire should take an additional 5 minutes to complete. The information you provide will be treated as completely confidential and will only be used anonymously (you will be asked for your email address to participate in the prize draw for Amazon vouchers, but that information will not be associated with your questionnaire results). Your information will not be shared with anyone beyond the two researchers involved.

Your assistance is greatly appreciated. If you have any queries do not hesitate to contact us (Professor Helen Petrie: Helen.petrie@cs.york.ac.uk and Mohd Kamal Othman, PhD student:kamal@cs.york.ac.uk).

Section A: Some information about your museum visit

1. Which museum did you visit?

_____

2. When was the museum visit? (Please remember to pick a visit that is as recent as possible and within the last six months)

	within the last month
	one to two months ago
	two to three months ago
	more than three months ago but less than six months ago

3. Approximately how long did you spend at the museum?

	less than one hour
	one to two hours
	two to three hours
	three hours or more

4. Do you make this visit by yourself or with other people?

	I went by myself
	with others

5. If you went with other people, how many others did you go with?

	1
	2
	3
	4
	5
	More than 5

Section B: Your experience of the exhibition at the museum

6. I felt engaged with the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

7. I was interested in seeing how the exhibition would unfold as my visit progressed

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

8. I enjoyed visiting the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

9. My visit to the exhibition was inspiring

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

10. I discovered new information from the exhibits

	Strongly Disagree
	Disagree
	Neutral
	Agree

	Strongly Agree

11. The exhibition held my attention

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

12. I felt I was experiencing the exhibition, rather just visiting it

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

13. My sense of being in the exhibition was stronger than my sense of being in the real world

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

14. I gained knowledge that I can use or have used as a result of my visit

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

15. My visit to the exhibition was very interesting

	Strongly Disagree
	Disagree
	Neutral

	Agree
	Strongly Agree

16. It was easy to move around the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

17. Visiting the exhibition was fun

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

18. I felt focused on the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

19. I could make sense of most of the things I saw and did at the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

20. Seeing the exhibition enabled me to imagine other places in time

	Strongly Disagree
	Disagree
	Neutral

	Agree
	Strongly Agree

21. I felt I was interacting with the exhibits

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

22. I lost track of time while I was in the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

23. I would make another visit to the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

24. The exhibition enabled me to reminisce about my past

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

25. I was overwhelmed with the aesthetic/beauty aspect of the exhibits

	Strongly Disagree
	Disagree
	Neutral

	Agree
	Strongly Agree

26. After visiting the exhibition, I was still interested to know more about the topic of the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

27. While at the exhibition, I became unaware of what was happening around me

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

28. I was completely immersed in the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

29. Seeing real exhibits of importance was the most satisfying aspect of my visit to the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

30. During my visit, I put a lot of effort into thinking about the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

31. Some things in the exhibition were hard to understand

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

32. I like text-based information as supporting material at museum exhibitions

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

33. During my visit I was able to reflect on the significance of the exhibits and their meaning

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

34. I felt emotionally involved with the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

35. I liked the graphics associated with the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

36. I wanted to own exhibits like those which I saw in the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

37. The information provided about the exhibits was clear

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

38. My visit enriched my knowledge and understanding about specific exhibits

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

39. I like graphic-based information as supporting material at museum exhibitions

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

40. Seeing rare exhibits gave me a sense of wonder about the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

41. I feel connected with the exhibits

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

42. I was overwhelmed by the amount of information provided for the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

SECTION C: Your experience with an audio or multimedia guide at this exhibition. We will use "audioguide" for simplicity.

Please skip this section if you did not use and audioguide.

43. The information given by the audioguide was too lengthy

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

44. I became unaware that I was even using any controls on the audioguide

	Strongly Disagree
	Disagree

	Neutral
	Agree
	Strongly Agree

45. It was difficult to determine where I was in the exhibition with the audioguide

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

46. I will use an audioguide again when I visit an exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

47. The audioguide was complicated to use

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

48. I felt self conscious using the audioguide

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

49. Learning to operate the audioguide was easy

	Strongly Disagree
	Disagree

	Neutral
	Agree
	Strongly Agree

50. The audioguide helped me to navigate around the exhibition

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

51. The audioguide responded too slowly

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

52. The controls of the audioguide were difficult to understand

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

53. Using the audioguide did not require much training

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

54. It was difficult to select the option I wanted with the audioguide

	Strongly Disagree
	Disagree

	Neutral
	Agree
	Strongly Agree

55. Using the audioguide enhanced my exhibition visit

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

56. The audioguide was a distraction

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

57. I felt that I was in control of the audioguide

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

58. I found it difficult to read the text on the screen of the audioguide

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

59. I found it difficult to hear the material on the audioguide

	Strongly Disagree
	Disagree

	Neutral
	Agree
	Strongly Agree

60. The audioguide presented information in an understandable manner

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

61. The audioguide clearly provided feedback about my actions

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

62. It was clear to me when the audioguide was taking the initiative to offer me information and when I needed to ask it for information

	Strongly Disagree
	Disagree
	Neutral
	Agree
	Strongly Agree

63. Gender

	Male
	Female

64. Age _____

65. Occupation _____

66. Are you a native speaker of English?

	Yes
	No

67. If you are not a native speaker of English, what is you native language?

_____

68. If not a native speaker of English, how would you rate you knowledge of English?

	Near native
	Good
	Basic

Study 2: Between Groups analysis

Analysis 1: Male vs Female

Within-Subjects Factors	
Measure:MEASURE_1	
Factor	Dependent Variable
1	Engage
2	ME
3	KL
4	EC

Between-Subjects Factors		
		N
GENDER1M	1.00	88
	2.00	167

Descriptive Statistics				
	GENDER1M	Mean	Std. Deviation	N
Engage	1.00	3.8045	.77607	88
	2.00	3.9389	.64927	167
	Total	3.8925	.69706	255
ME	1.00	3.7636	.64223	88
	2.00	3.7210	.54439	167
	Total	3.7357	.57912	255
KL	1.00	3.8864	.63012	88
	2.00	3.9389	.51471	167
	Total	3.9208	.55656	255
EC	1.00	3.1068	.55082	88
	2.00	3.1401	.54420	167
	Total	3.1286	.54564	255

Multivariate Tests[b]						
Effect		Value	F	Hypothesis df	Error df	Sig.
Factor	Pillai's Trace	.633	144.293[a]	3.000	251.000	.000
	Wilks' Lambda	.367	144.293[a]	3.000	251.000	.000
	Hotelling's Trace	1.725	144.293[a]	3.000	251.000	.000
	Roy's Largest Root	1.725	144.293[a]	3.000	251.000	.000

Factor * GENDER1M	Pillai's Trace	.015	1.249[a]	3.000	251.000	.293
	Wilks' Lambda	.985	1.249[a]	3.000	251.000	.293
	Hotelling's Trace	.015	1.249[a]	3.000	251.000	.293
	Roy's Largest Root	.015	1.249[a]	3.000	251.000	.293

a. Exact statistic

b. Design: Intercept + GENDER1M
Within Subjects Design: Factor

Mauchly's Test of Sphericity[b]

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Factor	.979	5.214	5	.390	.986	1.000	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept + GENDER1M
Within Subjects Design: Factor

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Factor	Sphericity Assumed	92.965	3	30.988	145.112	.000
	Greenhouse-Geisser	92.965	2.958	31.432	145.112	.000
	Huynh-Feldt	92.965	3.000	30.988	145.112	.000
	Lower-bound	92.965	1.000	92.965	145.112	.000
Factor * GENDER1M	Sphericity Assumed	.915	3	.305	1.427	.233
	Greenhouse-Geisser	.915	2.958	.309	1.427	.234
	Huynh-Feldt	.915	3.000	.305	1.427	.233
	Lower-bound	.915	1.000	.915	1.427	.233
Error(Factor)	Sphericity Assumed	162.082	759	.214		
	Greenhouse-Geisser	162.082	748.276	.217		
	Huynh-Feldt	162.082	759.000	.214		
	Lower-bound	162.082	253.000	.641		

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source	Factor	Type III Sum of Squares	df	Mean Square	F	Sig.
Factor	Linear	49.601	1	49.601	227.677	.000
	Quadratic	25.084	1	25.084	119.625	.000
	Cubic	18.279	1	18.279	85.780	.000
Factor * GENDER1M	Linear	.125	1	.125	.572	.450
	Quadratic	.359	1	.359	1.711	.192
	Cubic	.431	1	.431	2.023	.156
Error(Factor)	Linear	55.118	253	.218		
	Quadratic	53.052	253	.210		
	Cubic	53.912	253	.213		

Tests of Between-Subjects Effects					
Measure:MEASURE_1 Transformed Variable:Average					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	12369.231	1	12369.231	15690.114	.000
GENDER1M	.454	1	.454	.576	.449
Error	199.451	253	.788		

Analysis 2: Native Vs non native English speaker

Within-Subjects Factors	
Measure:MEASURE_1	
Factor	Dependent Variable
1	Engage
2	ME
3	KL
4	EC

Between-Subjects Factors		
		N
native1	1.00	146
	2.00	109

Descriptive Statistics				
	native1	Mean	Std. Deviation	N
Engage	1.00	3.8658	.70783	146
	2.00	3.9284	.68396	109
	Total	3.8925	.69706	255
ME	1.00	3.7753	.60567	146

	2.00	3.6826	.53969	109
	Total	3.7357	.57912	255
KL	1.00	3.9301	.56549	146
	2.00	3.9083	.54673	109
	Total	3.9208	.55656	255
EC	1.00	3.0699	.55016	146
	2.00	3.2073	.53189	109
	Total	3.1286	.54564	255

Multivariate Tests[b]

Effect		Value	F	Hypothesis df	Error df	Sig.
Factor	Pillai's Trace	.651	156.236[a]	3.000	251.000	.000
	Wilks' Lambda	.349	156.236[a]	3.000	251.000	.000
	Hotelling's Trace	1.867	156.236[a]	3.000	251.000	.000
	Roy's Largest Root	1.867	156.236[a]	3.000	251.000	.000
Factor * native1	Pillai's Trace	.036	3.133[a]	3.000	251.000	.026
	Wilks' Lambda	.964	3.133[a]	3.000	251.000	.026
	Hotelling's Trace	.037	3.133[a]	3.000	251.000	.026
	Roy's Largest Root	.037	3.133[a]	3.000	251.000	.026

a. Exact statistic

b. Design: Intercept + native1
Within Subjects Design: Factor

Mauchly's Test of Sphericity[b]

Measure:MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[a]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Factor	.976	6.239	5	.284	.983	1.000	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept + native1
Within Subjects Design: Factor

Tests of Within-Subjects Effects

Measure:MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Factor	Sphericity Assumed	99.735	3	33.245	156.611	.000
	Greenhouse-Geisser	99.735	2.949	33.822	156.611	.000
	Huynh-Feldt	99.735	2.999	33.254	156.611	.000
	Lower-bound	99.735	1.000	99.735	156.611	.000

Factor * native1	Sphericity Assumed	1.878	3	.626	2.948	.032
	Greenhouse-Geisser	1.878	2.949	.637	2.948	.033
	Huynh-Feldt	1.878	2.999	.626	2.948	.032
	Lower-bound	1.878	1.000	1.878	2.948	.087
Error(Factor)	Sphericity Assumed	161.119	759	.212		
	Greenhouse-Geisser	161.119	746.047	.216		
	Huynh-Feldt	161.119	758.788	.212		
	Lower-bound	161.119	253.000	.637		

Tests of Within-Subjects Contrasts

Measure:MEASURE_1

Source	Factor	Type III Sum of Squares	df	Mean Square	F	Sig.
Factor	Linear	54.273	1	54.273	249.788	.000
	Quadratic	23.409	1	23.409	114.193	.000
	Cubic	22.053	1	22.053	102.782	.000
Factor * native1	Linear	.272	1	.272	1.252	.264
	Quadratic	1.546	1	1.546	7.543	.006
	Cubic	.059	1	.059	.277	.599
Error(Factor)	Linear	54.971	253	.217		
	Quadratic	51.864	253	.205		
	Cubic	54.283	253	.215		

Tests of Between-Subjects Effects

Measure:MEASURE_1
Transformed Variable:Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	13456.097	1	13456.097	17039.720	.000
native1	.114	1	.114	.144	.704
Error	199.792	253	.790		

Study 2: Post Hoc Analysis

ONEWAY Engage BY Group /STATISTICS DESCRIPTIVES /MISSING ANALYSIS /POSTHOC=TUKEY SCHEFFE LSD ALPHA(0.05).

Oneway

Descriptives

Engage

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.00	45	3.9333	.75919	.11317	3.7052	4.1614	.80	5.00
2.00	41	4.1854	.62031	.09688	3.9896	4.3812	2.40	5.00
3.00	100	3.8280	.68462	.06846	3.6922	3.9638	1.80	5.00
4.00	69	3.7855	.68024	.08189	3.6221	3.9489	1.80	5.00
Total	255	3.8925	.69706	.04365	3.8066	3.9785	.80	5.00

ANOVA

Engage

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.798	3	1.599	3.384	.019
Within Groups	118.618	251	.473		
Total	123.416	254			

Post Hoc Tests

Multiple Comparisons

Dependent Variable:Engage

	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD	1.00	2.00	-.25203	.14842	.327	-.6359	.1318
		3.00	.10533	.12340	.829	-.2138	.4245
		4.00	.14783	.13172	.676	-.1929	.4885
	2.00	1.00	.25203	.14842	.327	-.1318	.6359
		3.00	.35737*	.12748	.028	.0277	.6871
		4.00	.39986*	.13556	.018	.0493	.7505
	3.00	1.00	-.10533	.12340	.829	-.4245	.2138

		2.00	-.35737*	.12748	.028	-.6871	-.0277
		4.00	.04249	.10759	.979	-.2358	.3207
	4.00	1.00	-.14783	.13172	.676	-.4885	.1929
		2.00	-.39986*	.13556	.018	-.7505	-.0493
		3.00	-.04249	.10759	.979	-.3207	.2358
Scheffe	1.00	2.00	-.25203	.14842	.412	-.6698	.1657
		3.00	.10533	.12340	.866	-.2420	.4527
		4.00	.14783	.13172	.739	-.2229	.5186
	2.00	1.00	.25203	.14842	.412	-.1657	.6698
		3.00	.35737	.12748	.051	-.0014	.7162
		4.00	.39986*	.13556	.036	.0183	.7814
	3.00	1.00	-.10533	.12340	.866	-.4527	.2420
		2.00	-.35737	.12748	.051	-.7162	.0014
		4.00	.04249	.10759	.984	-.2603	.3453
	4.00	1.00	-.14783	.13172	.739	-.5186	.2229
		2.00	-.39986*	.13556	.036	-.7814	-.0183
		3.00	-.04249	.10759	.984	-.3453	.2603
LSD	1.00	2.00	-.25203	.14842	.091	-.5443	.0403
		3.00	.10533	.12340	.394	-.1377	.3484
		4.00	.14783	.13172	.263	-.1116	.4072
	2.00	1.00	.25203	.14842	.091	-.0403	.5443
		3.00	.35737*	.12748	.005	.1063	.6084
		4.00	.39986*	.13556	.003	.1329	.6668
	3.00	1.00	-.10533	.12340	.394	-.3484	.1377
		2.00	-.35737*	.12748	.005	-.6084	-.1063
		4.00	.04249	.10759	.693	-.1694	.2544
	4.00	1.00	-.14783	.13172	.263	-.4072	.1116
		2.00	-.39986*	.13556	.003	-.6668	-.1329
		3.00	-.04249	.10759	.693	-.2544	.1694

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

Engage				
			Subset for alpha = 0.05	
	Group	N	1	2
Tukey HSD[a,b]	4.00	69	3.7855	
	3.00	100	3.8280	
	1.00	45	3.9333	3.9333
	2.00	41		4.1854
	Sig.		.665	.212

Scheffe[a,b]	4.00	69	3.7855	
	3.00	100	3.8280	3.8280
	1.00	45	3.9333	3.9333
	2.00	41		4.1854
	Sig.		.729	.057

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 56.255.

b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

ONEWAY ME BY Group /STATISTICS DESCRIPTIVES /MISSING ANALYSIS /POSTHOC=TUKEY SCHEFFE LSD ALPHA(0.05).

Oneway

Descriptives

ME

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
1.00	45	3.6978	.53534	.07980	3.5369	3.8586	2.00	4.80
2.00	41	3.8488	.50750	.07926	3.6886	4.0090	2.80	4.80
3.00	100	3.8100	.63715	.06371	3.6836	3.9364	1.40	5.00
4.00	69	3.5855	.53393	.06428	3.4572	3.7138	2.00	4.80
Total	255	3.7357	.57912	.03627	3.6643	3.8071	1.40	5.00

ANOVA

ME

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.698	3	.899	2.736	.044
Within Groups	82.488	251	.329		
Total	85.185	254			

Post Hoc Tests

Multiple Comparisons							
Dependent Variable:ME							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
	(I) Group	(J) Group				Lower Bound	Upper Bound
Tukey HSD	1.00	2.00	-.15100	.12377	.615	-.4711	.1691
		3.00	-.11222	.10290	.696	-.3784	.1539
		4.00	.11227	.10984	.737	-.1718	.3964
	2.00	1.00	.15100	.12377	.615	-.1691	.4711
		3.00	.03878	.10631	.983	-.2362	.3137
		4.00	.26327	.11304	.094	-.0291	.5556
	3.00	1.00	.11222	.10290	.696	-.1539	.3784
		2.00	-.03878	.10631	.983	-.3137	.2362
		4.00	.22449	.08972	.062	-.0075	.4565
	4.00	1.00	-.11227	.10984	.737	-.3964	.1718
		2.00	-.26327	.11304	.094	-.5556	.0291
		3.00	-.22449	.08972	.062	-.4565	.0075
Scheffe	1.00	2.00	-.15100	.12377	.685	-.4994	.1973
		3.00	-.11222	.10290	.756	-.4019	.1774
		4.00	.11227	.10984	.790	-.1969	.4214
	2.00	1.00	.15100	.12377	.685	-.1973	.4994
		3.00	.03878	.10631	.988	-.2604	.3380
		4.00	.26327	.11304	.146	-.0549	.5814
	3.00	1.00	.11222	.10290	.756	-.1774	.4019
		2.00	-.03878	.10631	.988	-.3380	.2604
		4.00	.22449	.08972	.102	-.0280	.4770
	4.00	1.00	-.11227	.10984	.790	-.4214	.1969
		2.00	-.26327	.11304	.146	-.5814	.0549
		3.00	-.22449	.08972	.102	-.4770	.0280
LSD	1.00	2.00	-.15100	.12377	.224	-.3948	.0928
		3.00	-.11222	.10290	.277	-.3149	.0904
		4.00	.11227	.10984	.308	-.1041	.3286
	2.00	1.00	.15100	.12377	.224	-.0928	.3948
		3.00	.03878	.10631	.716	-.1706	.2482
		4.00	.26327*	.11304	.021	.0406	.4859
	3.00	1.00	.11222	.10290	.277	-.0904	.3149
		2.00	-.03878	.10631	.716	-.2482	.1706
		4.00	.22449*	.08972	.013	.0478	.4012
	4.00	1.00	-.11227	.10984	.308	-.3286	.1041

		2.00	-.26327*	.11304	.021	-.4859	-.0406
		3.00	-.22449*	.08972	.013	-.4012	-.0478
*. The mean difference is significant at the 0.05 level.							

Homogeneous Subsets

ME			
			Subset for alpha = 0.05
	Group	N	1
Tukey HSD[a,b]	4.00	69	3.5855
	1.00	45	3.6978
	3.00	100	3.8100
	2.00	41	3.8488
	Sig.		.073
Scheffe[a,b]	4.00	69	3.5855
	1.00	45	3.6978
	3.00	100	3.8100
	2.00	41	3.8488
	Sig.		.118
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 56.255.			
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.			

ONEWAY KL BY Group /STATISTICS DESCRIPTIVES /MISSING ANALYSIS /POSTHOC=TUKEY SCHEFFE LSD ALPHA(0.05).

Oneway

Descriptives								
KL								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
1.00	45	3.9200	.64863	.09669	3.7251	4.1149	.80	5.00
2.00	41	4.0488	.55638	.08689	3.8732	4.2244	2.20	5.00
3.00	100	3.9320	.52970	.05297	3.8269	4.0371	1.80	5.00
4.00	69	3.8290	.52499	.06320	3.7029	3.9551	2.40	4.80
Total	255	3.9208	.55656	.03485	3.8521	3.9894	.80	5.00

ANOVA					
KL					
	Sum of Squares	df	Mean Square	F	Sig.

Between Groups	1.266	3	.422	1.368	.253
Within Groups	77.414	251	.308		
Total	78.680	254			

Post Hoc Tests

Multiple Comparisons							
Dependent Variable:KL							
			Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
	(I) Group	(J) Group				Lower Bound	Upper Bound
Tukey HSD	1.00	2.00	-.12878	.11990	.706	-.4389	.1813
		3.00	-.01200	.09969	.999	-.2698	.2458
		4.00	.09101	.10641	.828	-.1842	.3662
	2.00	1.00	.12878	.11990	.706	-.1813	.4389
		3.00	.11678	.10299	.669	-.1496	.3831
		4.00	.21979	.10951	.188	-.0634	.5030
	3.00	1.00	.01200	.09969	.999	-.2458	.2698
		2.00	-.11678	.10299	.669	-.3831	.1496
		4.00	.10301	.08691	.637	-.1218	.3278
	4.00	1.00	-.09101	.10641	.828	-.3662	.1842
		2.00	-.21979	.10951	.188	-.5030	.0634
		3.00	-.10301	.08691	.637	-.3278	.1218
Scheffe	1.00	2.00	-.12878	.11990	.764	-.4662	.2087
		3.00	-.01200	.09969	1.000	-.2926	.2686
		4.00	.09101	.10641	.866	-.2085	.3905
	2.00	1.00	.12878	.11990	.764	-.2087	.4662
		3.00	.11678	.10299	.733	-.1731	.4066
		4.00	.21979	.10951	.261	-.0884	.5280
	3.00	1.00	.01200	.09969	1.000	-.2686	.2926
		2.00	-.11678	.10299	.733	-.4066	.1731
		4.00	.10301	.08691	.705	-.1416	.3476
	4.00	1.00	-.09101	.10641	.866	-.3905	.2085
		2.00	-.21979	.10951	.261	-.5280	.0884
		3.00	-.10301	.08691	.705	-.3476	.1416
LSD	1.00	2.00	-.12878	.11990	.284	-.3649	.1074
		3.00	-.01200	.09969	.904	-.2083	.1843
		4.00	.09101	.10641	.393	-.1186	.3006
	2.00	1.00	.12878	.11990	.284	-.1074	.3649
		3.00	.11678	.10299	.258	-.0861	.3196
		4.00	.21979*	.10951	.046	.0041	.4355
	3.00	1.00	.01200	.09969	.904	-.1843	.2083

		2.00	-.11678	.10299	.258	-.3196	.0861
		4.00	.10301	.08691	.237	-.0682	.2742
	4.00	1.00	-.09101	.10641	.393	-.3006	.1186
		2.00	-.21979*	.10951	.046	-.4355	-.0041
		3.00	-.10301	.08691	.237	-.2742	.0682
*. The mean difference is significant at the 0.05 level.							

Homogeneous Subsets

KL			
			Subset for alpha = 0.05
	Group	N	1
Tukey HSD[a,b]	4.00	69	3.8290
	1.00	45	3.9200
	3.00	100	3.9320
	2.00	41	4.0488
	Sig.		.156
Scheffe[a,b]	4.00	69	3.8290
	1.00	45	3.9200
	3.00	100	3.9320
	2.00	41	4.0488
	Sig.		.224
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 56.255.			
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.			

ONEWAY EC BY Group /STATISTICS DESCRIPTIVES /MISSING ANALYSIS /POSTHOC=TUKEY SCHEFFE LSD ALPHA(0.05).

Oneway

Descriptives								
EC								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
1.00	45	3.0978	.53193	.07930	2.9380	3.2576	1.60	4.20
2.00	41	3.2488	.45778	.07149	3.1043	3.3933	2.40	4.20
3.00	100	3.0640	.55913	.05591	2.9531	3.1749	1.80	4.20
4.00	69	3.1710	.57729	.06950	3.0323	3.3097	1.60	4.20

Descriptives								
EC								
					95% Confidence Interval for Mean			
	N	Mean	Std. Deviation	Std. Error	Lower Bound	Upper Bound	Minimum	Maximum
1.00	45	3.0978	.53193	.07930	2.9380	3.2576	1.60	4.20
2.00	41	3.2488	.45778	.07149	3.1043	3.3933	2.40	4.20
3.00	100	3.0640	.55913	.05591	2.9531	3.1749	1.80	4.20
4.00	69	3.1710	.57729	.06950	3.0323	3.3097	1.60	4.20
Total	255	3.1286	.54564	.03417	3.0613	3.1959	1.60	4.20

ANOVA					
EC					
	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1.176	3	.392	1.322	.268
Within Groups	74.445	251	.297		
Total	75.621	254			

Post Hoc Tests

Multiple Comparisons							
Dependent Variable:EC							
						95% Confidence Interval	
	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Tukey HSD	1.00	2.00	-.15100	.11758	.574	-.4551	.1531
		3.00	.03378	.09776	.986	-.2191	.2866
		4.00	-.07324	.10435	.896	-.3431	.1967
	2.00	1.00	.15100	.11758	.574	-.1531	.4551
		3.00	.18478	.10099	.262	-.0764	.4460
		4.00	.07777	.10739	.887	-.2000	.3555
	3.00	1.00	-.03378	.09776	.986	-.2866	.2191
		2.00	-.18478	.10099	.262	-.4460	.0764
		4.00	-.10701	.08523	.592	-.3275	.1134
	4.00	1.00	.07324	.10435	.896	-.1967	.3431
		2.00	-.07777	.10739	.887	-.3555	.2000
		3.00	.10701	.08523	.592	-.1134	.3275
Scheffe	1.00	2.00	-.15100	.11758	.649	-.4819	.1799
		3.00	.03378	.09776	.989	-.2414	.3089
		4.00	-.07324	.10435	.920	-.3669	.2205

	2.00	1.00	.15100	.11758	.649	-.1799	.4819
		3.00	.18478	.10099	.343	-.0995	.4690
		4.00	.07777	.10739	.913	-.2245	.3800
	3.00	1.00	-.03378	.09776	.989	-.3089	.2414
		2.00	-.18478	.10099	.343	-.4690	.0995
		4.00	-.10701	.08523	.665	-.3469	.1329
	4.00	1.00	.07324	.10435	.920	-.2205	.3669
		2.00	-.07777	.10739	.913	-.3800	.2245
		3.00	.10701	.08523	.665	-.1329	.3469
LSD	1.00	2.00	-.15100	.11758	.200	-.3826	.0806
		3.00	.03378	.09776	.730	-.1588	.2263
		4.00	-.07324	.10435	.483	-.2788	.1323
	2.00	1.00	.15100	.11758	.200	-.0806	.3826
		3.00	.18478	.10099	.068	-.0141	.3837
		4.00	.07777	.10739	.470	-.1337	.2893
	3.00	1.00	-.03378	.09776	.730	-.2263	.1588
		2.00	-.18478	.10099	.068	-.3837	.0141
		4.00	-.10701	.08523	.210	-.2749	.0608
	4.00	1.00	.07324	.10435	.483	-.1323	.2788
		2.00	-.07777	.10739	.470	-.2893	.1337
		3.00	.10701	.08523	.210	-.0608	.2749

Homogeneous Subsets

EC			
			Subset for alpha = 0.05
	Group	N	1
Tukey HSD[a,b]	3.00	100	3.0640
	1.00	45	3.0978
	4.00	69	3.1710
	2.00	41	3.2488
	Sig.		.276
Scheffe[a,b]	3.00	100	3.0640
	1.00	45	3.0978
	4.00	69	3.1710
	2.00	41	3.2488
	Sig.		.358
Means for groups in homogeneous subsets are displayed.			
a. Uses Harmonic Mean Sample Size = 56.255.			
b. The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.			

The LSD test for Engagement component on the Multimedia Guide Questionnaire

Dependent Variable:Engage							
	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	1.00	2.00	-.25203	.14842	.091	-.5443	.0403
		3.00	.10533	.12340	.394	-.1377	.3484
		4.00	.14783	.13172	.263	-.1116	.4072
	2.00	1.00	.25203	.14842	.091	-.0403	.5443
		3.00	.35737*	.12748	.005	.1063	.6084
		4.00	.39986*	.13556	.003	.1329	.6668
	3.00	1.00	-.10533	.12340	.394	-.3484	.1377
		2.00	-.35737*	.12748	.005	-.6084	-.1063
		4.00	.04249	.10759	.693	-.1694	.2544
	4.00	1.00	-.14783	.13172	.263	-.4072	.1116
		2.00	-.39986*	.13556	.003	-.6668	-.1329
		3.00	-.04249	.10759	.693	-.2544	.1694

*. The mean difference is significant at the 0.05 level.

The LSD test for Meaningful Experience component on the Multimedia Guide Questionnaire

Dependent Variable:ME							
	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	1.00	2.00	-.15100	.12377	.224	-.3948	.0928
		3.00	-.11222	.10290	.277	-.3149	.0904
		4.00	.11227	.10984	.308	-.1041	.3286
	2.00	1.00	.15100	.12377	.224	-.0928	.3948
		3.00	.03878	.10631	.716	-.1706	.2482
		4.00	.26327*	.11304	.021	.0406	.4859
	3.00	1.00	.11222	.10290	.277	-.0904	.3149
		2.00	-.03878	.10631	.716	-.2482	.1706
		4.00	.22449*	.08972	.013	.0478	.4012
	4.00	1.00	-.11227	.10984	.308	-.3286	.1041
		2.00	-.26327*	.11304	.021	-.4859	-.0406
		3.00	-.22449*	.08972	.013	-.4012	-.0478

*. The mean difference is significant at the 0.05 level.

The LSD test for Knowledge and Learning component on the Multimedia Guide Questionnaire

Dependent Variable:KL							
	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	1.00	2.00	-.12878	.11990	.284	-.3649	.1074
		3.00	-.01200	.09969	.904	-.2083	.1843
		4.00	.09101	.10641	.393	-.1186	.3006
	2.00	1.00	.12878	.11990	.284	-.1074	.3649
		3.00	.11678	.10299	.258	-.0861	.3196
		4.00	.21979*	.10951	.046	.0041	.4355
	3.00	1.00	.01200	.09969	.904	-.1843	.2083
		2.00	-.11678	.10299	.258	-.3196	.0861
		4.00	.10301	.08691	.237	-.0682	.2742
	4.00	1.00	-.09101	.10641	.393	-.3006	.1186
		2.00	-.21979*	.10951	.046	-.4355	-.0041
		3.00	-.10301	.08691	.237	-.2742	.0682
*. The mean difference is significant at the 0.05 level.							

The LSD test for Emotional Connection component on the Multimedia Guide Questionnaire

Multiple Comparisons							
Dependent Variable:EC							
	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
LSD	1.00	2.00	-.15100	.11758	.200	-.3826	.0806
		3.00	.03378	.09776	.730	-.1588	.2263
		4.00	-.07324	.10435	.483	-.2788	.1323
	2.00	1.00	.15100	.11758	.200	-.0806	.3826
		3.00	.18478	.10099	.068	-.0141	.3837
		4.00	.07777	.10739	.470	-.1337	.2893
	3.00	1.00	-.03378	.09776	.730	-.2263	.1588
		2.00	-.18478	.10099	.068	-.3837	.0141
		4.00	-.10701	.08523	.210	-.2749	.0608
	4.00	1.00	.07324	.10435	.483	-.1323	.2788
		2.00	-.07777	.10739	.470	-.2893	.1337
		3.00	.10701	.08523	.210	-.0608	.2749

Appendix J

Study 3: Questionnaire for Mobile Technology in Cultural Spaces: Multimedia Guide Application using iPhone

Section A: Questions about your experience with the audioguide (mobile guide.)

1. The information given by the audioguide was too lengthy

Strongly Disagree Disagree Neutral Agree Strongly Agree

2. I became unaware that I was even using any controls on the audioguide

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. It was difficult to determine where I was in the exhibition with the audioguide

Strongly Disagree Disagree Neutral Agree Strongly Agree

4. I will use an audioguide again when I visit an exhibition

Strongly Disagree Disagree Neutral Agree Strongly Agree

5. The audioguide was complicated to use

Strongly Disagree Disagree Neutral Agree Strongly Agree

6. I felt self conscious using the audioguide

Strongly Disagree Disagree Neutral Agree Strongly Agree

7. Learning to operate the audioguide was easy

Strongly Disagree Disagree Neutral Agree Strongly Agree

8. The audioguide helped me to navigate around the exhibition

Strongly Disagree Disagree Neutral Agree Strongly Agree

9. The audioguide responded too slowly

Strongly Disagree Disagree Neutral Agree Strongly Agree

10. The controls of the audioguide were difficult to understand

Strongly Disagree Disagree Neutral Agree Strongly Agree

11. Using the audioguide did not require much training

Strongly Disagree Disagree Neutral Agree Strongly Agree

12. It was difficult to select the option I wanted with the audioguide

Strongly Disagree Disagree Neutral Agree Strongly Agree

13. Using the audioguide enhanced my exhibition visit

Strongly Disagree Disagree Neutral Agree Strongly Agree

14. The audioguide was a distraction

Strongly Disagree Disagree Neutral Agree Strongly Agree

15. I felt that I was in control of the audioguide

Strongly Disagree Disagree Neutral Agree Strongly Agree

16. I found it difficult to read the text on the screen of the audioguide

Strongly Disagree Disagree Neutral Agree Strongly Agree

17. The audioguide presented information in an understandable manner

Strongly Disagree Disagree Neutral Agree Strongly Agree

18. The audioguide clearly provided feedback about my actions

Strongly Disagree Disagree Neutral Agree Strongly Agree

19. It was clear to me when the audioguide was taking the initiative to offer me information and when I needed to ask it for information

Strongly Disagree Disagree Neutral Agree Strongly Agree

SECTION B: Your demographics information.

1. Your Gender:

_____

2. Age

_____

3. Occupation:

_____

4. Are you native speaker of English?

Yes No

5. If you are not native speaker of English, what is your native language?

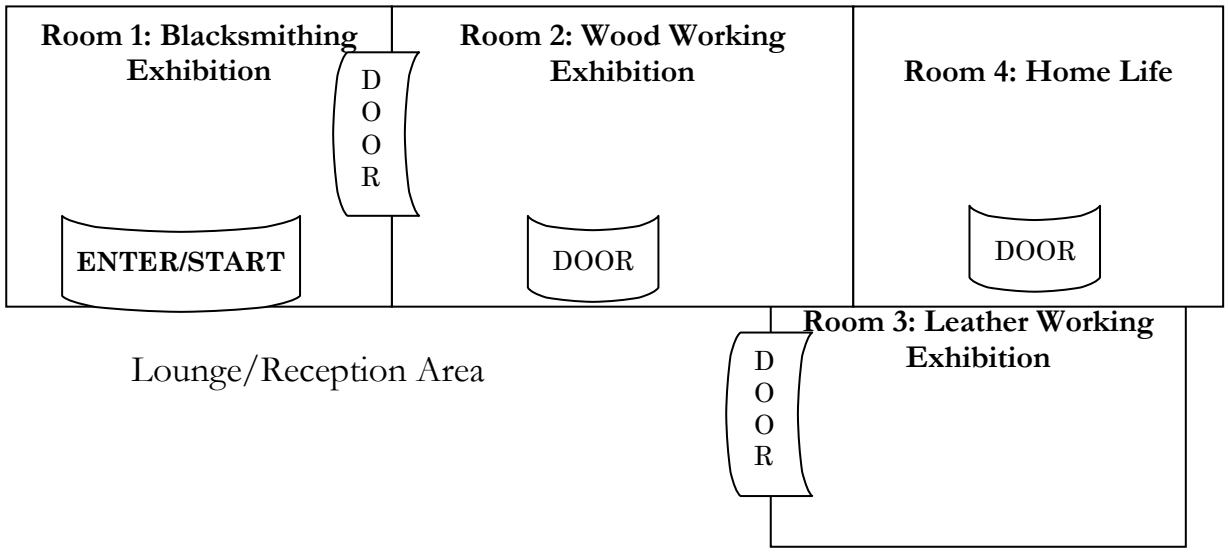
_____

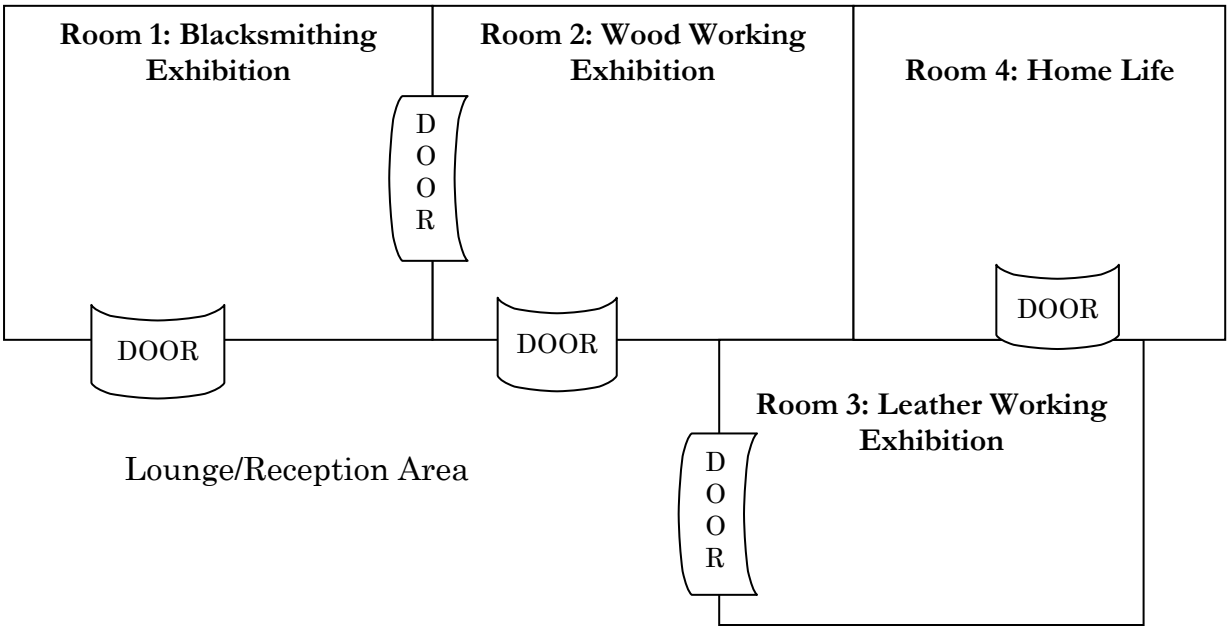
6. If you are not native speaker of English, how would you rate your knowledge of English?

Good Average Near native

Study 3: Exhibition Map

Exhibition Map (Guided Tour)





Study 3: Informed Consent Form

Mobile technology in cultural spaces: multimedia guides application using iPhone

Before you participate in this study, please complete Section A, printing your name in the first space and then sign at the end.

Once the study is over and you have been debriefed, you will be asked to initial the three statements in Section B, to indicate your agreement.

Section A

I, _____, voluntarily give my consent to participate in this study for the Cultural Spaces: Examine Free Choice Learning with Technology Integrations in Museums Project. I have been informed about, and feel that I understand the basic nature of the project. I understand that I may withdraw from the interview/focus group at any time without prejudice. I also understand that my information is confidential. Only Mohd Kamal Othman and Prof Helen Petrie will have access to the data collected today in its original format and it will only be shared with other project members in an anonymous format.

_____ _____

Signature of Research Participant Date

Section B

Please initial each of the following statements when the study has been completed and you have been debriefed.

I have been adequately debriefed Your initials:

I was not forced to complete the study. Your initials:

Study 3: Instructions

1- Guided Tour Instructions:

Thank you for agreeing to take part in our study.

As a respondent of this study, we would like you to follow the instructions below before you begin.

6. Assuming that you are in the Jorvik Viking Centre and are viewing the real exhibits in their exhibitions.
1. Please use the Iphone guide tour to assist you in the Jorvik Viking Centre exhibition and use the map provided to help you with your location in the exhibition area.
2. There will be four different room (as labeled on the door), each with few exhibits on the wall.
3. Please visit the exhibition in this particular order, start with blacksmithing room followed by woodwork room. Then continue to the leather working room and finished with the home life room.
4. As the Iphone's user, please navigate the guided tour as you always do during navigation and browsing of information on Iphone to assist you with the exhibits.
5. Please answer the questionnaires given after you have done with the Iphone tour.
6. This questionnaire is divided into two sections, namely Section A to gather information about your experiences with this Iphone tour and Section B to get your demographic information.

The purpose of distributing this questionnaire is to obtain your view on the use of the Iphone as a tour guide at the Jorvik Viking Centre. This Jorvik Viking Centre Iphone guided tour is specially designed for the purpose of gathering your value comments about information presentations, layout, design, and other comments that related to learning about museum exhibitions using Iphone Guided Tours. The information given will be used for academic purposes only and will be treated as confidential. As this research is a part of PhD study, we value every comment and information you have provided and your co-operation are greatly appreciated. If you have any queries do not hesitate to ask us. This evaluation will take about 15-20 minutes of your time.

2- Free-choice Tour Instructions:

Thank you for agreeing to take part in our study.

As a respondent of this study, we would like you to follow the instructions below before you begin.

1. Assuming that you are in the Jorvik Viking Centre and are viewing the real exhibits in their exhibitions.
2. Please use the iPhone guide tour to assist you in the Jorvik Viking Centre exhibition and use the map provided to help you with your location in the exhibition area (room).
3. There is no particular order to visit the exhibits in this exhibition. There will be four different room (as labeled on the door), each with few exhibits on the wall. These rooms are Blacksmithing room, Woodwork room, Leather working, Home life.
4. As the iPhone's user, please navigate the guided tour as you always do during navigation and browsing of information on iPhone to assist you with the exhibits.
5. Please answer the questionnaires given after you have done with the iPhone tour.
6. This questionnaire is divided into two sections, namely Section A to gather information about your experiences with this iPhone tour and Section B to get your demographic information.

The purpose of distributing this questionnaire is to obtain your view on the use of the iPhone as a tour guide at the Jorvik Viking Centre. This Jorvik Viking Centre iPhone guide tour is specially designed for the purpose of gathering your value comments about information presentations, layout, design, and other comments that related to learning about museum exhibitions using iPhone Tours. The information given will be used for academic purposes only and will be treated as confidential. As this research is a part of PhD study, we value every comment and information you have provided and your co-operation are greatly appreciated. If you have any queries do not hesitate to ask us. This evaluation will take about 15-20 minutes of your time.

Study 3: Heuristic Evaluations

Heuristic Evaluation of Guided Tour Version

Page	Problem	Solution
General comments	Sometimes you have a space before and after a dash, and sometimes only after the dash.	Space before and after a dash
Home Page	Uses Times New Roman font, rest of the site uses Arial, so it doesn't seem to be part of the same site.	Change the font type to match up with the rest of the site.
	Colour and background also different, so don't match up.	Change the Home Page Screen with new design and colour to match up with the rest of the page.
	It comes up really, really tiny on my screen with lots and lots of blank space.	The problems solved after the new homepage were introduced.
Jorvik: Mobile Tour Guide	As you are not using all the page at the moment. Centre should be on Top Jorvik Viking Centre Mobile Tour Guide	The alignment have been changed to look better on screen. Centre are now at the top.
	Then I would have: About the Centre About the Exhibition as the links	The proportions of the text and screen have been revamped to look better on the screen and make use the space. Both "About the Centre" and "about the Exhibition" are remain as the links.
About Viking Centre	The link from the previous page (About Jorvik) does not match the heading on this page.	Changed this page heading to "About Jorvik Viking Centre".
	The next heading repeats "About Viking Centre".	Have "History" as the second heading on the page.
Main Exhibition	Again, the title does not match the link. I	The title and link have been

	would make the title of this page (and the link on the previous page): Exhibition Guide	changed.
	Have a sentence above the four headings "The exhibition is about four areas of Viking life:"	"The exhibition is about four areas of Viking life:" has been insert into the page.
Introduction to Blacksmithing	Jorvik is in capital letters on this page. No need for that.	The capital letter has been changed.
Chateline	Heading "The Vikings Chateline" should be "The Viking Chateline" (no s, and capital C for Chateline)	"The Vikings Chateline" has been changed to "The Viking Chateline"
	I would re-order the items in the menu. It makes sense to tell people about the object before showing them more pictures of it, so I would make the order: Use History Interesting Facts More Pictures	After careful consideration, the items have been re-ordered to: Use History More Pictures Interesting Facts
Chateline: History	This page seems to end in the middle of the story. How do archaeologists know that this object belonged to a man or a woman? Is there any more text? If not, need a full stop at the end of the last sentence.	Include the fullstop.
Chateline: Use	This page refers to a "possible reconstruction". But that does not seem to be included in the More Pictures (I'm getting one picture currently unavailable from FLICKR, so it might be that one). If you do not have the picture of the reconstruction, I would just drop this sentence.	The picture of the "possible reconstruction" is now available.
Interesting Facts	Heading "Fact 01" is a bit geeky. If there	New headings: "Interesting Fact

	is only one fact, I would not have a heading. If you have more than one fact, I would have headings "Interesting Fact No 1", "Interesting Fact No 2" etc	No 1", "Interesting Fact No 2" etc
Chateline Facts	Grammar on first sentence is incorrect. Should be "What makes us suspect …"	The grammar has been changed.
	No space between Anglian and the "(".	Insert space between Anglian and the "(".
Chateline Images	Heading does not match the link which was "More Pictures". I would use "Chateline: More Pictures".	Changed the heading to Chateline: More Pictures.
	Individual pages of pictures – each is headed "Chateline", it needs a more specific heading, e.g. Chateline Detail	The individual pages of pictures have been updated to describe the object.
	Captions are "Image 01" etc. Again, this is rather geeky. I would label them "Picture 1" etc.	Captions are now changed to "Picture 1" , "picture 2" etc.
	Instead of "Back", the link back to the thumbnails of pictures is "Index". I would change this to "Back" for consistency.	Changed the link to previous page to "Back".
Prick Spurs	Title and heading don't match: I would made both the page title and the heading Viking Prick Spurs, so they match.	The page title and heading is now "Viking Prick Spurs".
Interesting Facts	When I clicked on "Next" in Interesting Facts in Prick Spurs, I go to "Wood Tools: Facts". This should go to "Introduction to Woodworking"	The broken links have been resolved.
	This link should tell me I am going to the "Next Section" (Next is not enough) So I went back to the menu of the four sections and went into Wood work from there.	The link is now changed to "Next Section: Woodworking" to highlights the woodworking exhibition in the next section.
	I think it is more common to have woodwork and woodworking as single words in English.	The words "wood working" and "wood work" now as single words.

Introduction to Woodworking	The Title is "Jorvik". Should match the link I came from "Woodwork".	Changed title from Jorvik to Woodworking.
	No capital letter on beginning of 3rd sentence "At Coppergate .."	Removed capital letter
	As the reconstruction of the workshop is not here, I would make the text "A reconstruction of his workshop .."	Changed the text as suggested.
	No full stop at the end of the text.	Insert full stop.
Wooden Bowl	Title should be the same as the heading – "The Wooden Bowls" (because there is a collection of them, not just one)?	Changed title and heading to "The Wooden Bowls"
	More Pictures, not More Picture	The missing "s" is included.
	corrections to captions and Index, as before	Captions have been changed to describe the picture. Change link to previous page from Index to Back.
Wooden Bowl: History	"dont" should be "don't", but better "do not"	The word "do not" is in use now.
	Lots of little typos in the sentence beginning "The York archaeological …" It should be "The York Archaeological Wood Centre which forms part of York Archaeological Trust, has gained …."	Changed the typo.
Wood Tools: Use	The text here is from the spur, not the bowls!	The text has been updated.
Wood Tools: Facts	Heading should be "Wood Tools: Interesting Facts".	Changed the heading to "Wood Tools: Interesting Facts".
	Fact 01 as before	New headings: "Interesting Fact No 1", "Interesting Fact No 2" etc
	Three small typos in Fact 1. No space between sentence 1 and 2, space after comma in second sentence after "first", and no full stop at the end of the sentence.	All typos have been rectified.
	Fact 1 is in a different font size to Fact 2	Standardized the font size and type.

Wood Tools	Heading should be "The Viking Wood Tools". The title of the page should match this.	Changed the title to match the content.
	Image 02 – typo in caption "sppon" - not sure what this should be.	Changed sppon to spoon. Change Image02 to Picture 02.
Wood tools: history	Where is "this beautiful Viking-Age mallet"? Is it in the main picture? If so, say so. This page really does not make sense to me.	The picture of Viking-Age mallet is in the picture section and text "refer to picture 03" is now included.
Wood tools: use	general-purposed -> general purpose	Change the general-purposed to general purpose
	what axe? I thought you meant an axe in the pictures. If not, say "Axes are heavy wedge-shaped (NOT wedged-shaped) pieces of forged iron …"	Changed the text.
	I would have: The "spoon bit" or auger was used …	The " " is included before and after the word spoon bit.
Wood tools: (interesting) facts	font change.	Changed the font inconsistencies.
	type icluding -> including.	Change the typo.
Introduction to Leather working	small typo "woolen Sock" -> "woolen sock".	Change the typo.
Shoes	Title and heading should be "The Viking leather shoes".	Change Title and heading.
Shoe picture 1	small type ength -> length	
Shoes: History	typo angle-Scandinavian -> Anglo-Scandinavian (twice)	Change the typo.
	featured -> pictured	Replaced the word featured with pictured.
	A seam run down -> A seam ran down	Changed the typo.
Page Shoes: Use	Very small font, different from before.	Changed font inconsistencies to match with the rest of the site.
	angle-Scandinavian -> Anglo-Scandinavian	Changed the typo.
	turnshoe -> "turnshoe"	Changed the typo.

	space between shape and comma	Changed the typo.
	soulded -> moulded???	Changed the typo.
	withe -> with	Changed the typo.
	full stop missing at the end of the text	Changed the typo.
Shoe facts	6-8 pavement -> 6 – 8 Pavement	Changed the typo.
Socks (Should be The York Sock)	The title and heading should be "The York Sock"	Changed the Title and heading.
Picture 1	nalebinding -> "nalebinding"	Changed the typos.
	"the wool sock" should be "the York Sock"	Changed the wool sock to the York sock.
Picture 2	Text should be "The York sock after conservation (actual length 250 mm)"	Change the text.
Socks: History	condition -> conditions	Changed the typos.
	nalebinding -> "nalebinding"	Changed the typos.
	building -> buildings	Changed the typos.
	red ban -> red band	Changed the typos.
Socks: Use	leg binding -> leg bindings.	Changed the typos.
Socks: Interesting facts	example -> examples	Changed the typos.
	Post_Roman –> Post-Roman	Changed the typos.
	Mittens -> mittens	Changed the typos.
	Sweeden -> Sweden	Changed the typos.
Introduction to Home Life	" … such as the mallets and shovel on display…' but are they on display? Same for " … the bone skates hanging on the wall" -> should be " ..the bone skates in the photo"	Changed the text to match the description and condition.
	hnefatafl -> "hnefatafl"	Changed the typos.
	No full stop at the end of the text.	Changed the typos.
Bone skates: use	the wearer leather boot -> the wearer's leather boot	Changed the typos.
Bone Skates: Interesting Facts	The skates cpould -> The skates could …	Changed the typos.
	Although River Ouse –> Although the	Changed the typos.

	River Ouse	
Sewing Equipment: use	This would have been used -> They would have been used	Changed the typos.
	"Many seamstresses and tailors may have used lining in thimble to provide …." No full stop at the end of the text.	Changed the typos.
Sewing Equipment: history	14th- century -> 14th century	Changed the typos.
Sewing Equipment: facts	Interesting fact 1 – this has already appeared on the history page. Interesting fact 2 - No full stop at the end of the text.	Change typos.
End of tour	Should do to a thank you and what to do next page, not back to the beginning.	Create a new page and include thank you and tell users what to do next.
Jorvik Viking Centre: Online Tours and Guides	Middle line of text is in a different font (serif) Text should also match in the wording of both bits "Please click on the link below to START the tour".	Changed the inconsistencies in Font.
About Jorvik Viking Centre	If this is the guided tour, don't we want people going through in a sequential fashion – here you have them go into About the Centre, then come back and then go to About the Exhibition. This is not consistent with what comes next.	A new link to the next section has been created to solve this problem.
Exhibition Guide	Should start "The exhibition …"	Changed the typos.
Introduction to Blacksmithing	Title is just Jorvik. That's too general. Shouldn't it be Blacksmithing? "Tools and some products were sharpened on rotary grindstones and hones whetstones." Hones is wrong. I think it should be	All pages title have been changed to reflect their contents. Text should be "hones or whetstones."

	honed, but check the original text.	
Chateline use	Title is Jorvik. History -> Chateline History	Changed the title and Heading.

Heuristic Evaluation Free Choice Learning Version of The Jorvik Guide

Page	**Problem**	**Solution**
Home page	"Please click on the link below to begin the tour" is in a serif font whereas the other text is in a sans-serif font.	Change the font.
Start	About Jorvik Exhibition Should be About the Centre About the Exhibition (see other HE)	
The Exhibition Guide	See item 10 from other HE ("The exhibition is about four areas of Viking life:"	
Introduction to Blacksmithing	There is clear evidence that blacksmith's workshop ->\ There is clear evidence that a blacksmith's workshop (update on GT as well)	
	iron working tools found include small anvil ->\ iron working tools found include a small anvil (update on GT as well)	
	hones whetstones ->\ honed whetstones I think this is what this should be. Hones whetstones doesn't make sense. I think you need to check the text.	
Chateline	Picture ->	

	More Pictures	
Viking Prick Spurs	The Vikings Spurs -> The Viking Spurs	
Prick Spurs Picture 01	Another Anglo-Scandinavian prick spurs -> Another Anglo-Scandinavian prick spur (there's only one spur in the picture!)	
Prick Spurs Picture 03	Almost complete tin plated prick spur -> Almost complete tin plated prick spur	
Wooden Bowl	Should be Wooden Bowls (twice on the page)	
Wooden bowls: use	(35) from previous HE: The text here is from the spur, not the bowls!	
Wooden bowls: More Picture	Should be More Pictures	
Wooden bowls: Interesting facts	The first , -> The first,	Typo.
The Vikings leather shoes	-> The Viking leather shoes	
Viking Leather Shoes	Picture -> More Pictures	
Picture 01	An Ankle Shoes -> An Ankle Shoe	
	(reconstructed ength 235mm) -> length	
Home life	No full stop at the end of the text	
	Homelife Objects -> Home Life Objects	
Bone Skates	The Vikings Bone Skates -> Viking	
	Picture -> More Pictures	
Skateimage01	From Picture 1 I could not get back to the picture thumbnails using the back button in the application, I had to use the browser back button	
Sewing equipment: use	The needles -> These needles	
	This would have been used -> They would	

Study 4: Table of Possible Questions for Engagement with Historic Church Questionnaire (Initial Pool)

Question	Source	Measures
1. I felt engaged with the church features		Engagement directly
2. The church features held my attention	Adapted from Jennett et al immersion in games questionnaire (App B/Q1)	Measures attention directly
3. I felt focused on the church features/elements	Adapted from Jennett et al immersion in games questionnaire (App B/Q2)	Measures attention
4. I prefer text-based to graphics-based supporting material at church	From MLA GLO document	Measures Enjoyment, Creativity & Inspiration in GLO How does this measure enjoyment, creativity and inspiration?
5. I found it was easy to move around the church	From MLA GLO document	Measures Action & Behavior in GLO
6. There was too much text associated with the features in the church	From MLA GLO document	Measures Enjoyment, Creativity & Inspiration in GLO How does this measure enjoyment, creativity and inspiration?
7. The graphics associated with the features were boring	From MLA GLO document	Measures attitudes & Values in GLO
8. I prefer graphical (images or pictures) materials to explain features in a church	Adapted from Jennett et al immersion in games questionnaire (App A/Q9)	Measures attitudes & Values in GLO
9. I enjoyed my experience at the	From MLA GLO document	Measures Enjoyment &

church		Inspiration in GLO
10. The contents on displays clearly explain the information about church features	From MLA GLO document	Measures knowledge & understanding in GLO
11. I got bored with the design of the church	From MLA GLO document	Measures attitudes & Values in GLO
12. The information provided about the features in the church was clear	From MLA GLO document	Measures knowledge & understanding in GLO
13. I was overwhelmed by the amount of information provided for the features	From MLA GLO document	Measures knowledge & understanding in GLO
14. After visiting the church, I was still interested to know more about the specific features	From MLA GLO document	Measures knowledge & understanding in GLO
15. The church was intellectually stimulating	From MLA GLO document	Measures knowledge & understanding in GLO
16. The design of the church motivated me to learn about the feature	From MLA GLO document	Measures attitudes & Values in GLO
17. My church visit aroused my curiosity and interest	From MLA GLO document	Measures Enjoyment & Inspiration in GLO
18. The information given by the audioguide was too lengthy	From MLA GLO document	Measures Enjoyment & Inspiration in GLO
19. I like to move around freely in the church without having to follow a specific sequences	From MLA GLO document	Measures Action & Behavior in GLO
20. I did not feel any emotional attachment to the church.	Adapted from Jennett et al immersion in games questionnaire (App A/Q2)	Measures emotions
21. I sometimes found myself to become so involved with the church features that I wanted to speak to speak directly to the features or the people who	Adapted from Jennett et al immersion in games questionnaire (App A/Q7)	

once owned them.		
22. I did not like the graphics and imagery associated with the church features.	Adapted from Jennett et al immersion in games questionnaire (App A/Q10)	
23. I enjoyed visiting the church.	Adapted from Jennett et al immersion in games questionnaire (App A/Q11)	
24. Visiting the church was not fun.	Adapted from Jennett et al immersion in games questionnaire (App A/Q12)	
25. I was unaware of what was happening around me.	Adapted from Jennett et al immersion in games questionnaire (App A/Q21)	Measures immersion/flow
26. I was aware of surroundings.	Adapted from Jennett et al immersion in games questionnaire (App A/Q22)	Measures lack of immersion/flow
27. I felt detached from the outside world.	Adapted from Jennett et al immersion in games questionnaire (App A/Q23)	Measures immersion/flow
28. I still felt in touch with the real world.	Adapted from Jennett et al immersion in games questionnaire (App A/Q24)	Measures immersion/flow
29. At the time the church feature was my only concern.	Adapted from Jennett et al immersion in games questionnaire (App A/Q25)	Measures immersion/flow
30. Everyday thoughts and concerns were still very much on my mind.	Adapted from Jennett et al immersion in games questionnaire (App A/Q26)	Measures immersion/flow

31. I did not feel the urge at any point to stop attending to the church features and see what was going on around me.	Adapted from Jennett et al immersion in games questionnaire (App A/Q27)	Measures immersion/flow
32. I was interested to know what might be happening around me.	Adapted from Jennett et al immersion in games questionnaire (App A/Q28)	Measures immersion/flow
33. I did not feel like I was in the real world but the world of the church features.	Adapted from Jennett et al immersion in games questionnaire (App A/Q29)	Measures immersion/flow
34. I still felt as if I was in the real world whilst walking around the church.	Adapted from Jennett et al immersion in games questionnaire (App A/Q30)	Measures immersion/flow
35. To me it felt like only a very short amount of time had passed.	Adapted from Jennett et al immersion in games questionnaire (App A/Q31)	Measures immersion/flow
36. How immersed did you feel?	Adapted from Jennett et al immersion in games questionnaire (App A/Q33)	Measures immersion/flow
37. How much effort did you put into thinking about the church features?	Adapted from Jennett et al immersion in games questionnaire (App B/Q3)	Measure cognitive involvement/effort
38. To what extent did you lose track of time?	Adapted from Jennett et al immersion in games questionnaire (App B/Q5)	Measures flow
39. To what extent did you feel consciously aware of being in the real world whilst walking around the church?	Adapted from Jennett et al immersion in games questionnaire (App B/Q6)	immersion
40. To what extent did you forget	Adapted from Jennett et al	immersion

about your everyday concerns?	immersion in games questionnaire (App B/Q7)	
41. To what extent were you aware of yourself in your surroundings?	Adapted from Jennett et al immersion in games questionnaire (App B/Q8)	immersion
42. To what extent did you notice events taking place around you?	Adapted from Jennett et al immersion in games questionnaire (App B/Q9)	immersion
43. To what extent did you feel that you were interacting with the features?	Adapted from Jennett et al immersion in games questionnaire (App B/Q11)	?
44. To what extent did you feel that the features was something you were experiencing, rather than something you were just visiting?	Adapted from Jennett et al immersion in games questionnaire (App B/Q13)	involvement
45. To what extent was your sense of being in the church stronger than your sense of being in the real world?	Adapted from Jennett et al immersion in games questionnaire (App B/Q14)	immersion
46. To what extent did you feel motivated while walking around the church?	Adapted from Jennett et al immersion in games questionnaire (App B/Q19)	movitation
47. To what extent did you feel emotionally involved with the church?	Adapted from Jennett et al immersion in games questionnaire (App B/Q23)	Emotional response
48. To what extent were you interested in seeing how the church features/elements would progress?	Adapted from Jennett et al immersion in games questionnaire (App B/Q24)	?

49. To what extent did you enjoy the graphics and the imagery of the features?	Adapted from Jennett et al immersion in games questionnaire (App B/Q28)	Measures Enjoyment & Inspiration
50. How much would you say you enjoyed visiting the church?	Adapted from Jennett et al immersion in games questionnaire (App B/Q29)	Measures Enjoyment & Inspiration
51. My visit to the church was very interesting	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Enjoyment, Creativity & Inspiration
52. My visit to the church was inspiring.	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Enjoyment, Creativity & Inspiration
53. I discovered new information from the exhibits	Adapted from MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures knowledge & understanding in GLO
54. I learnt things that changed my mind	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Attitudes & Values
55. My feelings and emotions were engaged	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Attitudes & Values
56. Some things were hard to understand	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures knowledge & understanding in GLO
57. I felt that I learnt some new information about features in the church	Adapted from MLA website- question Bank	Measures knowledge & understanding in GLO
58. I have developed an increased interest in something I knew little about before my visit	MLA website- question Bank	Measures knowledge & understanding in GLO
59. I could make sense of most of the things I saw and did at the church	MLA website- question Bank	Measures knowledge & understanding in GLO
60. I have gained knowledge that I can use or have used in my	MLA website- question Bank	Measures knowledge & understanding in GLO

work as a result of my visit		
61. church are more interesting than I thought	MLA website- question Bank	Measures Attitudes & Values
62. I left the church more interested in the subject of the exhibition than when I came	MLA website- question Bank	Measures Attitudes & Values
63. I have developed a new interest during my visit to the church	MLA website- question Bank	Measures Action, Behaviour and Progression
64. I can use the knowledge I learnt here when I visit other similar places	MLA website- question Bank	Measures Action, Behaviour and Progression
65. I would make another visit to that exhbition	MLA website- question Bank	Measures Action, Behaviour and Progression

Study 4: Final Questions for Engagement with Historic Church Questionnaire

Question	Source	Measures
1. I felt engaged with the church and its features		Engagement directly
2. The church features held my attention	Adapted from Jennett et al immersion in games questionnaire (App B/Q1)	Measures attention directly
3. I felt focused on the church and its features	Adapted from Jennett et al immersion in games questionnaire (App B/Q2)	Measures attention
4. I felt move in the church	From MLA GLO document	Measures Action & Behavior in GLO
5. There was too much information provided about the church and its features	From MLA GLO document	Measures Enjoyment, Creativity & Inspiration in GLO How does this measure enjoyment, creativity and inspiration?
6. I enjoyed my experience at the church	From MLA GLO document	Measures Enjoyment & Inspiration in GLO
7. I got bored with the church and its features	From MLA GLO document	Measures attitudes & Values in GLO
8. The information provided about the church and its features was clear	From MLA GLO document	Measures knowledge & understanding in GLO
9. I was overwhelmed by the amount of information provided about the church and its features	From MLA GLO document	Measures knowledge & understanding in GLO
10. After visiting the church, I was still interested to know more	From MLA GLO document	Measures knowledge & understanding in GLO

about it		
11. The church and its features were intellectually stimulating	From MLA GLO document	Measures knowledge & understanding in GLO
12. The church and its features motivated me to learn more	From MLA GLO document	Measures attitudes & Values in GLO
13. My church visit aroused my curiosity and interest	From MLA GLO document	Measures Enjoyment & Inspiration in GLO
14. I felt connected with the church and its features	Adapted from Jennett et al immersion in games questionnaire (App A/Q2)	Measures emotions
15. I enjoyed visiting the church.	Adapted from Jennett et al immersion in games questionnaire (App A/Q11)	Measures Enjoyment & Inspiration
16. I felt detached from the outside world while visiting the church.	Adapted from Jennett et al immersion in games questionnaire (App A/Q23)	Measures immersion/flow
17. I still felt in touch with the real world while visiting the church.	Adapted from Jennett et al immersion in games questionnaire (App A/Q24)	Measures immersion/flow
18. During my visit the church feature was my only concern.	Adapted from Jennett et al immersion in games questionnaire (App A/Q25)	Measures immersion/flow
19. During my visit everyday thoughts and concerns were still very much on my mind.	Adapted from Jennett et al immersion in games questionnaire (App A/Q26)	Measures immersion/flow
20. I felt as if only a very short amount of time had passed while I was in the church	Adapted from Jennett et al immersion in games questionnaire (App A/Q31)	Measures immersion/flow
21. During my visit I put a lot of effort into thinking about the church features and its features?	Adapted from Jennett et al immersion in games questionnaire (App B/Q3)	Measure cognitive involvement/effort
22. I felt I lost track of time while I was in the church	Adapted from Jennett et al immersion in games	Measures flow

	questionnaire (App B/Q5)	
23. I felt the church and its features were something I was experiencing, rather than just visiting?	Adapted from Jennett et al immersion in games questionnaire (App B/Q13)	involvement
24. My sense of being in the church was stronger than your sense of being in the real world?	Adapted from Jennett et al immersion in games questionnaire (App B/Q14)	immersion
25. I felt emotionally involved with the church and its features?	Adapted from Jennett et al immersion in games questionnaire (App B/Q23)	Emotional response
26. I enjoyed the imagery of the church?	Adapted from Jennett et al immersion in games questionnaire (App B/Q28)	Measures Enjoyment & Inspiration
27. My visit to the church was inspiring.	MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures Enjoyment, Creativity & Inspiration
28. I felt that I learnt new information from the visit to the church	Adapted from MLA website- Generic Learning Outcomes (GLO) Exit Survey	Measures knowledge & understanding in GLO
29. I have developed an increased interest in something I knew little about before my visit	MLA website- question Bank	Measures knowledge & understanding in GLO
30. I could make sense of most of the things I saw at the church	MLA website- question Bank	Measures knowledge & understanding in GLO
31. I have gained knowledge as a result of my visit	MLA website- question Bank	Measures knowledge & understanding in GLO
32. The church are more interesting than I thought it would be	MLA website- question Bank	Measures Attitudes & Values
33. I have developed a new interest as a result of my visit	MLA website- question Bank	Measures Action, Behaviour and Progression
34. I can use the knowledge I learnt during the visit when I visit other churches	MLA website- question Bank	Measures Action, Behaviour and Progression
35. I would make another visit to	MLA website- question Bank	Measures Action, Behaviour

this one		and Progression
36. I felt spiritually involved with the church and its features		Measures spiritually involvement
37. My visit enriched my knowledge and understanding	Adapted from Pekarik, Zoering & Karns (1999)	Measure cognitive experiences
38. Seeing the special features of the church gave me a sense of wonder	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
39. Visiting the church enabled me to reminisce about my past	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
40. I felt a peace in the church		Measures spiritually involvement
41. Seeing the special features of the church was the most satisfying aspect of my visit	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
42. The church had a spiritual atmosphere		Measures spiritually involvement
43. I was overwhelmed with the beauty of the church and its features	Adapted from Pekarik, Zoering & Karns (1999)	Measure object experiences
44. During my visit I was able to reflect on the significance of the church and its features	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences
45. Seeing the church and its features enabled me to imagine other places and time	Adapted from Pekarik, Zoering & Karns (1999)	Measure introspective experiences

Appendix Q

Study 4: Visitor Experience Questionnaire

Please indicate how much you agree with each of the following statements about your visit to Historic Church today. For each statement, mark one of the scale from strongly agree to strongly disagree.

The statements often ask about your reactions to the "church and its features". By this we mean the church building, its architecture and features from large to small such as chapels, stained glass, art work, statues, altars, carvings, fonts and so on. In fact, anything and everything you saw in the church.

Part A: Your Church Experience

1. My visit to the church aroused my curiosity and interest

Strongly Disagree Disagree Neutral Agree Strongly Agree

2. I felt engaged with the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. The church and its features held my attention

Strongly Disagree Disagree Neutral Agree Strongly Agree

4. There was too much information provided about the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

5. I enjoyed my experience at the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

6. The information provided about the church and its features was clear

Strongly Disagree Disagree Neutral Agree Strongly Agree

7. I felt focused on the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

8. After visiting the church I am still interested to know more about it

Strongly Disagree Disagree Neutral Agree Strongly Agree

9. I got bored with the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

10. I felt detached from the outside world while visiting the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

11. I was overwhelmed by the amount of information provided about the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

12. I felt moved in the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

13. The church and its features were intellectually stimulating

Strongly Disagree Disagree Neutral Agree Strongly Agree

14. The church and its features motivated me to learn more

Strongly Disagree Disagree Neutral Agree Strongly Agree

15. I enjoyed visiting the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

16. During my visit everyday thoughts and concerns were still very much on my mind

Strongly Disagree Disagree Neutral Agree Strongly Agree

17. It felt as if only a very short amount of time had passed while I was in the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

18. During my visit I put a lot of effort into thinking about the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

19. I felt the church and its features were something I was experiencing rather than just visiting

Strongly Disagree Disagree Neutral Agree Strongly Agree

20. I felt emotionally involved with the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

21. I still felt in touch with the real world while visiting the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

22. I felt spiritually involved with the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

23. I enjoyed the imagery of the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

24. During my visit the church and its features were my only concern

Strongly Disagree Disagree Neutral Agree Strongly Agree

25. My visit to the church was inspiring

Strongly Disagree Disagree Neutral Agree Strongly Agree

26. My sense of being in the church was stronger than my sense of being in the rest of the world

Strongly Disagree Disagree Neutral Agree Strongly Agree

27. My visit enriched my knowledge and understanding

Strongly Disagree Disagree Neutral Agree Strongly Agree

28. I felt that I learnt new information from my visit to the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

29. I felt I lost track of time while I was in the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

30. I have developed an increased interest in something I knew little about before my visit

Strongly Disagree Disagree Neutral Agree Strongly Agree

31. I could make sense of most of the things I saw in the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

32. Seeing the special features of the church gave me a sense of wonder

Strongly Disagree Disagree Neutral Agree Strongly Agree

33. I have gained knowledge as a result of my visit

Strongly Disagree Disagree Neutral Agree Strongly Agree

34. The church was more interesting than I thought it would be

Strongly Disagree Disagree Neutral Agree Strongly Agree

35. I have developed a new interest as a result of my visit

Strongly Disagree Disagree Neutral Agree Strongly Agree

36. Visiting the church enabled me to reminisce about my past

Strongly Disagree Disagree Neutral Agree Strongly Agree

37. I can use the knowledge I learnt during the visit when I visit other churches

Strongly Disagree Disagree Neutral Agree Strongly Agree

38. I would like to make another visit similar to this one

Strongly Disagree Disagree Neutral Agree Strongly Agree

39. I felt at peace in the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

40. Seeing the special features of the church was the most satisfying aspect of my visit

Strongly Disagree Disagree Neutral Agree Strongly Agree

41. The church had a spiritual atmosphere

Strongly Disagree Disagree Neutral Agree Strongly Agree

42. I was overwhelmed with the beauty of the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

43. I felt connected with the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

44. During my visit I was able to reflect on the significance of the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

45. Seeing the church and its features enabled me to imagine other places in time

Strongly Disagree Disagree Neutral Agree Strongly Agree

Part B: Your Demographic Information

Your age (decade only)

Are you male/female

I came alone / with one other person/ with bigger group

Nationality:

If you would like to be in the draw for 10 £25 Amazon gift vouchers, please provide the following information:

Name:

Email or physical address

This information will only be used for the draw, will not be passed to any other parties and will be destroyed after the draw.

Study 5: Heuristic Evaluation

Severity ratings of usability problems

The severity rating is based on a combination of three factors:

- The frequency with which the problem will occur – will users encounter it often or only rarely?
- The impact of the problem – is it difficult or easy to overcome
- The persistence of the problem – is it a "one time only" and then users will know what to do, or will users be repeatedly annoyed by it?

Severity rating scale:

4 – catastrophic problem, users will not be able to continue to their goal, must be fixed

3 – major problem, users will be very frustrated/have difficulty continuing to their goal, should be fixed

2 – minor problem, users will be frustrated/have difficulty continuing to their goal, could be fixed

1 – cosmetic problem, users will be mildly frustrated, would be nice to fix

0 – not a usability problem

Problem	Screen	Problem	CP	DS	KO	HP	
	Shakespeare Trail						Average
1	Introduction	Text too small	3	2	2	3	2.5
2		background showing through, obscuring text	2	2	3	3	2.5
3		button "view in church" too small	2	2	3	3	2.5
4		icon looks like trash can	1	1	1	2	1.25
5		"view in church"label is unclear	2	2	2	2	2
6		inconsistency between "The Shakespeare Trail" and text under inkwell picture which is "Shakespeare's church"	2	2	2	1	1.75

7		Cannot re-size text with pinch zoom - inconsistent with iPhone conventions	2	2	2	3	2.25
8		The inkwell icon does not look as if it is an icon, no-one realized it would navigate to somewhere else or where that would be	3	3	3	3	3
9		when you have the map view from the "explore the interior" the icons look very similar to the icons on the map view in the trails (they do have different symbols but they are very difficult to see) but you are taken to a panaromic view not a text/picture panel - inconsistent behaviour of the app	3	3	2	2	2.5
	map screen						
10		help icon too small	3	3	3	3	3
11		help icon hardly visible due to poor contrast with the background	3	3	3	3	3
12		no back button - no way back	3	4	3	4	3.5
13		what is the + icon for? Usually adding something (current use not consistent with iPhone conventions)	3	3	3	3	3
14		if you open the menu, then tap on the map, menu closes,but + sign does not return, a minus sign remains	3	2	3	4	3
15		purpose of icons in the menu not clear	2	2	2	3	2.25
16		if I return to the map view, no indication of which points of	2	2	3	3	2.5

		interest I've visited (although this is indicated in the in church view)					
17		if I return to the map view from in church view, a background view remains, but no indication of where that is on the map	2	1	2	2	1.75
18		from map view, cannot go back to the previous point of interest that I was looking at	3	3	3	3	3
	Help						
19		instructions are using open/close (a window metaphor), whereas the buttons in the app itself are using a web metaphor (not using the iPhone gestures and metaphor)	3	2	4	4	3.25
20		Instructions talk about a back button, but there is no back button on the map panel	3	3	2	3	2.75
21		too much information in one go, unstructured and difficult to read	2	3	1	3	2.25
22		when you access help from the in chruch view, the church view moves as you scroll the help	2	2	2	2	2
23		Wording of help message assumes the user will find things easy, this isn't necessary so	2	2	2	2	2
24		when you access help from the in exterior view, the church spins as you scroll the help	2	2	2	2	2
	Object of interest screen						
25		no indication that the text scrolls	2	2	2	2	2
26		help button is behind text and can only be activated with	2	3	2	2	2.25

		difficulty					
	View in church screen						
27		no indication that you can move around					
28		scrollling not consistent with other iPhone apps	2	2	2	0	1.5
29		purpose of black arrow on green background icon unclear	1	1	1	2	1.25
30		transition action disorienting, not clear where I've gone	3	3	3	3	3
31		how can I "undo" /go back from the transition?	3	3	3	3	3
32		colour coding of point of interest icons (green/yellow) unclear	2	2	2	2	2
33		up/down scrolling is directly mapped (look up, move finger up) whereas the left/right scrolling is inverted (look right, move finger left)	3	3	3	3	3
	Exterior church view						
34		when you access text from the exterior view, the church spins as you scroll the text, so you lose the aspect of the church you are reading about	3	3	2	3	2.75
35		tapping an area of the church exterior opens description panel, tapping the area again does not close it, despite the highlighting being removed	3	3	3	3	3
36		as you move the time slider, the church spins as well, so you can not see particular changes (and	3	3	2	3	2.75

		spin is another gesture)					
37		it is possible to slip off the time slider without any interruption to the church spinning	3	3	3	3	3
38		no markers on the time slider	2	2	2	2	2
39		if you come into the exterior view from a trail, you cannot return to the trail you were on	3	4	4	3	3.5

Study 5: Visitor Experience Questionnaire

Please indicate how much you agree with each of the following statements about your visit to Holy Trinity Stratford today. For each statement, please circle one of the statements from strongly agree to strongly disagree, like this:

I feel happy today

Strongly Disagree Disagree Neutral Agree Strongly Agree

The statements often ask about your reactions to the "church and its features". By this we mean the church building, its architecture and features from large to small such as chapels, stained glass, art work, statues, altars, carvings, fonts and so on. In fact, anything and everything you saw in the church.

Part A: Your experience in the church

1. My visit to the church aroused my curiosity and interest

Strongly Disagree Disagree Neutral Agree Strongly Agree

2. I felt engaged with the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

3. The church and its features held my attention

Strongly Disagree Disagree Neutral Agree Strongly Agree

4. I enjoyed my experience at the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

5. I felt focused on the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

6. I felt detached from the outside world while visiting the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

7. I was overwhelmed by the amount of information provided about the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

8. I felt moved in the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

9. I enjoyed visiting the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

10. During my visit everyday thoughts and concerns were still very much on my mind

Strongly Disagree Disagree Neutral Agree Strongly Agree

11. I felt emotionally involved with the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

12. I still felt in touch with the real world while visiting the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

13. I felt spiritually involved with the church and its features

Strongly Disagree Disagree Neutral Agree Strongly Agree

14. My sense of being in the church was stronger than my sense of being in the rest of the world

Strongly Disagree Disagree Neutral Agree Strongly Agree

15. I felt that I learnt new information from my visit to the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

16. I have developed an increased interest in something I knew little about before my visit

Strongly Disagree Disagree Neutral Agree Strongly Agree

17. I have gained knowledge as a result of my visit

Strongly Disagree Disagree Neutral Agree Strongly Agree

18. I have developed a new interest as a result of my visit

Strongly Disagree Disagree Neutral Agree Strongly Agree

19. The church had a spiritual atmosphere

Strongly Disagree Disagree Neutral Agree Strongly Agree

20. I felt detached from the outside world while visiting the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

Part B: Your experience with the iPhone guide

21. The information given by the iPhone guide was too lengthy

Strongly Disagree Disagree Neutral Agree Strongly Agree

22. I became unaware that I was even using any controls on the iPhone guide

Strongly Disagree Disagree Neutral Agree Strongly Agree

23. It was difficult to determine where I was in the church with the iPhone guide

Strongly Disagree Disagree Neutral Agree Strongly Agree

24. I will use an iPhone guide again when I visit a church or exhibition

Strongly Disagree Disagree Neutral Agree Strongly Agree

25. The iPhone guide was complicated to use

Strongly Disagree Disagree Neutral Agree Strongly Agree

26. I felt self conscious using the iPhone guide

Strongly Disagree Disagree Neutral Agree Strongly Agree

27. Learning to operate the iPhone guide was easy

Strongly Disagree Disagree Neutral Agree Strongly Agree

28. The iPhone guide helped me to navigate around the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

29. The iPhone guide responded too slowly

Strongly Disagree Disagree Neutral Agree Strongly Agree

30. The controls of the iPhone guide were difficult to understand

Strongly Disagree Disagree Neutral Agree Strongly Agree

31. Using the iPhone guide did not require much training

Strongly Disagree Disagree Neutral Agree Strongly Agree

32. It was difficult to select the option I wanted with the iPhone guide

Strongly Disagree Disagree Neutral Agree Strongly Agree

33. Using the iPhone guide enhanced my visit to the church

Strongly Disagree Disagree Neutral Agree Strongly Agree

34. The iPhone guide was a distraction

Strongly Disagree Disagree Neutral Agree Strongly Agree

35. I felt that I was in control of the iPhone guide

Strongly Disagree Disagree Neutral Agree Strongly Agree

36. I found it difficult to read the text on the screen of the iPhone guide

Strongly Disagree Disagree Neutral Agree Strongly Agree

37. The iPhone guide presented information in an understandable manner

Strongly Disagree Disagree Neutral Agree Strongly Agree

38. The iPhone guide clearly provided feedback about my actions

Strongly Disagree Disagree Neutral Agree Strongly Agree

39. It was clear to me when the iPhone guide was taking the initiative to offer me information and when I needed to ask it for information

Strongly Disagree Disagree Neutral Agree Strongly Agree

Appendix T

Study 5: Open Ended Questions

1. During your visit to the church, did you feel really immersed in the experience of the church, that the rest of your life and concerns dropped away?
   Very much / to some extent / a bit / Not at all Why/How/Comments:
2. Do you think that there was not enough / enough / too much information provided about the church and its features?
   not enough / enough / too much Why/How/Comments:
3. Did your visit to the church hold your attention and engage you completely?
   Very much / to some extent / a bit / Not at all Why/How/Comments:
4. Did your visit visit stimulate your curiosity and interest?
   Very much / to some extent / a bit / Not at all Why/How/Comments:
5. Did you enjoy your visit to the church?
   Very much / to some extent / a bit / Not at all Why/How/Comments:
6. Did you learn new information from your visit?
   Very much / to some extent / a bit / Not at all
   If yes, what kind of information, how did you learn this info?
7. Do you think you would develop a new interest or an increased interest in something you knew little about before, as a result of your visit?
   Yes / No if yes, what/how?
8. Did you feel you had a spiritual or tourist experience during your visit?
   Spiritual / tourist / both Comments
9. At any point during your visit, did you feel an emotional engagement with the church and its features?
   Yes / No Comments
10. Did you find the iPhone Guide easy to use?
    Very much / to some extent / a bit / Not at all Comments

11. Did you find the iPhone Guide easy to control?

Very much / to some extent / a bit / Not at all Comments

12. Did you have to learn and remember how to use the iPhone Guide?

Very much / to some extent / a bit / Not at all Comments

13. How did you feel about the general quality of interaction with the iPhone guide?

14. Visited the church: alone / with one family member - friend / with several family members – friend / as part of a group

15. Where have you come from today?

likely answers: staying in Stratford or nearby (if so, how long for?)

from Birmingham

from London (if so how long in Stratford?)

other:

16. Where will you go after Stratford?

17. Did you find the church easily?
(prompts: did they use a map, tourist brochure, follow signs, just stumble on it)

18. Have you visited the church website, Facebook page [we will have slips with the addresses for these to give to people, if they are interested]

19. What brought you to Holy Trinity Stratford?

Shakespeare connection / a historic church / to pray / light a candle / other

Follow up: if they came for Shakespeare, did they like other things about the church?

Gender: Male / Female

Age:

iPhone user: Yes / No If yes, how long (years):

Nationality:

Time tour started:

Time returned:

Study 5: Instructions

Guided Tour Instructions:

1. To start the tour, please tap on the **Introduction** icon and read the introduction screen.
2. Then tap on the **Back** button to return to the main screen, and tap on the **Explore the Interior** icon. This will take you to a map of the church. The map has three ***i*** icons for different places of interest in the church.
3. Please use the map provided to help you find the location of the place of interest in the church.
4. Start your tour by tapping on the first ***i*** icon on the left. There are four points of interest in the picture to explore.
5. You can navigate around the picture view of the church by scrolling up/down/left/right.
6. After you finished, tap on the **+** icon in the top right of the screen and tap on the compass symbol (top right), and you will go back to the map.
7. For this tour, please don't use the green arrows to navigate if you encounter them!
8. Repeat the exploration process for the other two ***i*** icons on the map, going from left to right. The thumbtack icon means you have already visited a place of place.
9. Please return to the reception area after you finish the tour and one of the research team will then give you a short questionnaire and interview.

If at any stage you are having difficulty with the guide, just ask one of the research team and they will assist you.

Many thanks for your help with this research on the guide

Free choice Tour Instructions:

1. To start the tour, please tap on the **Introduction** icon and read the introduction screen.
2. Then tap on the **Back** button to return to the main screen, and tap Trails and you will be given three set of trails, **Shakespeare's Church**, **Pilgrim Trail** and **Highlights & Hidden Treasures**.
3. Pick one of the trails that interests you to follow.
4. Tap on the icon for the trail you wish to follow and read the introduction.
5. Then tap on the **View In Church** icon, and it will take you to a map of the church. The map has ***i*** icons for different places of interest on the trail.
6. Use the map to help you find your location and move to the different places of interest on the trail.
7. For this tour, please don't use the green arrows to navigate if you encounter them!
8. After you finished each place of interest in the trail, tap on the **+** icon and then tap on the compass symbol (top right), and you will go back to the map.
9. When you have visited all the places of interest on the trail (or wish to finish your visit) please return to the reception area and one of the research team will then give you a short questionnaire and interview.

If at any stage you are having difficulty with the guide, just ask one of the research team and they will assist you.

Many thanks for your help with this research on the guide

Study 5: Post-hoc test for time analysis for the three groups of participants

LSD	1.00	2.00	-4.236	2.428	.087	-9.10	.63
		3.00	-9.053*	2.488	.001	-14.04	-4.07
	2.00	1.00	4.236	2.428	.087	-.63	9.10
		3.00	-4.817	2.428	.052	-9.68	.05
	3.00	1.00	9.053*	2.488	.001	4.07	14.04
		2.00	4.817	2.428	.052	-.05	9.68

*. The mean difference is significant at the 0.05 level.