THE IMPACT OF LEARNING STYLES AND CULTURAL BACKGROUND ON USERS' EXPERIENCE OF WEBSITES

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ABSTRACT

Many different types of people now use websites for many sources of information. Nevertheless, the diversity and complexity of the online information available on websites and the desire to make websites provide all information for all users, regardless their interest, ability or characteristics, means that websites can be overwhelming to users. Museum websites are a case in point, trying to provide information to a great diversity of users. For these reasons, there have been numerous efforts to individualize user experiences in websites. These efforts have been based on users' individual or group differences such as their goals, interests, preferences, knowledge, backgrounds, demographic characteristics, experience, learning styles, and culture. This programme of research investigates whether learning styles as an individual difference and cultural background as a group difference can affect web users' experience, performance and perceived usability by conducting a card sort study, an interview study and an ecologically valid study of users' experience with museum websites.

To investigate learning styles, the Felder-Silverman Learning Style Model was used with its associated Felder-Solomon Index of Learning Styles (ILS). The ILS was developed in English, making it unsuitable for Turkish learners, one of the target cultural groups for this research programme. Therefore, the ILS was translated into Turkish and adequate reliability and validity established by administering it twice over a four-week interval to 63 undergraduate students in Turkey. Henceforth, the Turkish version of the ILS will be referred as the Turkish Index of Learning Styles (T)ILS.

The aim of the card sort study was to investigate user understandings of the organization of the museum and news websites and to reveal learning styles and cultural differences between participants' categorizations and mental models of the information architectures. The study was conducted in UK and Turkey with 214 and 90 participants, respectively. Analysis of the data showed that participants have mental models that differ substantially from the typical websites in these domains. In addition, interesting and meaningful differences were found between participants with different learning styles profiles and among British, Chinese, Indian and Turkish participants. This study also made a methodological contribution, showing that the card sort method can be used to show learning styles and cultural differences.

The aim of the interview study was to investigate the perceptions of museum personnel concerning the adaptation of websites in relation to both learning styles and cultural differences among visitors and to investigate whether they were interested in these issues. Five developers from Turkey and five developers from UK and USA were interviewed and content analysis was used to analyze their responses. The study showed that almost none of the interviewees were aware of the concept of learning styles, but the majority were very interested when they were told about it. Furthermore, a majority of interviewees thought learning styles had potential to make their websites more appealing to a wider range of visitors. Lastly, most interviewees were interested in the idea of dealing with cultural differences in other ways than mere translation of texts.

The final study investigated how learning styles and cultural differences affect users' experience, performance and perception of the usability of two museum websites. It was administered in the UK with an international sample of 210 participants. Participants were asked to perform a number of tasks on these websites, the tasking being carefully chosen to direct participants to aspects of the websites that would suit particular learning styles. This study showed significant differences among users depending on their learning styles and cultural background. This study also makes an important methodological contribution in that moves away from the paradigm of trying to manipulate online materials to match or clash with users' learning styles or other preferences.

The results of this research programme will be important for developers of museum and similar websites who want to take the advantage of developing supportive websites by focusing on users' learning styles and cultural differences.

LIST OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

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AUTHOR'S DECLARATION

I declare that the research work presented in this thesis is original work of my own, unless otherwise indicated in the text. Parts of this thesis have been published in the following paper:

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Chapter 1: Introduction

Many different types of people now use websites for many sources of information. Nevertheless, the diversity and complexity of the online information available on websites and the desire to have websites provide all information for all users, regardless their interest, ability or characteristics, means that websites can be overwhelming to users. Museum websites are a case in point, trying to provide information and informal learning environment to a great diversity of users. Users have individual or group differences such as their goals, interests, preferences, knowledge, backgrounds, demographic characteristics, experience, learning styles, and culture. Therefore, it is very difficult to satisfy and engage a wide range of users or improve their experience with websites. Users show striking differences when they are acquiring new information that suggests they have different learning style profiles. Furthermore, users' cultural background affects how they think, feel and act. Websites present environments for users to learn, whether they are formal or informal, and if they are developed regarding these two user characteristics they can enhance users' engagement, experience and learning. However, little research exists that examines the impact of learning styles and cultural background on users' experience of websites. My research programme will help to fill this gap. This research investigates whether learning styles as an individual difference and cultural background as a group difference can affect web users' experience, performance and perceived usability by conducting a card sort study, an interview study and an ecologically valid study of users' experience with museum websites.

To investigate users' learning styles the Felder-Silverman Learning Style Model (LSM) was selected since it has been widely used in information systems (see Section 3.2 for explanation on selection of the LSM) and the associated Felder-Solomon Index of Learning Styles (ILS) was used to measure learning styles. As a Turkish researcher, I wished to include Turkish users as one of the cultural groups of this research programme. However, the ILS was developed in English, and although it has been translated into a number of languages, I was not aware of a Turkish version. Therefore, the ILS was translated into Turkish and the studies on reliability and validity of the questionnaire were performed. In the course of conducting this work, it was discovered that the ILS had already been translated into Turkish. However, I found many problems with that translation. Unlike the previous translation, I used professional translation techniques during development of the questionnaire. In addition, I established the reliability and validity of the questionnaire by conducting two different test administrations with a four-week inter-test interval. Therefore my Turkish version of the ILS is a useful contribution to the study of learning styles.

In the first study, I examined learning styles and cultural differences to reveal differences in users' categorizations and mental models of the information architectures (IAs) in two website domains (museum and news sites) by using a card sort methodology. These informal learning domains were selected since people who visit museum websites may well be tourists coming from different cultures and many people visit news websites almost every day and people would seem to be familiar with their structure. Furthermore, these domains provide rich multimedia information for its users. To evaluate IAs of the websites, I used a simple, quick, cheap, and reliable method that is called the card sort technique. This study illustrated interesting and meaningful differences between users with different learning styles and among different cultural groups. This study also made a methodological contribution, showing that the card sort methodology could be used to show learning styles and cultural differences.

Next, I wished to move on to investigate informal learning on museum websites in more detail and the effects of learning styles and cultural background. But while it is fairly clear that museum personnel should be interested in the cultural background of their visitors, given the highly international nature of tourism and museums, it is not clear that they would be interested in trying to address differences in learning styles amongst the visitors to their websites. Therefore, I wanted to investigate whether the results of such research would have practical use to museums. For that reason, a series of interviews were conducted with museum personnel to investigate their perceptions of visitor needs for adaptation of websites in relation to both learning styles and cultural background and to find out whether they were interested in these issues. The study showed that almost none of the interviewees were aware of the concept of learning styles, but the majority were very interested when they were told about it. In addition, a majority of interviewees thought learning styles had potential for how to make their websites more appealing to a wider range of visitors. Lastly, most were interested in the idea of dealing with culture in other ways than their current strategy of merely translating texts.

In the light of the above results, the museum website study of the research programme investigated how learning styles and cultural background affect users' experience, performance and perception of the usability of two museum websites. The museum website study showed significant differences among users depending on their learning styles and cultural background. This study also makes an important methodological contribution in that moves away from the paradigm of trying to manipulate online materials to match or clash with users' learning styles or other preferences. Instead, a more ecologically valid approach was taken. Two real museum websites were analyzed in order to identify pages and functionality that would particularly suit people with particular learning styles. Tasks were then created that would direct people to those particular pages, so that I would measure their performance and experience on those pages in a naturalistic scenario of use. In this manner, the experience, performance and perceived usability

of users with different learning styles and cultural background in realistic museum website environments were assessed and the effects of elements of websites that might suit different learning styles and cultural backgrounds were investigated.

1.2 Research Issues

This research investigates what users' understanding of IAs on websites and their experience, performance and perceived usability of websites are in relation to two user characteristics: learning styles and cultural background. In order to study this, three research questions have been proposed:

1) *Are there any differences in users' categorizations and mental models of the IAs based on their learning styles and cultural background?*
2) *What are museums trying to do with their websites and how are they trying to accommodate the wide range of user preferences (such as learning styles or cultural background) and are museums interested in using concepts such as learning style to make their online materials more engaging to users?*
3) *How do learning styles and cultural background affect users' experience, performance and perceived usability of informal learning websites such as large museum websites?*

The rest of the thesis is organised as follows:

Chapter 2 discusses relevant literature and background to the thesis. A number of research areas will be covered including learning styles, cultural differences and personalization.

Chapter 3 presents the selection method for the LSM used in the research, the Felder-Silverman LSM along with its questionnaire ILS. Furthermore, it provides the development of the Turkish Index of Learning Styles (T)ILS and the studies on its reliability and validity.

Chapter 4 presents the study that explores learning styles and cultural background to reveal the differences in users' categorizations and mental models of the IAs by using card sort methodology in two website domains (museum and news sites) to address the first research question.

Chapter 5 presents the interviews with museum personnel to investigate their perceptions of visitor needs for adaptation of websites in relation to both learning styles and cultural background and to find out whether they are interested in these issues to address the second research question.

Chapter 6 presents the museum website study which investigates the third research question that is how learning styles and cultural background affect users' experience, performance and perception of the usability of informal learning websites such as large museum websites.

Chapter 7 presents the overall discussion of the main outcomes, contributions, limitations, future plans, implications and guidelines of the programme of research.

Chapter 2: Literature Review

2.1 Introduction to Literature Review

This programme of research draws on a number of widely varying research areas: learning styles, cultural differences and the personalization of online learning systems (OLSs).

There are different types of learning: formal and informal learning. In addition, there are different terminologies that are used to describe the ways of supporting learning with computers, educational software and websites. Firstly, definitions of learning styles and these terminologies will be given. Some researchers incorrectly use the terms learning and cognitive styles interchangeably and these terms have been constantly criticized for creating conceptual confusion. Therefore, the difference between learning and cognitive styles will be clarified (see subsection 2.2.1) followed by a discussion of the link between learning styles and informal learning that happens on websites.

A considerable number of studies have been carried out in the area of learning styles and many learning style models (LSMs) have been proposed in the literature. Hence, an overview of LSMs will be provided (see subsection 2.2.2). Next, the difficulty of assessing learning styles will be discussed since this is the one of the main issues in learning styles research (see subsection 2.2.3). Then, key LSMs will be introduced with examples from their use in OLSs (see subsection 2.2.4).

Some LSMs overlap considerably with each other. There are lots of similarities and relationships between these models and their dimensions and there is no agreed taxonomy. Thus, an integration of dimensions from key LSMs will be proposed (see subsection 2.2.5). In addition, there are several important issues that have been still under discussion in the field of learning style. Hence, a discussion of criticisms of learning styles and LSMs will be provided at the end of this section (see subsection 2.2.6).

In the third section of this chapter, cultural differences amongst web users will be explored. The section includes the following topics: the definition of culture (see subsection 2.3.1), Hofstede's theory (see subsection 2.3.2) and its criticism (see subsection 2.3.3), cultural differences in website design (see subsection 2.3.4) and cultural differences in museum environments (see subsection 2.3.5).

Researchers argue that learners' early experiences through their life play a role in forming one's learning style. Thus, the relationship between learning styles and cultural differences will be discussed in the fourth section (see section 2.4).

One way of incorporating learning style and cultural differences into OLSs and websites is to allow personalization of material. The fifth section will present the definition of personalization, an overview of the different approaches proposed for personalizing such systems, research on these approaches and benefits of personalization. Then, a critique of that research and a proposal for an alternative approach will be provided, which will be explored in Chapter 6 of the thesis (see section 2.5).

Finally, this chapter will end with a conclusion that points to why the studies in this research programme have been undertaken in the light of this critique of the literature (see section 2.6).

2.2 Learning and Learning Styles

2.2.1 Introduction to Formal and Informal Learning and Learning Styles

Online learning systems (OLSs) can be defined as presenting information to learners through the web. Users can either learn online by taking an online course (*formal learning*) or visiting a website (*informal learning*). The Organisation for Economic Co-operation and Development (OECD)[1] defines formal learning as "… always organised and structured, has learning objectives and is always intentional" whereas informal learning as "…is never organised, has no set objective in terms of academic performances and is never intentional from the learner's standpoint". For instance, learners may undertake formal learning by taking a specific course through an OLS that uses electronic information resources whereas they may undertake informal learning while they are visiting a museum website.

Learning styles have been studied in different disciplines including psychology, education and computer science and can be defined as "…how people acquire and understand new knowledge and skill" (ETaLD, 2005, p.5). Some researchers incorrectly use the terms *learning styles* and *cognitive styles* interchangeably and have been constantly criticized for creating a conceptual confusion. Rayner (2001, p.2172) highlighted the distinction by defining these terms as: "individuals possess a personal way of learning (learning style) or thinking (cognitive style)". Therefore, if researchers' are concerned about the learning process and achievement of learners then they are studying learning styles rather than on cognitive styles. In other words, they should focus on individual differences in the process of learning rather than learners themselves, or learners' thinking processes.

[1] http://www.oecd.org/edu/skills-beyond-school/recognitionofnon-formalandinformallearning-home.htm, Accessed 7th Aug 2014

Sadler-Smith (2001) also explored the relationship between the terms learning and cognitive styles. In an empirical study the author used Kolb's Learning Style Inventory (LSIb) (see subsection 2.2.4.2) to measure learners' learning styles and Riding's Cognitive Style Analysis (CSA) (Riding, 1991) to measure their cognitive styles. The author gathered data from 107 undergraduate students and analyzed the data by using correlation and principal component analysis (PCA) (see Glossary section for the definition of the term). The correlations between dimensions of learning and cognitive styles were non-significant (see subsection 2.2.4.2 for further text on Kolb LSM and its dimensions). In further analysis, scores for each dimension of learning and cognitive styles were subjected to PCA. The dimensions of learning and cognitive styles loaded exclusively to different factors. Therefore, the findings of the study suggested that these two concepts are independent and should be treated as separate terms.

There are different terminologies used to describe the ways of supporting learning with computers, educational software and websites. Tavangarian, Leypold, Nölting and Röser (2004, p.274) defined *e-learning, elearning* or *technology-enhanced learning* (TEL) as "…all forms of electronic supported learning and teaching, which are procedural in character and aim to effect the construction of knowledge with reference to individual experience, practice and knowledge of the learner. Information and communication systems, whether networked or not, serve with specific media to implement the learning process." E-learning is a more recent and broader term that is used in relation to *online learning systems (OLSs)* or *web-based learning (WBL). Computer-based learning (CBL)* is another term that is used widely and it is the process of using computer as a key component for learning as a part of the learning materials and part of the delivery. I will use OLSs to refer these terms throughout the thesis since this term matches studies that I will discuss in this chapter.

Many educational institutions now use the concept of learning style in developing educational materials, including web materials and OLSs (ETaLD, 2005) and teachers recognize the importance of using different instructional methods and materials matched to their students' learning styles (Leite, Svinicki & Shi, 2010). Schaller and Allison (2005) noted that over the past thirty years researchers have investigated OLSs but the majority of that research has focused on formal learning and it is not clear that results of these studies are transferable to informal learning. When considering specifically the key focus of this programme of research, informal learning on museum websites, Lin and Gregorc (2006) argued that there have been remarkably few studies that guide us on what the characteristics of museum websites should have to encourage learning. Regardless the type of learning experience on the web (formal or informal), learning styles are not an only source of difference in learners' behaviour, but they are a significant factor in affecting the reactions of learners in OLSs (Bousbia, Rebai, Labat & Balla, 2010).

The next subsection introduces learning style models (LSMs) and then a number of key LSMs will be presented (see subsection 2.2.4).

2.2.2 Overview of Learning Style Models (LSMs)

A considerable number of studies have been carried out in the area of learning styles and many LSMs have been proposed in the literature. Coffield, Moseley, Hall & Ecclestone (2004) identified 71 LSMs /cognitive style models (CSMs) and the instruments, inventories or questionnaires[2] that are used to measure learning and cognitive styles. They categorised 13 models as major ones, according to their theoretical importance in the field, widespread use, and their influence on other models. They also recognized and highlighted the incorrect usage of terms and concepts in learning style research. However, they themselves referred to some of the models in their research as LSMs although them were CSMs, thus perpetuating the inaccuracy of terminology. They examined each model to check whether they met four criteria: whether measurement of the model demonstrates internal consistency, test–retest reliability, construct and predictive validity (see Glossary section for the definitions of these terms). They reported that Allison and Hayes' Cognitive Style Index (CSI) was the only questionnaire that met these four criteria. Allison and Hayes (1996) tested their questionnaire for its reliability and validity. 1000 adults participated in the study and the results showed that the questionnaire has an excellent reliability and validity for the purposes of internal consistency and stability. However, even Allison and Hayes believed that the results should be replicated and extended.

Table 2.1 on the next page lists a number of LSMs along with their dimensions, questionnaire and key references. Bold rows indicate LSMs from the Coffield et al. (2004) review. As this thesis focuses on learning styles rather than cognitive styles, CSMs that Coffield et al. reviewed are not included. In addition, the table lists some other popular and widely used LSMs that I encountered during my literature survey (rows not in bold).

[2] Numerous terms are used. Henceforth, I will use the term questionnaire.

Table 2.1 Major LSMs with their Dimensions, Questionnaire and References

LSMs	Dimensions	Questionnaire	Model Reference-Questionnaire Reference
Dunn and Dunn LSM	**Environmental** **Emotional** **Sociological** **Physiological** **Psychological**	**Learning Styles Inventory (LSIa)** **The Building Excellence Inventory (BEI)**	**Dunn and Dunn (1974) - Dunn, Dunn and Price (1996)- Rundle and Dunn (2000)**
Kolb LSM	**Accommodating** **Assimilating** **Converging** **Diverging**	**Learning Style Inventory (LSIb)**	**Kolb (1976) - Kolb and Kolb (2006)**
Honey and Mumford LSM	**Activist** **Reflectors** **Pragmatist** **Theorists**	**Learning Style Questionnaire (LSQ)**	**Honey and Mumford (1982) - Honey and Mumford (2000)**
Felder-Silverman LSM	Active-Reflective Sensing-Intuitive Visual-Verbal Sequential-Global	Felder and Solomon Index of Learning Styles (ILS)	Felder and Silverman (1988)-Felder, Silverman and Solomon (1996)
VARK LSM	Visual Aural Read/Write Kinaesthetic	VARK Questionnaire (VARK)	Fleming (1995)
Sarasin LSM	Auditory Visual Tactile/Kinaesthetic	-*	Sarasin (1999)

* Sarasin LSM does not have a questionnaire.

I will review the LSMs that are presented in Table 2.1 above in some detail in subsection 2.2.4. However before that, the next subsection discusses the difficulty of measuring learning styles.

2.2.3 Measuring Learning Styles

One of the main issues in learning style research is the need to assess learners' learning styles. A simple and widespread approach is to ask learners to complete a questionnaire. However, questionnaires can bother learners if they are long or complex, as these kinds of questionnaires can be tedious to take. In cases where learners are irritated, they tend to choose answers arbitrarily rather than thinking carefully about them. As Popescu (2008) highlighted, the accuracy of learners' responses is questionable since learners' may not want to give misleading impressions and may be subject to the demand characteristics (see Glossary for the definition of the term) of the situation. In addition, it may be difficult to get learners to complete questionnaires, particularly if they are not aware of consequences of the questionnaire. Another problem is that not all questionnaires to measure learning styles have versions in different languages and not all of these different versions have been evaluated in terms of reliability and validity. Thus conducting research in different countries and cultures on learning styles is not simple. Finally, as Graf (2007) noted, the use of questionnaires is based on the assumption that learning styles are stable over time and situations. However, the stability of learning styles is still an open question, which will be discussed in subsection 2.2.6.

Several researchers have used approaches to measuring learning styles based on artificial intelligence (AI). Garcia, Amandi, Schiaffino, Campo (2007) and Graf, Kinshuk, Liu (2009) both used *Bayesian networks* (BNs), that is graphical probabilistic models, to identify learning styles. Their attempt was to estimate learning styles by observing and modelling learners' behaviour by using BNs. The number of learners' postings in a forum or the number of times learners participate in a chat can be examples of behaviours that can predict Active learners (see subsection 2.2.4.4 for explanation of Active learners) since this kind of learners like to be active during their learning process. The studies both compared learning styles modelled by using BNs with learning styles obtained by the ILS (see subsection 2.2.4.4 for the details of this questionnaire) with 27 and 127 learners, respectively. Garcia et al. (2007) and Graf et al. (2009) compared the results with a precision formula. Garcia et al. (2007) obtained a precision of 58% in the Active-Reflective dimension, 77% in the Sensing-Intuitive dimension and 63% in the Sequential-Global dimension whereas Graf et al. (2009) obtained a precision of 79% in the Active-Reflective dimension, 77% in the Sensing-Intuitive dimension, 77% in the Visual-Verbal dimension and 73% in the Sequential-Global dimension. Graf et al. (2009) achieved results

better than Garcia et al. (2007). In addition, Graf et al. (2009) took all dimensions of the Felder-Silverman LSM into account whereas Garcia et al. (2007) discarded the Visual-Verbal dimension. However, evaluations of this approach yielded good results in both studies so that both of them concluded that the approach is suitable for identifying learning styles automatically.

Case-based reasoning (CBR) also an AI technique that solves new problems based on the solutions of similar past problems. ARTHUR (Gilbert & Han, 1999) is an OLS that attempts to identify learning styles using CBR. One of the reasons that the authors used this approach is that the system implements the Sarasin LSM (see subsection 2.2.4.6 for the details of this model) and Sarasin has not developed a questionnaire to assess learners on the dimensions of this LSM. The system consists of several different styles of instruction from several different instructors from the same field. To illustrate, instructor A can use audio-based instruction while instructor B can use text-based instruction. When learners enter the system, they assigned to a course concept (small sections of the course) by chance. Each concept ends with an evaluation quiz entered by the instructor. Each learner should get a score of 80% or better to continue with in the current instruction mode or move to the next concept. That means when learner gets adequate score for a specific concept, the system assumes that the instruction mode that is used is suitable for the learner. The system also logs the questions that the learner failed to answer. ARTHUR creates a learner model when a learner successfully completes a course using the system, classifies them and uses this information to assign new learners to the most suitable learning environment. For example, learner A completed first concept successfully that is given by instructor A but failed on the second concept. The system then assigned learner A to instructor B and learner A completed the second concept successfully. Suppose that learner B completed first concept successfully that is given by instructor A but failed on second concept and failed to answer same questions with learner A. Then the system assumes that learner A and learner B have similar learning styles and assigns learner B to instructor B automatically. Therefore, by using CBR the system gives a solution to learner B by using a similar case, learner A's case.

The same approach can be used to automatically assess learning styles by observing learners' different behaviours such as emotions or their reaction to some specific features of the website, aspects such as navigation, content, design or organization of the page. Bousbia et al. (2010) demonstrated that there is a relationship between learning styles and learners' navigation behaviour and concluded this relationship can be used to automatically detect learning styles. The authors explored the relationship with 27 graduate students using an OLS. The learners' navigation behaviour was evaluated using a navigation type indicator that classifies the learners' navigation behaviour in four types: Overviewing (the learners scan to get an overview of the

course), Studying (the learners completely read the course pages), Deepening (the learners that stay on course pages relatively long time), and Flitting (the learners surf the course without a particular goal and have lack of concentration on the course). The ILS (see subsection 2.2.4.4 for the details of this questionnaire) was used to identify learners' learning styles. Chi-square tests were applied to show relationships between learning style dimensions and the navigation type indicator. Even though these tests showed a significant relationship only for the Sensing-Intuitive dimension, the authors claimed that the observations affirm relationships for all dimensions. To illustrate, Active learners tended to make more navigation to gain overviews whereas Reflective learners tended to make more studying navigation (see subsection 2.2.4.4 for explanation of Active and Reflective learners). This finding is consistent with expectations, as Active learners prefer to actively explore the contents and Reflective learners take more time to think and read. In the authors' recent study (Bousbia et al., 2011), they proposed an OLS that is called indicators for the deduction of learning styles (IDLS) and evaluated the system with 45 undergraduate students. The participants asked for browsing a course according to their needs and interests and their patterns were logged with a keylogger. At the end of the experiment they also asked to answer the ILS. Although they also validated their approach with this study, a larger sample size should be applied to generalize the study findings.

The first step for providing an OLS is to establish learners' learning styles and the above studies have shown that it is possible to deal with the limitations of the questionnaire-based approach by observing and modelling learners' behaviour. The main obstacle of predicting learning styles by observing and modelling learners' behaviour is to diagnose which learner behaviours or characteristics are indicative of their learning styles since learners have lots of behaviours. Of course, one of the reasons for the prevalence of self-reporting surveys is because it is difficult to specify a learner model from user behaviour. Research needs large enough samples of participants to create the learner models and to be able to generalize their findings with confidence. For these reasons, observing and modelling learners' behaviour seems more complex and seems to need more effort to obtain learning styles when compared to the questionnaire-based approach.

2.2.4 Key LSMs

I will now discuss LSMs that are listed in Table 2.1 along with the questionnaires (if any) that they use to identify individuals' learning style preferences, as well as the research assessing their effectiveness in supporting learning in the context of OLSs.

2.2.4.1 Dunn and Dunn LSM

The Dunn and Dunn LSM was originally proposed in 1974 and extended in subsequent years. Dunn and Dunn (1974) specified 22 different elements for the LSM and classified them into five major categories: environmental (sound, light, temperature, seating design), emotional (motivation, task persistence, conformity/responsibility, structure), sociological (alone, pairs, peer, group, authority, variety), physiological (perceptual elements, intake, time of day, mobility) and psychological (global, analytical, impulsive, reflective). As an example of the definitions of the categories, the environmental category accounts for whether learners like to have sound, how much light learners need, what temperature learners need to have, whether learners want to sit on a chair/sofa/floor during their learning experience. Although the Dunn and Dunn LSM seems rich as it includes 22 elements, it is not particularly logical to put environmental influences together with psychological elements in a single learning styles theory.

The LSM has different questionnaires for children and adults. The Learning Styles Inventory (LSIa) (Dunn et al., 1996) is a questionnaire to identify children's learning styles and has 104 questions that employ three-point or five-point Likert items. The Building Excellence Inventory (BEI) (Rundle & Dunn, 2000) is the latest version of a questionnaire to identify adults' learning styles. This questionnaire has 118 questions with five-point Likert items that measure preferences on the five major categories discussed above. No free versions of the questionnaires are available online. Neither the LSIa nor the BEI is simple to take since they both have a large number of questions (see subsection 2.2.3 for the discussion of this problem on questionnaires).

As Curry (1987) reported and Cassidy (2004) emphasised, the LSIa has one of the highest reliability and validity ratings amongst all the different LSMs. In addition, Keefe (1982) identified the LSIa as the most widely used questionnaire for identifying learning styles amongst students in elementary and secondary schools. However, Coffield et al. (2004) noted there is a lack of independent research on the Dunn and Dunn LSM, although it is commercially very popular.

In addition, the Dunn and Dunn LSM has been incorporated into a number of OLSs. For example, iWeaver (Wolf, 2003) attempts to develop an individualized learning environment that accommodates specific learning styles. The system addresses different learning styles by offering different media representations. To illustrate, for Impulsive learners who like to try out new materials, the system provides a "Try-it-button". When learners log in to the system, they take the BEI. The system develops initial learner models based on learners' answers. Then, learners receive recommendations on media representations. However, learners are free to choose other media representations than the one that the system recommends at any time. Learners are also asked for feedback on the representations and the feedback is used to improve the learning models. The authors said that they would consider using BNs (see subsection 2.2.3) for

predicting learning styles in a future study, although no publication on such a study could be traced. It is quite difficult say whether iWeaver is an effective OLS and Dunn and Dunn LSM improves learner's learning experience without seeing any systematic evaluation of the system.

An OLS cannot easily support learners with different categories of the Dunn and Dunn LSM since it covers 22 elements in five categories. To illustrate, iWeaver, one of the popular OLSs that incorporates the Dunn and Dunn LSM, only implemented some of the categories. Besides, not all categories are suitable to be applied in an OLS such as environmental (like temperature and light) or physiological (like mobility) categories. Furthermore, no free versions of the questionnaires are available online, meaning individual learners are not able to access the questionnaires quickly and easily. In addition, educational institutions have to pay high fees to use the questionnaires, particularly if they have a large number of students. Even if the questionnaires were available, as noted above, neither LSIa nor BEI is simple to take since they have a large number of questions. Moreover, there is a lack of independent research on the Dunn and Dunn LSM on its reliability and validity.

2.2.4.2 Kolb LSM

In 1976, Kolb proposed a LSM that classifies learners in four learning styles: Accommodating, Assimilating, Converging, and Diverging. Accommodating learners prefer to work in groups and have broad cultural interests. These people learn best by actively solving problems. They need to be involved in risk-taking activities during the learning process. Assimilating learners prefer to focus on abstract concepts and ideas. These people learn best by using emotions and relationships. They need to be involved in pragmatic solutions. Converging learners prefer to deal with technical tasks and problems. They like to experiment with new ideas and work with practical applications. They need sequential steps during the learning process. Diverging learners prefer to work with others and test out different ways to complete a task. These people learn best by observing. They need to be engaged during the learning process. An OLS can easily support learners with different dimensions on the Kolb LSM. For example, abstract content could be used to enhance Assimilating learners on web pages of OLSs.

Kolb proposed the Learning Styles Inventory (LSIb) to assess learning styles on each of the four dimensions (Kolb, 1976); the questionnaire has been revised several times (Kolb & Kolb, 2006). The questionnaire applies a forced-choice ranking method to identify learning styles by means of 12 sentences that the learner has to complete by choosing one of the four choices (1 = least like you to 4 = most like you). The questionnaire is a simple one when compared to some of the LSM questionnaires. However, free version of the questionnaire is not available online. Learners are not able to access questionnaires quickly and without paying a fee. In addition, institutions have to pay high fees to use the questionnaire if they have large numbers of students.

According to Cassidy (2004), studies that examined the Kolb LSIb in terms of reliability and validity presented a mixed picture. In addition, Brown (2007) reported that particularly the reliability of the LSIb has long been in dispute and the latest version of the LSIb is still under examination. Therefore, the LSIb needs more evidence to be an acceptable questionnaire.

Differences between the academic performances of the learners in four learning style dimensions that are identified by Kolb LSM were investigated when they are using OLSs. Several studies that are detailed below did not find any significant results (Kraus, Reed & Fitzgerald 2001; Mammen, Fischer, Anderson, James, Nussbaum, Bower & Pritt, 2007; Miller, 2005; Reed, Oughton, Ayersman, Ervin & Giessler, 2000).

Reed et al. (2000) studied the effect of learning styles on navigation (navigational paths of the learners were recorded) and performance (measured by time on task) by gathering data from 18 graduate students in an Introduction to Computers in Education OLS. As a part of the class, students worked with an OLS that was related to the course and performed a number of tasks. However, the researchers could not find any effect of learning style as measured by the Kolb dimensions on navigation and performance.

Kraus et al. (2001) investigated the engagement of 17 graduate students who enrolled in Behavioral Disorders course in an OLS that was designed to solve people's emotional and behavioral problems by using CBR (see subsection 2.2.3 or Glossary section for the definition of the term). The students enrolled in this course for which they could complete assignments by using this OLS. To analyze the effect of learning styles on knowledge acquisition in the course, the authors investigated whether there was a difference between the learning style groups on pre- and post-test knowledge scores. Results showed that students, regardless of their learning style, benefited equally from using the OLS.

Miller (2005) examined the relationship between learning style and academic performance of 36 undergraduate students with an OLS that taught probability and statistics. Results failed to show any relation of learning styles with the amount of material learned or the final assessment scores. Neither could any relation between learning styles and the total amount of time spent with the system be found.

Mammen et al. (2007) administered the LSIb to 91 general surgery residents over a period of 12 years. The authors examined relationships between learning styles and academic performance, which was measured by examination scores. They did not find any correlation between these two variables although they gathered a large corpus of data over a period of 12 years. However, the authors did find that learning styles differ between male and female residents. As an illustration, the Accommodating style was relatively more frequent in women and Assimilating style was more frequent in men.

On the other hand, there are some studies that gave evidence of significant differences between learners in four learning style dimensions that are identified by Kolb LSM when they are using OLSs (Federico, 2000; Schaller, Borun, Allison-Bunnel & Chambers, 2007).

Federico (2000) also examined student attitudes towards varied aspects of OLSs by using a paper-based survey with a sample of 234 postgraduate students. Participants were asked to answer 60 items with seven-point scales (ranging from very strongly agree to very strongly disagree) on this survey. Results showed that Accommodating and Assimilating learners showed significantly more positive attitudes towards varied aspects of OLSs in comparison to Converging and Diverging learners. As an example, Accommodating learners were more favourable to low-density computer screen designs that have relatively large amount of white space than Diverging learners.

Finally, turning specifically to museum websites, Schaller et al. (2007) used the Kolb LSM to investigate the relationship between learning styles and online users' preferences for different types of activities ranging from discussion forum to deductive puzzles on museum websites. The authors used their preferred labels in place of name of the Kolb LSM's dimensions as follows: Social for Accommodating, Intellectual for Assimilating, Practical for Converging and Creative for Diverging. The authors hypothesized that users would prefer an activity that matches their dominant learning style over one that does not. To illustrate, the authors expect from Social learners to prefer discussion forum since this activity type allows the learners to interact with other people. They gathered data from both children and adults. They modified the LSIb by changing some of the terms in the questionnaire with simpler terms for children. An online survey was conducted to 1161 middle school aged children, 376 high school aged children, and 1056 adults. The participants asked for answering the LSIb followed by the sample activities that are on several museum websites and a Likert scale rating for each activity. The findings showed that children are more likely to have Social learning style. In comparison, adults are more likely to have an Intellectual style. Although no difference could be found between boys and girls respect to gender and learning style, it was found that females had a Social learning style compared to males. This finding is inline with the finding of Mammen et al. (2007) that is explained previously in this subsection. In addition, significant relationships were found between learning styles and activity preferences for both children and adults. As expected Social children preferred discussion forum more than to those with other learning style. Also, Intellectual children preferred interactive reference more than to those with other learning styles. However, no significant results could be found for the other two dimensions for children. For adults, it was found that Intellectual ones preferred interactive reference, Social ones preferred role-play and Practical ones preferred puzzles. Therefore, the authors concluded that learning styles is a major determinant of adult activity preference and "one size does not fit all" in

museum websites. Thus, this new insight should encourage web developers to create experiences that will suit to all kinds of users. In this manner, although, museum visitors are on an infrequent social visit, this will ensure them an enjoyable visit and encourage them to return.

2.2.4.3 Honey and Mumford LSM

Honey and Mumford LSM is very popular in business, particularly in management and human resources. Honey and Mumford (1982) extended the Kolb LSM and created their own LSM with four dimensions: Activist (similar to the Accommodating dimension in the Kolb LSM), Reflectors (similar to Diverging), Pragmatist (similar to Converging), and Theorists (similar to Assimilating). The authors themselves even mentioned that their LSM has more similarities than differences with the Kolb LSM (Honey & Mumford, 1992).

Activists learn best by doing and trying things out. They like to work with others and leading discussions. They tend to be act before thinking. They are also open-minded learners and like to experience new things and to take risks. Unlike Activists, Reflectors do not like to be action, but like to review and think carefully about new information. They learn best by thinking about what they have learned and by observing. Theorists are comfortable with theories, concepts and facts, so that they get new information by adapting it into complex but logically sound theories. They like to analyze and synthesize. They are rational and objective. Pragmatists like to connect theories with real world in practice. They do not like abstract concepts unless they see them work in practice. Their motto is "If it works it's good". They are comfortable with testing new ideas rather than talking about them. An OLS can easily support learners with different dimensions on the Honey and Mumford LSM. To illustrate, discussion forums could be used to enhance Activists or facts, theories, etc. could be used to enhance Theorists on web pages of OLSs.

Honey and Mumford LSM identifies learning styles based on the Learning Style Questionnaire (LSQ). It has been revised in several times (Honey & Mumford, 1992, 2000, 2006). The questionnaire has two versions currently including 80 items and 40 items respectively, all with true/false answers. These versions are online[3] but they are not free to take. Thus, learners are not able to access the questionnaires easily. In addition, educational institutions have to pay high fees to use this LSM, particularly if they have large numbers of students.

Duff and Duffy (2002) evaluated the LSQ in terms of reliability and validity with 388 undergraduate students and concluded that LSQ has only modest levels of internal consistency (see Glossary section for the definition of the term) (see also Cassidy, 2004; Coffield et al.,

[3] http://www.peterhoney.com, Accessed 19th June 2014

2004). Furthermore, the authors of this LSM have not assessed validity and more evidence is needed for the LSQ to be an acceptable questionnaire.

In spite of these limitations, a number of studies have used the Honey and Mumford LSM in their research on OLSs.

The INSPIRE (Papanikolaou, Grigoriadou, Kornilakis & Magoulas, 2002) is an OLS that supports an introductory course on architecture and uses the Honey and Mumford LSM to adapt the learning environment dynamically based on learning styles. The system also adapts itself to learners' knowledge levels and follows their progress. It also gives control of the adaptation to learners, which means the system is both adaptable and adaptive (see subsection 2.5.2.1 and 2.5.2.2 for the definitions of the terms). An initial evaluation of the system was conducted with undergraduate students and their initial reactions used to improve the system. The authors mentioned that a study in which students with learning styles use particular types of educational materials was in progress. For example, they expected Activist learners to spend most of their time on activities and exercises, while the Reflector learners would spend most of their time on theoretical presentations and examples. Moreover, the authors mentioned that they could use this information to adapt the presentation of educational material during learners' interaction with the system. However, no further papers could be found which followed up on this initial study and presented the results of such an evaluation.

2.2.4.4 Felder-Silverman LSM

The Felder-Silverman LSM (Felder & Silverman, 1988) is one of the most widely used LSMs (Akbulut & Cardak, 2012). Dag and Gecer (2009) reviewed 54 studies completed between 1998 and 2008 related to OLSs and learning styles. They found that the Kolb LSM (see subsection 2.2.4.2 for the details of the model) is the most used model (17 out of 54 studies), followed by the Felder-Silverman LSM (11 out of 54 studies). According to Litzinger, Lee, Wise and Felder (2005), educators identify learning styles for more than 100,000 learners annually using the questionnaire of this LSM.

The Felder-Silverman LSM was originally formulated to identify the most important learning style differences among engineering students and to provide a teaching approach for engineering instructors (Felder & Silverman, 1988). It was originally formulated with five dimensions of learning style: Active-Reflective, Sensing-Intuitive, Visual-Auditory, Sequential-Global and Inductive-Deductive.

Felder and Solomon subsequently changed the name of the Auditory endpoint of the Visual-Auditory dimension to Verbal since verbal activity covers both spoken and written words. In addition, the Inductive-Deductive dimension was omitted since Felder realized that students

need to be taught both inductive and deductive methods for pedagogic reasons, in spite of preferring one over the other. Felder (2002, p.1-2) explained this as: "I don't want instructors to be able to determine somehow that their students prefer deductive presentation and use that result to justify continuing to use the traditional but less effective lecture paradigm in their courses and curricula. I have therefore omitted this dimension from the model."

In the revised version of the model, the Felder-Silverman LSM now has four learning style dimensions: Active-Reflective, Sensing-Intuitive, Visual-Verbal, Sequential-Global. The Active-Reflective dimension is the learner preference for processing information. If learners prefer to discuss new information, they are more towards the Active end of the dimension. Alternatively, if learners prefer to think about new information, then they are more towards the Reflective end of the dimension. The Sensing-Intuitive dimension depends on the type of information learners preferentially perceive. In other words, if learners connect information in the real world with signs, sounds, physical sensations, they are more towards the Sensing end of the dimension. On the other hand, if they are more comfortable with abstractions and rely on their own hunch, they are more towards the Intuitive end of the dimension. The Visual-Verbal dimension is the sensory channel that learners prefer while they are acquiring information. If learners prefer acquiring information through pictures, diagrams, graphs, they are more towards the Visual end of the dimension. In contrast, Verbal learners prefer acquiring information from words, written and spoken explanations. Lastly, the Sequential-Global dimension is related to learners' progress towards understanding. If learners are more likely to learn in linear steps, not in large jumps, then they are more towards the Sequential end of the dimension. Conversely, if learners prefer to see the big picture first, they are more towards the Global end of the dimension.

An OLS can easily support learners with different dimensions on the Felder-Silverman LSM. To illustrate, puzzles, games, discussion forums, etc. could be used to enhance Active users or facts, figures, etc. could be used to enhance Sensing learners or multimedia elements such as images, graphics, etc. could be used to enhance Visual learners or next buttons to show further information could be used to enhance Sequential learners on web pages of OLSs.

There is some confusion over the title of this LSM and the associated questionnaire used to measure its dimensions: the model is based on the work of Felder and Silverman, but the questionnaire is the work of Felder, Silverman and Solomon (Felder, Silverman & Solomon, 1996), so the questionnaire is often referred to as the Felder-Solomon Index of Learning Styles (ILS)[4]. It has both pencil-and-paper and online versions[5] and it is free to take. The ILS consists of 44 items (11 items for each of the four dimensions), each of which has a binary choice

[4] Henceforth, I will use the ILS abbrevation to refer this questionnaire.

[5] www.engr.ncsu.edu/learningstyles/ilsweb.html, Accessed 12th June 2014

(option a or b) for the learner. Therefore, taking this questionnaire is not particularly tedious; it is not nearly as long as the LSIa or BEI (see subsection 2.2.4.1). At the end of the questionnaire learners get a score on the four dimensions with values between +11 and -11 in steps of +/-2. The ILS scores provide a detailed description of learning styles, a main benefit of this questionnaire in comparison to other LSM questionnaires. Furthermore, free versions of the questionnaires are available online. This enables learners to access the questionnaire quickly and without difficulty. In addition, educational institutions do not have to pay any fees to use the ILS.

Felder and Spurlin (2005) investigated ILS and showed that it can be considered reliable, valid and suitable for identifying learning styles. There have been a number of studies conducted on the reliability and validity of the ILS (Felder & Spurlin, 2005; Litzinger et al., 2005, 2007; Livesay, Dee, Felder, Hites, Nauman & O'Neal, 2002; van Zwanenberg, Wilkinson & Anderson, 2000; Zywno, 2003). These studies have resulted in some contradictory findings. Livesay et al. (2002), Zywno (2003), Litzinger et al. (2007), and Felder and Spurlin (2005) all found that the ILS is questionnaire with acceptable reliability and validity, whereas van Zwanenberg et al. (2000) concluded that the questionnaire needs further studies on its reliability and validity. Felder and Spurlin (2005) summarize most of the reliability and validity studies to give readers an overview of what has been done to test and validate the ILS. Litzinger et al. (2007) not only tested the reliability, factor structure, and construct validity (see Glossary for the definition of the term) of the ILS, but also whether changing the dichotomous response scale of the ILS to a five-option response scale would improve reliability and validity. They found that a five-option scale improved the reliability of the ILS, but it did not change the validity strength of the questionnaire. Brown (2007) mentioned that in terms of reliability and validity, the Felder-Silverman LSM is one of the few questionnaires that scores moderately well and has acceptable standards.

The Felder-Silverman LSM has been used many times, particularly in OLSs. Carver et al. (1999) developed an OLS to enhance a computer systems course (CS383) by using a series of hypertext, multimedia and hypermedia (see Glossary for the definitions of the terms) tools, each of which addressed different learning styles. To illustrate, the system enables learners to make choices through the course. By doing this, the system facilitates Active learners who like to be dynamic during learning process. As another example, main menu provides not only lesson objective but also the entire lesson objective to satisfy Global learners who like to see the whole picture before starting learning process. There are also graphic and video files to support Visual learners. The authors performed an informal assessment of the system by following 100 students' grades each semester for two years and this assessment showed a positive change in

learners' learning. However, the authors did not conduct a formal, quantitative evaluation of the learning effects of this system.

Brown et al. (2006) developed the WHURLE OLS, which adapts its contents by evaluating learning styles of students. WHURLE identifies learning styles by asking learners to take the ILS at initial registration. Since the system focuses only on the Visual-Verbal dimension, questions related to the other three dimensions are not used. 221 undergraduate and postgraduate students were randomly assigned to neutral, matched and mismatched learning style and content groups. The content was adapted to suit either Visual or Verbal learners. For Visual learners the content used more visual elements such as images and for Verbal learners, the content used more text. The results showed no significant differences between the academic performances of the three groups, which were gathered via a multiple-choice quiz. According to the authors, there are several possible reasons for these results. The authors mentioned that Visual-Verbal representations might not have been correctly designed. However, it is not hard to design Visual-Verbal representations, the Visual-Verbal dimension is the easiest dimension of the Felder-Silverman LSM to implement in systems, so this seems a strange argument to make. In addition, the authors concluded that learning styles might not be static. However, the data were collected over a period of only two weeks. In such a short period any change on learning styles should not be expected. In addition, ILS has good test-retest reliability as was discussed at the beginning of this section. Therefore, these reasons do not adequately explain the results.

Similar to WHURLE in terms of its lesson plan and content chunks, is the DEUS (Digital Environment Utilising Styles) system proposed by Brown et al (2007b). 82 children (aged 9-11 years old) took part in an evaluation of this system. The ILS was again used to analyze learning styles. However, this research focused on two dimensions of the Felder-Silverman LSM: the Visual-Verbal and Sequential-Global dimensions. Firstly, learners answered the ILS (only the Visual-Verbal and Sequential-Global questions) and took a pre-test on their existing knowledge. Once their learning style was assessed, they were assigned into one of four groups: matched Sequential, mismatched Sequential, matched Global and mismatched Global. To illustrate, matched Sequential group consists of learners who are identified as Sequential learners by the ILS and they studied in a learning environment that is suitable for Sequential leaners. Then, learners were asked to browse the system and they were asked to answer several questions. Once they had completed these questions, learners completed a post-test. The post-test quiz score minus the pre-test quiz score was calculated to assess knowledge gained. No statistically significant differences were found between learning style and content matched and unmatched groups. The authors presented possible reasons for these results. They could be the result of complex factors interacting with learning such as IQ, socio-economic background, etc. In addition, the authors mentioned that the ILS is an adult test and not a suitable questionnaire for

children. However, to handle this limitation of the study, a suitable LSM for children such as the Dunn and Dunn LSM or a suitable population, for example university students could have been used. Other examples on applications of the Felder-Silverman LSM similar to the above studies in the context of OLSs include Sterbini and Temperini (2009) and Wang, Li and Chang (2006).

Research has shown that OLSs using the Felder-Silverman LSM produce contradictory findings in relation to the usefulness of learning style adaptations. Some of the studies present evidence on improving learners' learning experience (Carver et al., 1999; Popescu, 2010) whereas some of them showed no significant differences in relation to learning styles (Brown et al., 2006; Brown et al., 2007b).

2.2.4.5 VARK LSM

Another recent and widely used LSM is the VARK (Fleming, 1995). In this LSM, there are four modes: Visual, Aural, Read/Write, Kinaesthetic. Visual learners access information in the form of graphics, charts, and flow diagrams. As noted by Fleming (1995), one of the most popular information exchange modes is speech. Information in this mode is gathered by ear and is referred as Aural by this LSM. Other learners prefer to gather information through written text. These learners are classified as Read/Write learners and labelled as. Lastly, Kinaesthetic learners need all senses in order to receive information. As can be realized, the name of the LSM comes from the first letters of the dimension names. An OLS can easily support learners with different dimensions on the VARK LSM. To illustrate, images, graphics could be used to enhance Visual users or audio based text could be used to enhance Aural learners or text based text could be used to enhance Read/Write learners or games, puzzles, discussion forums could be used to enhance Kinaesthetic learners on web pages of OLSs.

The VARK LSM identifies learning styles using a questionnaire that consists of 16 items. Therefore, this is one of the simplest questionnaires to take. This questionnaire is online[6] and it is free to take. Learners are able to access questionnaires quickly and without any fee.

iLearn (Peter, Bacon & Dastbaz, 2010) is a recent OLS that implements the VARK LSM. The small number of questions in the questionnaire and clear mapping of dimensions to learning materials were the reasons for the authors to select and use this LSM in iLearn. Different learning objects were presented in iLearn based on Fleming's recommendations of study strategies: for example to enhance Visual learners videos, vodcasts, and Powerpoint slides were presented; to enhance Aural learners Powerpoint slides with audio, multimedias, and podcasts were presented; to enhance Read/Write learners text documents were presented; and to enhance

[6] http://www.vark-learn.com/english/page.asp?p=questionnaire, Accessed 19th June 2014

Kinaesthetic learners, multimedia interactivity were presented in the system. However, no publication on the evaluation of iLearn could be traced.

Leite et al. (2010) in a recent study provides evidence of the validity of the VARK by administrating it to 15,136 students and by checking whether the scores of the VARK support the four-factor structure of the scale hypothesized by its author. On the other hand, there is another study claims that the main limitations of the VARK questionnaire are reliability and validity issues (Breckler, Joun & Ngo, 2009).

2.2.4.6 Sarasin LSM

Similar to the dimensions of the VARK LSM, Sarasin proposed an LSM (Sarasin, 1999) that consists of three dimensions: Auditory, Visual, Tactile/Kinaesthetic. Based on this LSM, if learners prefer to hear the information, they are Auditory. Alternatively, if they prefer visual items such as charts and graphics, then they are Visual. Lastly, if they learn by doing, moving and touching in the learning process, they are Tactile/Kinaesthetic. Hence, an OLS can easily support learners with different dimensions on the Sarasin LSM. To illustrate, audio based text could be used to enhance Auditory learners or images, graphics, etc. could be used to enhance Visual learners or games, puzzles, discussion forums could be used to enhance Tactile/Kinaesthetic learners on web pages of OLSs. An example system using this LSM is ARTHUR (Gilbert & Han, 1999; see also subsection 2.2.3 above, where ARTHUR was discussed in relation to measuring learning styles), an OLS that implements the Sarasin LSM and identifies learning styles by using AI techniques such as CBR (see Glossary section or subsection 2.2.3 for the definition of the term). ARTHUR creates a learner model when a learner completes a course using the system, classifies them and uses this information to assign new learners to the most suitable learning environment.

The main disadvantage of using this LSM is that there is not corresponding questionnaire to identify learning styles. Since the questionnaire-based approach for measuring learning styles is the simplest and quickest approach, the authors should develop one for learners to make the usage of this LSM effective in research and teaching.

2.2.5 Integration of dimensions from the different LSMs

A considerable number of studies have been carried out in the area of learning styles and many LSMs have been proposed in the literature. There are over 71 worth consideration LSMs according to Coffield et al. (2004). As Graf (2007) argued this high number of LSMs makes it difficult to decide on which LSM is most relevant and should be used in a particular context. Furthermore, some LSMs overlap each other, there are lots of similarities and relationships between these LSMs and the dimensions they propose and there is no agreed taxonomy.

Despite having no agreed taxonomy, there are common dimensions and this make it possible to group dimensions of different LSMs. Most of the LSMs that are listed in Table 2.1 have some dimensions in common. I have categorised these dimensions into eight groups and listed along with their common characteristics in Table 2.2. According to this classification, Felder-Silverman LSM is only model that covers almost all the groups, only not having a dimension in the Auditory Group. However, its Verbal dimension covers both spoken and written words.

Table 2.2 Dimension Groupings of the Key LSMs

Active Group	Common Characteristics
Activist (Honey and Mumford LSM) Accommodating (Kolb LSM) Active (Felder-Silverman LSM) Tactile/Kinaesthetic (Sarasin LSM)	This group learns best by doing and trying things out. They tend to be act before thinking. They like to discuss new information.
Reflective Group	
Reflector (Honey and Mumford LSM) Diverging (Kolb LSM) Reflective (Felder-Silverman LSM)	This group learns best by thinking about what they have learned and observing. They like to think about new information.
Sensing Group	
Pragmatist (Honey and Mumford LSM) Converging (Kolb LSM) Sensing (Felder-Silverman LSM) Tactile/Kinaesthetic (Sarasin LSM) Kinaesthetic (VARK LSM)	This group learns better if they can connect new information in the real world with signs, sounds and physical sensations.
Intuitive Group	
Theorist (Honey and Mumford LSM) Assimilating (Kolb LSM) Intuitive (Felder-Silverman LSM)	This group learns best by using emotions and relationships. They are more comfortable with theories, concepts and facts.
Visual Group	
Visual (Felder-Silverman LSM) Visual (Sarasin LSM) Visual (VARK LSM)	This group learns best by acquiring new information through pictures, diagrams, graphs, etc.
Verbal Group	
Verbal (Felder-Silverman LSM) Read/Write (VARK LSM)	This group learns best by acquiring new information from words, written and spoken explanations.
Auditory Group	
Aural (Sarasin LSM) Auditory (VARK LSM)	This group learns best by hearing new information.
Partially or No Associated Group	
Sequential (Felder-Silverman LSM) Global (Felder-Silverman LSM) Environmental (Dunn and Dunn LSM) Emotional (Dunn and Dunn LSM) Sociological (Dunn and Dunn LSM) Physiological (Dunn and Dunn LSM) Psychological (Dunn and Dunn LSM)	

In the Tactile/Kinaesthetic dimension of the Sarasin LSM, learners learn best by doing, moving and touching. Therefore, this dimension is put in both the Active and Sensing groups. The Sequential dimension of the Felder-Silverman LSM can be put in the same group as the Converging dimension of the Kolb LSM, since Converging learners need sequential, linear steps in the same way that learners in Sequential dimension need. In addition, the Global dimension

of Felder-Silverman LSM can be put in the same group with the Theorists dimension of Honey and Mumford LSM since Theorists like to see the big picture, which is the same thing that Global learners like. In the same manner, the Sensing-Intuitive and Sequential-Global dimensions of the Felder-Silverman LSM can be classified in the same groups. However, it is known that there are weak correlations between these dimensions (see Table 3.6 for the correlations between the dimensions of Felder-Silverman LSM). It is not suitable to try to classify the five categories of the Dunn and Dunn LSM with the other LSM dimensions, since these categories are based on both biological and environmental characteristics.

Peterson, Rayner and Armstrong (2009) administered a global survey of 94 learning/cognitive style researchers to find whether there could be agreement about the conceptual confusion and contested definitions of learning styles and cognitive styles and future direction of learning/cognitive style research. According to this study, 93% of the learning/cognitive style researchers believe that learning/cognitive style research was undermined by a lack of consensual theory. Therefore, if learning/cognitive style researchers could discuss and try to find some kind of consensus, then the field could move forward with more certainty.

2.2.6 Criticisms of Learning Styles and LSMs

As Popescu (2008) noted, there are many factors that affect the learning process including the intrinsic factors to the individual (effort, intelligence, health, motivation, socio-economic background) and the extrinsic factors (reinforcements provided and the learning environment). Therefore, learning itself is a complex process and it is difficult to analyze which factors of the learning process can encourage learning.

As Graf (2007) pointed out, many educational researchers believe learning styles are an important factor in the learning process and have suggested that implementing them in education has potential to enhance learners during their learning processes. In addition, Felder and Silverman (1988) emphasized that learners with a strong preference for a specific learning style may experience difficulties if the teaching style does not match with their learning style. As Graf (2007) discussed, making learners aware of their learning styles lets them see their strengths and weaknesses and by focusing on their weaknesses they may be able to develop their learning processes. Learning styles are also a supportive factor in designing online learning environments. Finally, from the perspective of educators, by providing various learning materials to learners they hope to enhance learners' learning process.

However, there are several important issues that are still under discussion in the field of learning styles. As discussed in subsection 2.2.3, one of these issues is how to identify and measure particular learning styles. Some researchers also question whether people are stable over time in

their learning style or not. Moreover, some researchers are even disputing whether learning styles exist or not. These latter two issues will be discussed in detail in the following paragraphs of this subsection.

Some researchers make various claims about whether people are stable over time in their learning style. Some researchers label learning styles as "flexibly stable" that means there are factors that influence stability of learning styles over time such as previous learning experiences, context and task (Felder & Spurlin, 2005). On the other hand, other researchers label learning styles as "God-given" and not changeable. Messick (1976) distinguished learning styles from cognitive styles while discussing the stability of people in their learning style or cognitive style. According to these authors, cognitive styles may not be easily modified through training or experience, while this may not be the case for learning styles. This claim is in line with Curry (1983) who defines cognitive styles as a stable layer. Furthermore, Peterson et al. (2009) administered a global survey of 94 learning/cognitive style researchers (as discussed above in subsection 2.2.5) and found that although there was no clear consensus as to whether learning style or cognitive style was the broader term, or whether they were separate, learning/cognitive style researchers did agree that cognitive styles were more stable than learning styles. Keefe (1979, p.4) also defined learning styles as stable and used this term in the definition of learning styles: "characteristic cognitive, affective, and psychological behaviours that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment."

Some studies have reported significant positive test-retest correlations of questionnaires and concluded empirically that learning styles are stable. Loo (1997) investigated stability and change on Kolb's LSI (see subsection 2.2.4.2 for the details of the questionnaire) by gathering data from 152 undergraduate students at two points with a 10 week interval. Several statistic analyses were used such as test-retest correlations (see Glossary section for the definition of the term) and differences between mean scores. The results showed that test-retest correlations between the two administrations were significant and mean differences between the two administrations showed no significant differences. Like Loo (1997), other studies (e.g. Livesay et al., 2002; Pinto & Geiger, 1991; Ruble & Stout, 1991; Rakoczy & Money, 1995; Seery, Gaughran & Waldmann, 2003; Zywno, 2003) found significant correlations between administrations and no significant differences between the means of two administrations of learning style questionnaires. Furthermore, I also conducted two administrations of the Turkish Index of Learning Styles-(T)ILS and results showed that people's learning styles did not change over time (see subsection 3.3.2 for the details). Therefore, all these studies and my study on reliability and validation of the (T)ILS offered evidence on the stability of learning styles over time.

Researchers have also disputed whether learning styles exist or not. Some researchers believe that learning styles do not exist or even if they exist, they do not enhance academic performance (Pashler, McDaniel, Rohrer & Bjork, 2008; Riener & Willingham, 2010; Scott, 2010). Pashler et al. (2008) examined the validity of taking into account learning styles when designing instruction. They stated that credible validation must prove that the optimal teaching method for students with one style is not optimal for students with a different style. However, they could not find any study that achieved this criterion and they concluded that there is no scientific evidence to suggest that people learn better with instruction that is matched to their learning styles.

On the other hand, according to views of the 94 learning/cognitive style researchers surveyed by Peterson et al. (2009) learning style awareness is an important aspect in fully understanding a person's performance in learning and the work place. The learning/cognitive style researchers are still motivated to study in the field since they believe learning/cognitive style awareness and usage of learning styles can potentially improve learning outcomes and academic performance. Furthermore, as Rayner and Riding (1997) highlighted and Curry (1987, p.16) mentioned "Learning/cognitive styles may not exist other than as an insubstantial artefact of the person-environment interaction. Alternatively, learning styles may be real, stable, and potent enough to be useful to educational planners, particularly those with concern for truly individualised educational programming." Curry (1987) rightly went on to say, even though learning styles research has many challenges and controversial issues, it is obvious that it has potential to enhance learning process. Inline with this argument, there are some studies that explored whether people learn better with instruction that is matched to their learning styles found positive changes in learners' learning (Carver et al., 1999; Popescu, 2010).

According to Felder (2010), there is also something that: "The point is not to match teaching style to learning style but rather to achieve balance, making sure that each style preference is addressed to a reasonable extent during instruction". As highlighted by Felder (2010) instruction is ineffective if it strongly depends on one learning style over other. Therefore, the thing that Felder (2010) emphasized in his comment is creating OLSs, which present various materials that serve different learning styles in a balance.

I will now turn to an overview of cultural differences in website design and museum environments. Before this, I will present the definition of culture and give information on Hofstede's theory and its criticism.

2.3 Cultural Differences

As global access to the Web grows, it becomes more important that websites are created that meets the needs and preferences of an international user base. Thus, companies now need to

have awareness and prioritise providing website personalisation based on cultural differences (Singh & Pereira, 2005).

In the first subsection, I will discuss the term of culture, a term which has a number of different definitions depending on the source. Many different theories of culture have been proposed and Hofstede's theory is the most known theory on culture in the literature relating to technology use. For that reason, I will present Hofstede's theory (see subsection 2.3.2) and criticism of it as an all encompassing theory of culture (see subsection 2.3.3). Hofstede defines culture with two distinct meanings: as "civilization" or as "the way people think, feel, and act" [7].

After discussing the definitions, I will discuss cultural differences in websites (see subsection 2.3.4). According to Simon (2001), there are differences of perception and satisfaction with websites between different cultural groups and exploring these differences can improve websites and increase the propensity of people from different cultures to use the websites. Yet, there are only few websites that satisfy users by customizing interfaces based on their diversified cultural backgrounds and there is no theoretical structure relating design and culture (Daniel, Yinka, Frank & Adesina, 2013).

In addition, some researchers have drawn attention to the importance of showing sensitivity to issues of cultural differences in museum environments (Sachatello-Sawyer, Fellenz, Burton, Gittings-Carlson, Lewis-Mahony & Woolbaugh, 2002). Therefore, in the last subsection I will discuss several studies on cultural differences in museum environments (see subsection 2.3.5).

2.3.1 Definition of Culture

As noted above, the concept of culture is very difficult to define, but Hofstede defines it by providing two definitions for two different meanings of it. Following are two direct quotes from Hofstede's website [8]:

"The first, most common, meaning is civilization, including education, manners, arts and crafts and their products. It is the domain of a ministry of culture".

"The second meaning derives from social anthropology, but in the past decades it has entered common parlance. It refers to the way people think, feel, and act. Geert has defined it as the collective programming of the mind distinguishing the members of one group or category of people from another. The category can refer to nations, regions within or across nations, ethnicities, religions, occupations, organizations, or the genders. A simpler definition is the unwritten rules of the social game."

[7] http://www.geerthofstede.nl/culture, Accessed 11th Aug 2014

[8] http://www.geerthofstede.nl/culture, Accessed 11th Aug 2014

As mentioned on Hofstede's website [9], two meaning should not be confused and my research refers to culture in the second definition. In this programme of research, I investigated whether the way the people of one country think, feel and act distinguish from people from another country while they are using museum websites.

Hofstede also proposed a framework of cultural dimensions and his theory has been widely used in a number of fields such as cross-cultural psychology and cross-cultural communication. I will discuss this theory in the following subsection.

2.3.2 Hofstede's Theory

The original theory consists of four dimensions on which cultures are measured: power distance, individualism versus collectivism, masculinity versus femininity and uncertainty avoidance. In the 1990s, he added another dimension, long-term versus short-term orientation, and formed the theory as its today. Hofstede investigated and estimated values on these dimensions for more than 50 countries (Hofstede, 1980).

The five dimensions posited by Hofstede are:

- Power distance is the extent to which people accept unequal power distribution in a society.
- Individualism versus collectivism is the extent to which members of a culture pursue ends for other members of the culture or primarily for themselves.
- Masculinity versus Femininity is the extent to which a culture exhibits traditionally masculine or feminine value.
- Uncertainty avoidance is the extent to which individuals accept uncertainty of future events, rules, measures, or guidelines to lessen the nervousness or danger of uncertainty.
- Long-term versus Short-term orientation is the extent to which a culture considers the future in its present actions.

A comparative example that shows differences of Turkey and the UK on Hofstede's dimensions is presented in the following (see details on this page[10] for UK and this page[11] for Turkey):

Turkey has higher score (score of 66) on the power distance dimension compare to UK (score of 35), which means power is more centralized in Turkey and employees rely on managers, bosses and rules. The same structure can be observed for family structure in Turkey where father of the family acts as patriarch or head of family. Turkey has lower score (score of 37) on

[9] http://www.geerthofstede.nl/culture, Accessed 11th Aug 2014

[10] http://geert-hofstede.com/united-kingdom.html, Accessed 12th Aug 2014

[11] http://geert-hofstede.com/turkey.html, Accessed 12th Aug 2014

the individualism versus collectivism dimension compare to UK (score of 89). This dimension has the highest difference between the scores of two societies. UK is an individualist society whereas Turkey is a collectivist society that means "We" is more important than "I" in Turkey in comparison to the UK. The UK has the one of the highest individualistic scores amongst societies that means has a high degree of interdependence in its society. Turkey has lower score (score of 45) on the masculinity versus femininity dimension compare to UK (score of 66). Although both societies are masculine, UK society is more driven by competition, achievement and success. For uncertainty avoidance dimension, Turkey has a higher score (score of 85) compare to UK (score of 35) Turkey society deals with the fact that future can never be known whereas UK society are quite happy to wake up not knowing what the day brings. According to Hofstede's findings Turkey and UK have similar scores (score of 46 for Turkey and score of 51 for UK) on the dimension of long-term versus short-term orientation. Both societies have intermediate scores on this dimension. Therefore, dominant preferences cannot be determined for these societies in this dimension.

2.3.3 Criticism of Hofstede's Theory

As noted by McSweeney (2002), participants in Hofstede's study (2001) is the most common criticism since they were all IBM employees and examples of criticisms can be found in (Cray & Mallory, 1998; Korman, 1985; Triandis, 1982). Even IBM organization may have a distinct culture so that IBM employees may not represent real population (Søndergaard, 1994). Another important criticism that is mentioned by McSweeney (2002) is the influence of age and gender on responses. Hofstede supposed that these factors would have the same impact regardless of country. In addition, McSweeney (2002) criticised Hofstede on the fact that he refers to the culture as the nation. However, even cultures may consist of different cultures. Despite these criticisms, Hofstede's theory has been used widely in cross-cultural fields. Some of the examples will be discussed in the following subsection.

2.3.4 Cultural Differences in Website Design

There are approximately 2.8 billion Internet users according to Internet World Stats website[12] today who differ in their goals, interests, preferences, knowledge, cultural background, etc.

There are several examples of specific changes that are posited to better suit particular cultural groups. As discussed by Daniel et al. (2013), some of these elements are page layout, metaphor, language, icon and colour. For example, in relation to page layout, web content should be differently structured for Arabic users in comparison to European users, as they read from right to left. Barber and Badre (1998) showed that Arabic users prefer to use a scroll bar on the left-

[12] http://internetworldstats.com/stats.htm, Accessed 12th Aug 2014

hand side. Furthermore, translation is an important issue because each language has its unique idioms, a word may have many meanings in a language or may have not an equivalent, each language may have dialects, and so on. In addition, symbols, icons, colour have different meanings in different cultures. As an illustration, green is a colour of safety in the USA whereas it represents criminality in France (Barber and Badre, 1998).

As listed by Bello (2011) creating websites that take users' cultural differences into account is critical to attract customers and get their positive attitudes toward the site (Luna, Peracchio & De Juan, 2002; Wu, 1999), increase purchase habit (Pereira, 1998), and for better accessibility, usability and interactivity (Dholakia & Rego, 1998, Luna et al., 2002; Simon, 2001; Tsikriktsis, 2002; Yeo, Barbour & Apperley, 1998). Most of previous studies used Hofstede's cultural dimensions and theory (see subsection 2.3.2 for details of the theory) to explore the impact of cultural differences on website use.

To illustrate, Simon (2001) explored 160 undergraduate and graduate students' perceptions and satisfaction levels on four websites by using an adapted version of Hofstede's theory as a means of differentiation. The participants were grouped as representing the four cultural areas that are: Asians, Europeans, North Americans and Latin/South Americans. The participants asked to complete three different instruments that measured their cultural dimensions at the individual level, perception and satisfaction with that site after they visited four websites. They were also asked to answer open-ended questions on what kind of aspects of the site they found most/least appealing and what items they would change to improve their perception and satisfaction. MANOVA analysis showed that there are significant differences between the Asian and Latin/South American groups and the European and North American groups. Therefore, Simon (2001) concluded that perceptions of different cultural groups vary along the cultural differences predicted by the instrument. Furthermore, Simon (2001) found significant differences between Asian and Latin/South American groups and the European and North American groups in terms of their satisfaction levels. The study has also important qualitative results that give evidence on preference differences amongst different cultural groups. To illustrate, Asians suggested to use less bright colours while Europeans and North Americans suggested lighter and brighter colours and more images. Although, Simon's study (2001) presented valuable findings, it has a sampling bias by having participants solely from a single university.

Tsikriktsis (2002) also measured culture through Hofstede's theory to examine the relationship between culture and website quality expectations by gathering data from 171 graduate students. Tsikriktsis (2002) measured website quality expectations by an instrument that is called WEBQUAL (Loiacono, Watson & Goodhue, 2002). By using multiple regression analysis, the

author examined whether each website quality expectation was affected by Hofstede's cultural dimensions. The results showed that trust and responsiveness are not influenced by culture. That means whether the website provide trustful information or responsiveness of the website are important for all cultural groups. The author also found that two Hofstede's cultural dimensions that are masculinity and long-term orientation influence users' website expectations. To illustrate, masculine cultural group preferred more interactive websites.

Reinecke and Bernstein (2008) listed which user interface aspects are affected by certain dimensions of Hofstede's theory in their work and called this list as "adaptation rules" such as "if a user has a low score in the dimension power distance, then provide a complex interface." (p. 4). Furthermore, the authors validated the specified mapping of the dimensions to certain user interface preferences. Reinecke and Bernstein (2013) also proposed a prototype web application that is called MOCCA to address cultural differences on websites. The authors evaluated the prototype by comparing its automatically generated interfaces with 75 participants from Rwanda, Switzerland, and Thailand, plus 30 multicultural users who lived in at least two different countries. Evaluation results showed that MOCCA's results matched 51% of the participants' preferences on average and MOCCA achieved an average prediction of 61%. Therefore, the authors concluded that their approach to support users with interfaces that are suitable to their cultural preferences is feasible, even though they only successfully managed to adapt websites to users just over half the time.

There are other authors that similarly used Hofstede's cultural dimensions and theory in their study to explore cultural differences on different types of websites such as commercial websites (Chirkova, 2011), newspaper websites (De Troyer, Mushtaha, Stengers, Baetens, Boers, Casteleyn & Plessers, 2006) or governmental websites (Goyal, Miner & Nawathe, 2012). Besides, there have been a number of studies that recommend the adaptation of different environments to the users' cultural characteristics. To illustrate, Economides (2008) suggested the adaptation of *collaborative learning* environment according to learners' culture. Economides (2008, p. 243) defined collaborative learning as "educational method where a group of learners collaborate to learn and improve themselves". According to the author, learners' cultural differences may affect learners' learning and attitudes toward learning, learning behaviour and strategies, motivation, learning styles, computer usage, academic achievements, communication, participation, knowledge transfer and sharing. As noted by the author, it is important to ensure learners from different cultures to have equal opportunities in learning environments to optimise learners' potential to benefit from OLSs for knowledge acquisition. Economides proposed two cultural profiles for learners that are based on Hofstede (1983) and Trompenaars and Hampden-Turner (1998) models and let learners to declare their cultural profile, or choose from a list of profiles, or answer a questionnaire that helps learners to identify their profile.

Then, the author suggested adapting various types of collaboration tools for a particular cultural profile. The author defined examining which collaboration tool is suitable for a particular profile as a future study although no publication on such a study could be traced.

Singh and Pereira (2005) argued that users prefer to use websites that are presented in their local language. They support their claim with a survey from Forrester Research which found that non-English users stay twice as long on locally customized websites as they do on English-only websites. Furthermore, Cyr, Head and Larios (2010) argued that website colour appeal is a significant determinant for website trust and satisfaction differences across cultures. But, according to Daniel et al. (2013) there are not many websites that attempt to address the needs of users from different cultures by customizing interfaces and there is no good theoretical structure relating design and culture.

From the above research, it is clear that there is an awareness of cultural differences on websites, with a heavy emphasis on using Hofstede dimensions to drive changes to websites. However, this work is somewhat haphazard in its coverage of website design. More important, much of this work provides descriptive points about specific cultures and their preference of web design features, they do not provide how usability and broader user experience measures are impacted by cultural factors.

In the next subsection, how cultural differences affect website design in museum environment will be discussed.

2.3.5 Cultural Differences in Museum Environment

Falk and Dierking (2008) defined best museum as "the one that presents a variety of interesting material and experiences that appeal to different age groups, educational levels, personal interests, and technical levels" (p.19). They also summarized three contexts that influence museum experience: personal context, physical context and sociocultural context. According to the authors, the interactions and collaborations that museum visitors have with individuals with in their social group have a great effect on them. Therefore, visitors' cultural background should be considered in museum environment. As said by Clough, Marlow and Sanderson (2006), localised museum websites can be realized by considering specific design issues such as which languages to translate and how many, use of terminologies or offensive references specific to a particular culture, supporting resources like translation tools, formatting characters, layout and content, etc.

Marlow, Clough and Dance (2007) applied different methods such as online survey, log file analysis and machine translation system evaluation for getting a set if requirements and recommendations to provide multilingual content for users on the website of Britain's Tate art

galleries. They conducted an online questionnaire to 457 visitors on the website and found that providing more multilingual content would be appreciated by international users. They also analyzed log files that are recorded for 24-hour period and got some basic data on the types of search queries entered and concluded that it is not easy to identify the problems with foreign language searches since visitors are able to formulate queries in English. Furthermore, visitors were asked to evaluate a translated text by a machine translation system about its comprehensibility, acceptability and fidelity to its original. The authors found that visitors were somewhat willing to accept a text even it was difficult to comprehend.

Although Sachatello-Sawyer et al. (2002) have drawn attention to the importance of showing sensitivity to issues of cultural differences in museum environments there are few studies that deal with cultural differences on museum websites.

Much like the broader culture and web design literature, the studies in the museum sector tend to rely heavily preferences of users, and in particular self-report of preferences. There is little empirical work at all about user performance, experience and perceived usability in relation to those choices.

2.4 Relationship between Learning Styles and Cultural Differences

Researchers on learning styles argue that learners' early experiences in their life play a role in forming their learning styles. According to Joy and Kolb (2009), learners' cultural background shapes how learners perceive, progress, act on new knowledge and skills and affect their participation, motivation, satisfaction and performance during learning activities.

There are several studies claiming that learning styles may differ from one culture to another (Agerup & Busser, 2004; Boondao, Hurst & Sheard, 2008; De Vita, 2001; Joy & Kolb, 2009; Katz, 1988; Kim & Bonk, 2002; Pratt, 1991; Ramburuth & McCormick, 2001; Teng, 2007). Based on Teng's (2007) study, US students are more active when compared with Taiwan students. US students are more likely to post, read and response online messages. As another example, Kim and Bonk (2002) showed that US students were more action-oriented and pragmatic in seeking results or giving solutions compared to Finnish students who were more reflective. In another study, Asian and Australian students were compared and in the study it was found that there is a significant difference between these groups' learning style preferences (Ramburuth & McCormick, 2001). The study also showed that Asian students are more collaborative compare to Australian students whereas in Joy and Kolb (2009) found that Asian students act more quiet and reflective in extraverted classes than other cultures.

In the light of above-mentioned examples many researchers examined the development of culture-aware information systems (Boondao et al., 2008; LeBaron, Pulkkinen & Scollin, 2000; Michailidou & Economides, 2003; Triantafillou, Georgiadou & Economides, 2006).

From the point of view of the research programme reported in this thesis, if it is indeed the case that certain cultures tend to skew towards a particular learning style, then this skew must be taken into account during analysis. In particular, if particular groups are heavily weighted towards a given learning style within collected data, then this may make subgroups incomparable during analysis phases.

2.5 Personalization of OLSs

One way of incorporating learning style and cultural differences into OLSs and websites is to allow personalization of material. The next subsections will present the definition of personalization, an overview of the different approaches proposed for personalizing such systems, research on these approaches and benefits of personalization. I will then provide a critique of that research and a proposal for an alternative approach, which will be explored in Chapter 6 of the thesis.

2.5.1 Introduction to the Concepts and Terminology in Personalization of OLSs

Personalization has been defined as "customizing information for each user so that the user can get personally relevant information efficiently" (Kamba, Sakagami & Koseki, 1997, p. 789). The system characteristics such as visualization, content, functionality and others can be tailored to users' goals, interests, preferences, and knowledge and, of particular interest to this research, learning styles and cultural differences.

According to McGrenere, Baecker and Booth (2007), personalization of OLSs can be realized in two ways: user-initiated customization, referred to as *adaptable approach*, and system-initiated adaptation, referred to as *adaptive approach*.

A number of different terms are used in the literature for adaptable systems, including customizable and tailored systems. A useful definition of adaptable systems is: "…ones which the individual user can explicitly tailor to her own preferences" (Jameson, 2003, p. 306).

Adaptive systems are automatically customizing applications and intelligent systems. An adaptive system has been defined as: "[ones which]…performs updates to the user profile automatically by observing the user's browsing behaviour" (Hongjing, De Kort & De Bra, 2001, p. 141) or "…all hypertext and hypermedia systems, which reflect some features of the user in the user model and apply this model to adapt various visible aspects of the system to the user"

(Brusilovsky, 1996, p.88). The basic objective of adaptive approach is to get the user profile and tailor its interactive behaviour to best fit that profile. *Adaptive educational hypermedia (AEH)* is a term that is used when describing situations where web content is being personalised to learners based on information about them as stored in the user model.

One the most important issues in the adaptive approach to personalization is obtaining information about users with the aim of creating user profiles about the individual comprised of types of information such as those mentioned above. The user profile can be either a user-generated or system-generated profile based on the system input type. According to Jameson (2003) gathering information from the user is twofold: explicit input (for example: self-reports, self-assessments, response to test items, etc.) and non-explicit input (for example: naturally occurring actions).

Bunt, Conati & McGrenere (2004) also provided definitions for adaptable and adaptive systems. Bunt et al. (2004) defined adaptable systems as to personalize by giving users control of managing the interface. On the other hand, adaptive interfaces as to personalize through the system acting (instead of users) by modelling users' behaviour, limitations, preferences, etc. A third approach that is proposed by the Bunt et al. (2004) combines both first two approaches to personalize, which is called *mixed-initiative approach*. Horvitz (1999) also defined mixed-initiative approach as creating adaptive support for customization. A goal of the approach is solving problems to achieve user goals by combining customization and intelligent services effectively.

Research on the personalization approaches and personalization of OLSs will be discussed in the following subsection.

2.5.2 Research on the Different Approaches, Effectiveness and Acceptability of Personalization of OLSs

OLSs that personalize their material regarding learners' learning styles by using one of the personalization approaches have been studied extensively. Researchers have also attracted a great amount of their interest to evaluate those systems by comparing learner performances in matching and mismatching groups. Learners using systems that present suitable materials for their learning styles participate in *matching group* whereas learners using systems that present unsuitable materials for their learning styles participate in *mismatching group* during these evaluations. Next subsections provide research on the three approaches of personalization, critiques on comparing them and research on personalized museum systems.

2.5.2.1 Adaptable Approach

As noted by Stuerzlinger, Chapuis, Phillips and Roussel (2006), since users can analyze their needs better than developers, they should be in control of customization, not the developers. Moreover, Xiao, Stasko and Catrambone (2007) stated that developers could create systems that meet users' requirements and needs; in spite of this, it is better to give choices to the user and allow users to control the customization.

Rivera (2005) studied the effects of content customization on user performance, perceived workload and satisfaction. 14 IT support and administrative assistants used four different web prototypes that varied in content density and customization capability. The time taken on task, data entry errors and participants' perceived workloads (measured using the NASA Task Load Index) were collected as dependent variables. In addition, participants completed a satisfaction questionnaire. Participants were more efficient and perceived their workload to be lower with a customized interface.

Another study explored the effects of customizing an embodied conversation agent (ECA) on user perceptions and behaviour (Xiao et al., 2007). The experimenter randomly assigned participants to one of the four conditions in which participants were asked to complete two tasks about trip planning with the help from an ECA. Variables were whether the ECA was assigned by the experimenter or chosen by the participants and quality or appropriateness of the ECA for the task in terms of both appearance and ability. To illustrate, unqualified ECAs for this task domain were represented by a smiley face. Study variables were measure by conducting several questionnaires. The results showed that customization had a positive effect on the perception of the agent and user performance. Authors observed that participants are more interested in the topic, more likely to take agent suggestions and more motivated to succeed if they are able to customize their agent.

Allowing users to adapt or adjust the interface in accordance with their own goals can improve user performance and perception with the interface. However, users' customization ability is related with their knowledge and competency about the system. As noted by Bunt et al. (2004) adaptive interfaces are suitable when users cannot effectively customize their interfaces effectively according to their own preferences. Hence, another group of researchers have focused on the adaptive approach that gives the system the ability to model the user and change the interface automatically. Next subsection gives idea on adaptive approach.

2.5.2.2 Adaptive Approach

One of the most recent studies that use adaptive approach for personalizing learning materials according to learners' learning styles is WELSA (Web-based Educational system with Learning

Style Adaptation, Popescu, 2010). The system present a learning environment where learners can browse through the course, play simulations, solve exercises, discuss any topic with their peers, etc. It also supports teachers for generating their course materials. It uses a unified LSM that integrates characteristics from several LSM to identify learners' learning preferences. To personalize any course, the system observes learner actions and their identified learning preferences. The author evaluated the system with 64 Computer Science undergraduate students who enrolled to Artificial Intelligence (AI) course. Learners asked for following two sessions using WELSA: one adaptive and one non-adaptive. Moreover, in the latter session learners randomly assigned to two groups: matched group and mismatched group by regarding their learning preferences. At the end of second session, learners were asked for taking a knowledge assessment test and then a questionnaire to state their opinion about the course, effectiveness and satisfaction with the system. Survey results illustrated high degree of learner satisfaction with the system. Furthermore, evaluation results showed the positive effect of using learning style adaptation in an OLS. The author suggests that offering student the course with best matches learning style preference results in best learning.

There are other studies that use adaptive approach for personalizing learning materials based on learners' learning styles in an OLS (see subsection 2.2.4.1 for the details of Wolf (2003); see subsection 2.2.4.4 for the details of Brown et al. (2006), Brown et al. (2007b) and Carver et al. (1999); see subsection 2.2.4.5 for the details of Peter et al. (2010); see subsection 2.2.4.6 for the details of Gilbert and Han (1999)).

Several of these studies were evaluated and different findings have been obtained. Some of them showed that such systems to improve learning experience (Carver et al., 1999; Popescu, 2010). However, other studies have failed to show any significant contribution of such systems (Brown et al., 2006; Brown et al., 2007a). Critiques on the not significant studies can be found in subsection 2.2.4.4.

Although adaptive approach provides various benefits to users over the adaptable approach, it is quite difficult to learn about users without their input and for developers to incorporate this information and proper personalisation for that information into a system. For that reason, a mixed approach can be used to overcome the disadvantages of using either an adaptable or adaptive approach. Next subsection provides information on mixed-initiative approach.

2.5.2.3 Mixed-initiative Approach

One of the studies that use mixed-initiative approach for personalizing learning materials according to learning styles is WHURLE-LS (Brown et al., 2007a). It is an OLS that gathers information about learners not only by using an explicit method but also by applying an implicit method. Like most of the other systems, WHURLE-LS focuses on the visual/verbal dimension

of learning styles and uses the ILS to gather explicit information. This system examines implicit information by storing learners' trials on log data files over a period of two weeks. The main objective of the study is to examine learners' preferences for information when it is presented in different modes: visual, verbal and neutral modes. In order to achieve this objective, WHURLE-LS was developed in such a manner to allow learners to switch from one presentational mode to another. Therefore, this system can be classified as applying mixed-initiative adaptation approach. The system was evaluated in terms of learners' browsing behaviour by 144 undergraduate and postgraduate students. The findings of the study showed little evidence of learning styles and page characteristics effects on mode choice. However, it was found that learners prefer verbal mode during initial usage.

Adaptive Hypermedia for All (AHA!) (De Bra, Smiths & Stash, 2006) and TANGOW (Parades & Roriduez, 2004) are OLSs that also applies this approach but in different manners. AHA! implements the approach by letting users to decide on the learning style they want to use in their course whereas TANGOW implements the approach during the collection of information about learners. According to Parades and Roriduez (2004), explicit information is not enough to structure a learner model. For that reason, they integrated explicit information that was collected through the ILS with implicit information such as age, background, and language.

Another system that implements this approach is The INSPIRE (see subsection 2.2.4.3 for the details of the study, Papanikolaou et al., 2002).

Even though some studies' results favoured purely adaptable interfaces, the researchers of these studies suggested mixed-initiative approach as a best way to satisfy a wide range of users (Miah, Karageorgou & Knott, 1997; Findlater & McGrenere, 2004; Park, Han, Park & Cho, 2007).

I will compare these three approaches in the next subsection.

2.5.2.4 Comparing Three Approaches

There has been debate among researchers about the best approach of personalization. Nevertheless, some of researchers tended to support which approach is better than the other by conducting experiments that compare the three approaches: adaptable, adaptive and mixed-initiative approaches.

A mixed-initiative customer assistance (MICA) system was proposed which tends to find and produce an optimized personal interface with the help of user and system collaboration (Bunt et al., 2004). The aim of MICA is to improve users' customization effectiveness through adding adaptive support to adaptable interfaces. Authors conducted two experiments in this study. First experiment aims to answer the question "when to customize" and the second experiment was conducted in order to answers the question "what to customize". The authors claim that novice

users need help during customization and that users perform their tasks more efficiently if they customize as early as possible, not customize as they go. Moreover, they suggest that users need help about what to customize and maintain their customized interfaces.

MICA was evaluated in another study (Bunt, Conati & McGrenere, 2007). 12 participants completed the experiment. Participants were asked to complete two tasks, each of which required menu selections. Performance, customization behaviour, impact of recommendations on customization decisions, interface preference, reason for customizing and feeling towards recommendations were taken as measurements. Results showed that system's recommendations improve time on task and reduce customization time. Moreover, authors found that users evaluated this mixed initiative system as being much better than purely adaptable systems.

Users customization ability is related with their knowledge and competency about the system. Adaptive approach is suitable when users cannot effectively customize effectively. Although adaptive approach provides various benefits to users upon adaptable approach, it is quite difficult to learn about users and for developers to incorporate this logic into a system. Additionally, problems like predictability, privacy and controllability can arise in adaptive approach. For these reasons, a mixed approach can be used to overcome the disadvantages of using either an adaptable or adaptive approach.

2.5.2.5 Personalization of Museum Systems

Cultural institutions over the world, including museums, already recognize that they have heterogeneous users those users have a diversity of needs. These insitutions have started to give importance to personalization of their websites, audio guides and other materials. However, it is quite difficult for those responsible for these materials in cultural institutions to learn about the wide variety of users and for their developers to put this logic into systems. Picard (1997) indicated that there is a need for personalization in museum systems. As indicated by Fantoni (2002), efforts on personalization are not to make everything for everyone. The effort for an organization should be to identify its most natural users and take actions to serve them better. Personalization can support these users on museum websites by providing them or helping them to find the relevant and appropriate information, increasing usability, etc. by taking their age, visiting style, origin, type of interest, context, level of expertise, etc. into consideration. Therefore, users will be satisfied, motivated for coming back and reuse the system. As a result, museums can benefit economically from personalization by increasing their virtual and real visitors (Bowen & Fantoni, 2004). As Fantoni (2002) indicated museums are becoming more independent from government so that they are looking for other alternatives for funding.

In the past few years, there has been an increasing effort for personalizing systems especially in the museum environment. Personalized collections, alerts, agendas, guides are just a few

examples. The Active WebMuseum (Kohrs & Merialdo, 2001) used a collaboration and content based approach for creating a personalized museum website to satisfy user interests on paintings. The authors attempted to capture feedback from users and present recommended information based on the feedback in this system. Evaluation of this system has not been performed yet. The MyMuseum prototype (Bright, Kay, Ler, Ngo, Niu & Nuguid, 2005) is an adaptable museum guide that customizes its presentations to the user's interest and preferences. Moreover, the guide informs the user about what has been adapted to him/her and why. In an evaluation of the system, seven participants used the system and completed several post questionnaires. The authors concluded that all participants found the system useful for a museum visit. Other examples on personalization of museum websites can be found in (Oberlander, O'donnell, Mellish & Knott, 1998; Paterno & Mancini, 1999; Stock, Carenini, Cecconi, Franconi, Lavelli, Magnini, Pianesi, Ponzi, Samek-Lodovici & Strapparava, 1993; Rutledge, Aroya & Stash, 2006).

According to Fantoni (2002), museum website users can differ in their age, amount of time, visiting style, origin, type of interest, social context, level of expertise and other qualities, but they also show striking differences in their styles of learning. Museums are good environments to present content and teach using a variety of learning styles. Schroeder and Vance (1991) conducted Myers-Briggs Type Indicator (MBTI) to a hundred randomly selected visitors of the Milwaukee Public Museum to identify preferences of them. They detected 32 a strong sensing preference and 68 an intuitive preference. The authors claimed that the content and the organization of the museum's website should focus on intuitive learning styles rather than sensing learning style. Serrell (1991) suggested to personalize exhibits based on visitors' learning styles so that they can make clear decisions about where to spend their attention and time.

Furthermore, users' cultural differences may impact their approaches to museum experiences. Several researchers draw attention to importance of showing sensitivity to issues of cultural difference in museum environment (e.g. Sachatello-Sawyer et al., 2002). According to Simon (2001), there are perception and satisfaction differences on websites between the cultural groups. Previous studies showed that East Asians differ systematically from Westerners in cognitive activity (Masuda, Gonzales, Kwan & Nisbett, 2008).

Therefore, developing museum systems that personalized based on learning styles and cultural differences can enhance users by providing them or helping them to find relevant and appropriate information. These kind of systems have a potential to satisfy users and motivate them for coming back and reuse the system.

I will provide a critique of personalization research and a proposal for an alternative approach, which will be explored in Chapter 6 of the thesis in the next subsection.

2.5.3 Critique of Research on Personalization of OLSs and Proposal for a New Approach

There have been many personalized OLSs that have been developed and evaluated in the literature. What is agreed upon is that a one-size-fits-all model of OLSs no longer works. Some developers of these systems use personalization to mean that learners can choose what and how they learn based to their interests; other propose that personalized systems support differently for different learners.

The paradigm of trying to manipulate online materials to match or clash with users' learning styles or other preferences has been used in the studies that are presented in this chapter. Instead, a more ecologically valid approach could be taken. Any website in the real world is very unlikely to have a whole version that is optimized for each learning style. Therefore, rather than trying to construct a website fully suited to a particular learning style, real websites could be analyzed for pages and functionality that would particularly suit people with particular learning styles. Then, tasks could be constructed which would guide participants to these different pages on the websites that would suit/not suit to their learning styles. Thus the experience of participants with different learning styles in realistic website environments could be assessed and the effects of elements of the website that suit different learning styles could be investigated.

I will make a conclusion on the topics that I discussed so far in the next section.

2.6 Discussion and Conclusions

This chapter presents the necessary background to support the research discussed within this thesis. Main topics that are discussed in the chapter are learning styles, cultural differences and personalization of OLSs.

Schaller and Allison (2005) noted that over the past thirty years researchers have investigated OLSs but the majority of that research has focused on formal learning and it is not clear that results of these studies are transferable to informal learning. When considering specifically informal learning on museum websites, one of the focuses of this research, Lin and Gregorc (2006) argued that there was remarkably few studies that guide us on what are the characteristics of a museum website that encourage learning.

Many educational institutions now use the concept of learning style in developing materials, including web materials for their students (ETaLD, 2005) and teachers recognize the importance of using different instructional methods and materials matched to their students' learning styles (Leite et al., 2010). Some of the studies give cues about learning styles effect on learners' performance in OLSs (Carver et al., 1999; Popescu, 2010) whereas some of them showed no

significant difference of these variables (Brown et al., 2006; Brown et al., 2007b). As Bousbia et al. (2010) noted learning styles are not an only source of difference in learners' behaviour on the web, but they are a significant factor in affecting the reactions of learners in a web environment. This indicates that there is still quite a bit of work to be done to unpick the impact that learning styles have on performance in OLSs, and in particular in informal learning settings.

There are also studies in the literature that emphasized the importance of cultural differences during development of websites (Simon, 2001; Smith, Dunckley, French, Minocha & Chang, 2004). Furthermore, several studies found culturally customized websites enhance accessibility, usability and interactivity (Dholakia & Rego, 1998, Luna et al., 2002; Simon, 2001; Tsikriktsis, 2002; Yeo et al., 1998). In spite of that, there are only few OLSs that assure users by customizing interfaces based on their diversified cultural groups and there is no theoretical structure describing design and culture (Daniel et al., 2013). One of the things presented in this review is that there are some indications that culture can play a part in influencing prevalence of particular learning styles within groups of individuals. As a result, studies with a single culture are likely to produce results that are not generalizable. Therefore, in the following studies several different cultures were examined.

One way of incorporating learning style and cultural differences into OLSs and websites is to allow personalization of material. This has a distinct advantage when talking about learning styles as a source of differences in heterogeneous groups of users. It is unlikely that museums, or other purveyors of OLSs would optimize entire versions of their websites for a specific learning style. However, one could see a situation where, if it could be demonstrated that users with different learning styles react differently in performance or preference to particular types of content or structure in websites, that OLSs could use personalisation to swap in and out different features of their websites based on a user supplied or system derived user model.

In order to demonstrate that there would be advantages to such an approach, this dissertation will undertake studies using ecologically valid content and tasks. Instead of creating artificial websites that are suited to particular learning styles, content will be used from real websites for empirical studies that show the impact that learning styles and culture have on the experiences of users.

Literature review study that is presented in this chapter demonstrates that there is a value on exploring learning styles as individual difference and culture as group difference on OLSs. The information gained from these studies regarding the impact of learning styles and culture can be used to guide designers and developers in producing content and websites that suit the different needs of learners. The long-term benefit will be better design practices and better support for the needs and preferences of users.

Next chapter is about how a LSM (Felder-Silverman LSM) was selected to be used in this research, how its questionnaire (ILS) was translated and evaluated to develop the Turkish Index of Learning Styles (T)ILS.

Chapter 3: Selection of a Learning Style Model (LSM) and Development of the Turkish Index of Learning Styles (T)ILS

3.1 Introduction

In this research programme I wished to investigate the impact of learning styles on users' understanding of website architecture and experience of websites. Therefore an appropriate model of learning styles and a questionnaire for measuring learning styles was needed. A considerable number of studies have been carried out within the field of learning styles over the past decade and many learning style models (LSMs) have been proposed in the literature (see subsection 2.2.4 for details of key LSMs). This chapter presents the method for selecting a LSM for use in this research programme (see section 3.2).

The LSM chosen was the Felder-Silverman LSM. However, the questionnaire developed to measure the learning styles proposed by this LSM, the Felder-Solomon Index of Learning Styles (ILS) (see subsection 2.2.4.4 for the details of the questionnaire) was developed in English, although a number of translations into other languages exist. One of the targeted cultural groups of this research programme was Turkish group. To make it suitable for learners from Turkey, the ILS was translated into the Turkish language with permission from ILS's main author, Professor R. M. Felder. Although I initially failed to find a Turkish version of the ILS (a fact confirmed by Professor Felder), during the development of Turkish version of the ILS, I encountered a study that performed such a translation (Samanci & Keskin, 2007). However, my development has some important differences. Firstly, in the other study, the ILS was translated into Turkish with the help of academics whereas I applied professional translation techniques. I found many problems with the translation that was performed by the other authors. Furthermore, the other authors established the reliability and validity of their questionnaire by means of conducting only one administration whereas I conducted two different test administrations with a four-week inter-test interval. Hence, the third section covers the development of the Turkish Index of Learning Styles (T)ILS and pointed out these issues (see section 3.3).

Lastly, this chapter ends with a discussion and conclusions section (see section 3.4).

3.2 Selection of a LSM

In order to select a LSM for use in this research programme, a number of selection criteria were defined, based on an approach proposed by Brown (2007). The criteria that the LSM to be used must meet are as follows:

1. The LSM must be one widely used with online learning systems (OLSs).
2. The LSM must have a questionnaire to identify its learning styles.
3. The questionnaire must have a good degree of reliability and validity.
4. The questionnaire must be available online.
5. The questionnaire must be free or a low fee must be charged for using it.

Table 3.1 lists how some of the most commonly cited LSMs fared against these criteria.

Table 3.1 Evaluations of Key LSMs against the Criteria for Adoption

Model	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5
Dunn and Dunn LSM	Yes	Yes	Yes	Yes	No
Kolb LSM	Yes	Yes	No	No	No
Honey and Mumford LSM	Yes	Yes	No	Yes	No
Felder-Silverman LSM	Yes	Yes	Yes	Yes	Yes
VARK LSM	Yes	Yes	Yes	No	Yes
Sarasin LSM	Yes	No	-*	-*	-*

*Sarasin LSM has not been evaluated for Criterion 3, 4 and 5 since it does not have a questionnaire.

As can be seen from Table 3.1 above, the Felder-Silverman LSM was the only model that satisfies all the criteria required (see subsection 2.2.4.4 for the details of the model).

The Felder-Silverman LSM has been widely used in OLSs (Carver et al., 1999; Brown et al., 2006; Brown et al., 2007b) (see subsection 2.2.4.4 for the details of these studies). Dag and Gecer (2009) reviewed 54 studies that were undertaken between 1998 and 2008 that investigated OLSs and learning styles. As noted before, they found that the Kolb LSM (see subsection 2.2.4.2 for the details of the model) was the most frequently used model (17 out of 54 studies), but this was followed by the Felder-Silverman LSM (11 out of 54 studies). Furthermore, Litzinger et al. (2005) noted that educators use the ILS to identify learning styles for more than 100,000 learners annually. It has come in for many criticisms, but this has prompted the authors to improve the model in a number of ways to address these criticisms.

The Felder-Silverman LSM has four dimensions that are each measured on values between +11 and -11, in steps of +/-2. As Graf (2007) noted, this facilitates a detailed description of learners' learning styles. For example Visual learners can be categorized as strong, moderate or weak Visual learners. Furthermore, Felder and Spurlin (2005) investigated the ILS and showed that it can be considered reliable, valid and suitable (see subsection 2.2.4.4 for more information on reliability and validity of ILS). In addition, the ILS is an online and free questionnaire.

As discussed in subsection 2.2.5, some LSMs overlap with each other, there are lots of similarities and relationships between these models and there is no agreed taxonomy. However, there are common dimensions and this make it possible to group dimensions of different LSMs.

These dimensions could be categorized in eight groups and listed along with their common characteristics in Table 2.1. According to this classification, Felder-Silverman LSM is only model that covers most of the groups.

For these reasons, the Felder Silverman LSM and the ILS were selected to be used in this research programme.

3.3 Development of the (T)ILS

3.3.1 Translation of the ILS into Turkish

The original ILS was developed in English and has been widely used in that language. Since its development, it has been translated into numerous languages, including Chinese (Ku & Shen, 2009; Lawa & Meyer, 2010), Swedish (Nilsson, Ostergen, Fors, Rickenlund, Jorfeldt, Caidahi & Bolinder, 2012), Spanish, Portuguese, Italian, and German. To make it suitable for learners from Turkey, a topic of importance for this research programme, this study provides a definitive translation of the ILS into the Turkish language.

With permission from its main author, Professor R. M. Felder, the ILS was translated into Turkish. To verify translations and to reduce the risks that can be encountered while translating from one language to another, two different translation techniques were used. Although most studies that have translated questionnaires into other languages have applied one of the each translation techniques during the translation process (Isemonger & Sheppard, 2007), the use of both multiple forward and back-translation techniques in this study prevented poor translations and enabled translations to be crosschecked. In order to translate the ILS into Turkish, four translators who are native speakers of Turkish and advanced speakers of English were employed. These four translators will be referred to as Translator1, Translator2, Translator3 and Translator4 in this text. In addition, I did several additional translations where necessary.

Figure 3.1, below, illustrates the first phase of the ILS translation process.

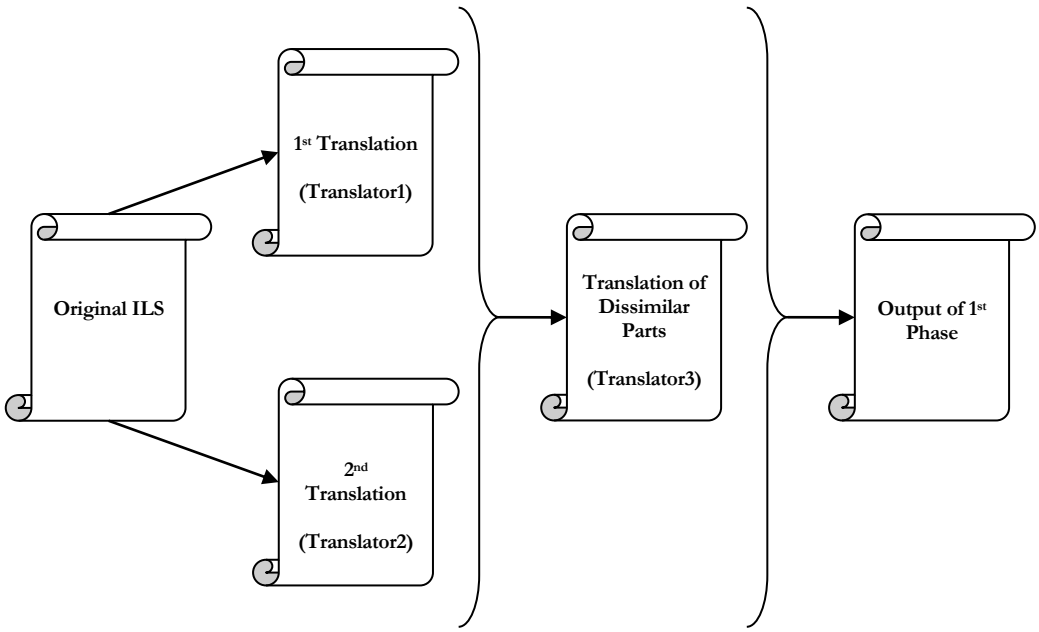


Figure 3.1 First Phase of the Translation Process

In the first phase, a *multiple forward translation technique* was used. A multiple forward translation technique is the translation of a document from the source language into the target language independently by a number of translators (Maxwell, 1996). Translator1 and Translator2 undertook two independent translations. Then I, as a native speaker of Turkish and fluent English speaker, compared these translations on an item-to-item basis in order to identify any differences in meaning. Then, Translator3 was asked to translate only the dissimilar parts of the first two translations. Next, the efforts of all three translators were evaluated and these efforts produced an overall first translation.

Figure 3.2, below, illustrates the second phase of the translation process.

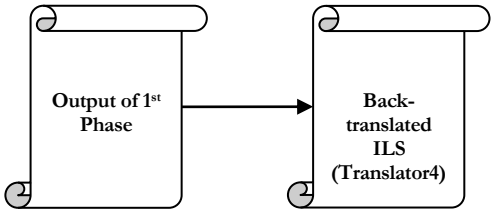


Figure 3.2 Second Phase of the Translation Process

In the second phase, a *back-translation technique* was used, that is a translation of a document that has been already translated into a target language back into the source language (Maxwell, 1996). Translator4 was asked to translate the output of first phase (the overall first translation of the ILS) back into English.

Figure 3.3, below, shows the third phase of ILS translation process.

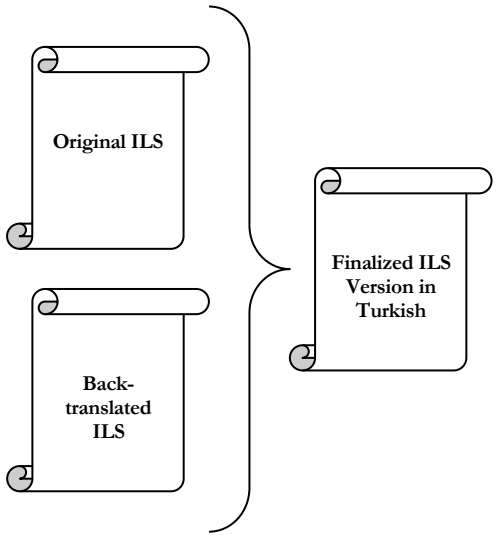


Figure 3.3 Third Phase of the Translation Process

In the third and last phase of translation process, the original ILS and the back-translated ILS were compared. Appropriate modifications were made and the Turkish version of ILS was finalized. The original ILS and finalized Turkish ILS version, now known as the (T)ILS can be found in Appendix A.

3.3.2 Reliability and Validation of the (T)ILS

In spite of a literature review that failed to find a Turkish version of the ILS (a fact confirmed by Professor Felder), in the course of conducting the development of the Turkish ILS, it was discovered that the ILS had already been translated into Turkish and studies on reliability and validity of the translated questionnaire had been performed (Samanci & Keskin, 2007). However, this study established the reliability and validity of the (T)ILS by means of conducting two different test administrations with a four-week inter-test interval. These methods will be discussed in detail in this section.

3.3.2.1 Participants

The (T)ILS was administered to a class of 63 undergraduate students in the Information Systems and Technology Department of Yeditepe University, Istanbul, Turkey. Students participated voluntarily in the study and received no compensation for their time. The questionnaire was administered twice, four weeks apart. After removing data from participants whom had missed either of the administrations of the (T)ILS, 60 valid sets of data from participants were available for analysis. There were 21 female and 39 male participants. They were all native Turkish speakers and their ages ranged between 20 and 23 years.

3.3.2.2 Procedure

Students worked with a pencil-and-paper version of the (T)ILS in a class environment. In addition to the responses on the (T)ILS, only basic demographic data were collected. Those students who did not wish to take part in the study left the class while participants completed the questionnaire. The sessions took approximately 15 minutes on the first occasion and approximately 10 minutes on the second occasion.

3.3.2.3 Results

To investigate the reliability of the (T)ILS, Cronbach alpha coefficients were conducted for each of the four dimensions. *Cronbach's alpha* can be defined as a measure of internal consistency that determines how well the test to measure the general construct produce similar scores (Cronbach & Shavelson, 2004). As noted by Felder and Spurlin (2005), Cronbach's alpha values of 0.5 or higher are acceptable for assessment. Table 3.2 presents the Cronbach's alpha values for the (T)ILS and a range of previous studies of the ILS. The comparison with previous studies in Table 3.2 shows that the (T)ILS generally has the highest Cronbach's alpha values among recent studies.

Table 3.2 Cronbach's Alpha Coefficients for Current and Previous Studies for the Four ILS Dimensions: Active-Reflective (Act-Ref), Sensing-Intuitive (Sen-Int), Visual-Verbal (Vis-Ver), Sequential-Global (Seq-Glo)

Study	n	Act-Ref	Sen-Int	Vis-Ver	Seq-Glo
Current study *	60	0.66	0.64	0.76	0.65
Samanci & Keskin (2007) *	381	0.43	0.54	0.59	0.32
Litzinger et al. (2005)	572	0.60	0.77	0.74	0.56
Litzinger et al. (2007)	448	0.61	0.77	0.76	0.55
Zywno (2003)	557	0.60	0.70	0.63	0.53
Livesay et al. (2002)	242	0.56	0.72	0.60	0.54
Spurlin (2002)	584	0.62	0.76	0.69	0.55
Van Zwanenberg et al. (2000)	284	0.51	0.65	0.56	0.41

Note. *Turkish version of ILS is used in these studies

To test the temporal stability of the (T)ILS, the *test-retest coefficient* was calculated, that is the correlation between scores gathered at two different times from the same set of respondents. The (T)ILS was administered to the same sample of participants on two occasions, approximately four weeks apart. As noted by Zywno (2003), the period between questionnaires is important since it has an effect on participant responses. Livesay et al. (2002) analyzed test-retest coefficient correlations for the ILS with a small sample size (n=24) at intervals of four, 7, 12 and 16 months. These different intervals gave linearly decreasing correlations. As indicated by

Felder and Spurlin (2005), the interval between test administrations should not be too large since learning style preferences might change over time. On the other hand, this interval should be large enough because respondents might remember their preferences, and that responses at first administration might influence responses on second administration. As applied by Seery et al. (2003) and approved by Felder and Spurlin (2005), a four week interval is suitable in order to prevent any such effects on responses. Table 3.3 lists a number of studies that measured test-retest correlation coefficients for the ILS, along with sample size and time lapse between the two administrations. The table also compares the results of the current questionnaire with previous studies and demonstrates that highest test-retest reliability coefficients were obtained for the current questionnaire.

Table 3.3 Test-retest Correlation Coefficients for a Range of Studies with the ILS

Study	n	Interval	Act-Ref	Sen-Int	Vis-Ver	Seq-Glo
Current study	60	4 weeks	0.964**	0.917**	0.951**	0.858**
Seery et al. (2003)	46	4 weeks	0.803**	0.787**	0.870**	0.725**
Livesay et al. (2002)	24	7 months	0.73*	0.78*	0.68*	0.60*
Zywno (2003)	124	8 months	0.683**	0.678**	0.511**	0.507**

Note: * $p < 0.05$, ** $p < 0.01$

Table 3.4 shows the test-retest mean scores in four dimensions of the (T)ILS on the two test occasions. A series of repeated measures t-tests showed that there were no significant differences between the mean scores of the two occasions. This finding demonstrates that learners' learning styles did not change during the four-week interval and also offers an evidence for the stability of the questionnaire.

Table 3.4 Participants' Test Mean Scores on Two Different Tests

Dimension	Mean Test 1	Mean Test 2	t value	Significance
Act-Ref	5.80	5.85	-0.554	n.s.
Sen-Int	7.30	7.30	0.000	n.s.
Vis-Ver	8.03	8.13	-0.925	n.s.
Seq-Glo	6.12	6.22	-0.603	n.s.

Note. df in all cases = 59

A principal components analysis (PCA) is a statistical analysis for transforming a number of potentially correlated variables into a smaller number of uncorrelated variables. To validate the dimension structure of the (T)ILS, a PCA was performed. According to Hair, Tatham, Anderson and Black (1998), to conduct a factor analysis including a PCA, the sample should not be fewer than 50 observations, if possible it should be larger than 100. Thus, the sample size of

60, although towards the lower end of the recommended size, is adequate for a PCA. Several studies have performed factor analysis on the ILS (Litzinger et al., 2005; Zynwno, 2003). Zynwno (2003) obtained a five-factor solution, while Litzinger et al. (2005) produced eight factors.

In this study, first the KMO and Bartlett tests were used to test the appropriateness of the data set for factor analysis. The KMO is a statistic that indicates the proportion of variance in the variables that might be caused by underlying factors (KMO value should be greater than 0.5) and Bartlett test was used to check whether the correlation matrix is an identity matrix (KMO value $0.54 > 0.50$, $p < 0.001$; Bartlett's Test of Sphericity = 2530.16, df = 946, $p < 0.01$). Results of these tests showed that the data are suitable for factor analysis. Kaiser's criterion method was used to extract the factors. Since the ILS has four dimensions, a principal component analysis with four factors was performed with varimax rotation method. Table 3.5 lists the factors obtained along with the number of items from each ILS dimension, which loaded onto these factors. In the model, each factor loaded most of the items that were related to the respective learning style dimension except for Act-Ref dimension. The variance explained by the model is 34%. This model explained the variance better compared to the results of a recent study of both the ILS and the Kolb Learning Style Inventory (Platsidou & Metallidou, 2009) that explained only 24% of the variance in the ILS.

Table 3.5 Relationship between Items on ILS Dimensions and the New Principal Components Analysis

Dimension	1	2	3	4
Act-Ref	5	1	5	0
Sen-Int	1	3	0	7
Vis-Ver	10	0	1	0
Seq-Glo	1	7	1	2

As illustrated in Table 3.5, the Act-Ref dimension loads onto two factors, factor-1 with 5 items and factor-3 with 5 items from that dimension. As illustrated in Table 3.6, there is a correlation between the Act-Ref and Vis-Ver dimensions ($r = 0.467$, $p < 0.01$). Some previous studies (Van Zwanenberg et al., 2000; Zywno, 2003) that performed factor analyses also found a correlation between these two dimensions. The Sen-Int dimension predominantly loads into factor-4 with 7 items from that dimension. Moreover, factor-1 is predominantly related to the Vis-Ver dimension as 10 items from that dimension load into this factor and only one item loads any other factor. Lastly, the Seq-Glo dimension predominantly loads into factor-2 with 7 items from that dimension. This analysis support that the questionnaire has construct validity. The Structure

of the (T)ILS was not changed in line with the results of the new principal components analysis in order to keep the (T)ILS directly comparable with other versions of the ILS.

Table 3.6 indicates the correlations between the four dimensions. If the results of the factor analyses are valid, these correlation values should be minimal. Of the six correlations, three are not significant while the other three are significant: between the Act-Ref and Vis-Ver dimensions ($r = 0.467$, $p < 0.01$), Act-Ref and Seq-Glo dimensions ($r = -0.215$, $p < 0.05$) and Sen-Int and Seq-Glo dimensions ($r = 0.213$, $p < 0.05$). However, two of these are relatively weak correlations, each accounting for less than 5% of the variance (the Act-Ref and Seq-Glo and the Sen-Int and Seq-Glo correlations). Only the correlation between the Act-Ref and Vis-Ver dimensions accounts for a substantial amount of variance (21.8%). Some previous studies that performed factor analyses also found some overlaps between these dimensions, particularly between the Act-Ref and Vis-Ver dimensions (Van Zwanenberg et al., 2000; Zywno, 2003). In general, the weak or non-significant inter-dimension correlations support the factor analysis findings.

Table 3.6 Correlations between the Four (T)ILS Dimensions

Dimension Pair	Pearson Coefficient	Significance
Act-Ref vs. Sen-Int	- 0.074	n.s.
Act-Ref vs. Vis-Ver	0.467	$p < 0.01$
Act-Ref vs. Seq-Glo	- 0.215	$p < 0.05$
Sen-Int vs. Vis-Ver	- 0.125	n.s.
Sen-Int vs. Seq-Glo	0.213	$p < 0.05$
Vis-Ver vs. Seq-Glo	- 0.159	n.s.

3.3.2.4 The Distinction between (T)ILS and Samanci & Keskin's Study

In spite of a literature review that failed to find a Turkish version of the ILS (a fact confirmed by Professor Felder), in the course of conducting the development of the Turkish ILS, it was discovered that the ILS had already been translated into Turkish and studies on reliability and validity of the translated questionnaire had been performed (Samanci & Keskin, 2007). However, (T)ILS is a definite translation of the ILS since it has distinctions from Samanci and Keskin's study.

The ILS was translated into Turkish with the help of academics in Samanci and Keskin's study whereas four different translators were participated in development process of the (T)ILS. Besides, some problems were found in the translations of Samanci and Keskin. These problems will be discussed in the next paragraph. In addition, both multiple forward and back-translation techniques were used in development process of (T)ILS to prevent poor translations and enable translations to be crosschecked. Lastly, this study established the reliability and validity of the

(T)ILS by means of conducting two different test administrations with a four-week inter-test interval.

When the (T)ILS was compared with Samanci and Keskin's translation of the ILS , nine items were found to differ in meaning (see Table 3.7 for a full list of the items). In item #3, they translated *getting a picture* as getting a film. However, they translated the word *picture* in item #7 as it was translated in this work in both item #3 and #7. In item #9, the translation of the *sit back* phrase should give the meaning of being inactive while something is happening. But, their translation gives the meaning of staying in the background. Respondents might not select this option since many people may interpret this phrase translation as a negative behaviour. In item #14, the translation of the word *nonfiction* differs in the two translations. Samanci and Keskin translated *reading nonfiction* as *reading nonliterary material*. However, *nonliterary material* is not the same as *nonfiction* and again has a negative connotation. In item #18, in the translation of *certainty,* two different Turkish words are used in the two translations. However, both of them give the meaning of certainness. Item #24 is part of the Seq-Glo dimension of the ILS. In this item, the phrase *a fairly regular pace* relates to sequential learners' preference for learning in linear, sequential steps. However, Samanci and Keskin's translation of this phrase does not imply this meaning. Although the phrase has nothing to do with learners' learning speed, they translated it as *learning in regular equal speed. Fits and starts* phrase in the next choice refers to irregular intervals. Although the phrase has nothing to do with learners' time taken during their study, Samanci and Keskin translated this phrase as *studying intensively in a short period of time*. Similarly, in the first choice of item #32, "*working on the beginning of the paper and progress forward*" gives the idea of working sequentially. However, Samanci and Keskin translated this as first thinking on the subject as a whole and then writing on it, the opposite effect. Moreover, in the second choice of item #32, they translated *work on different parts of the paper* as *dividing subject into parts, think and write on them*, a very different meaning. In Item #30, the first choice refers to learners who prefer to learn the best way of doing a task while they perform it. But Samanci and Keskin's translation of this choice refers to learners who prefer to use a particular way and being an expert on this way. They consider the word *master* as an adjective for learner. However, it is a verb that describes the way of doing a task. Additionally, in the second choice, the word *come up with* means invent or create. But, in their translation the meaning for this word is missing. In Items #34 and #37, the words *imaginative* and *outgoing* have translation problems, respectively. Samanci and Keskin translated *imaginative* as *creative*. Being imaginative is having a creative imagination whereas creative means only having the ability to create. Samanci and Keskin translated *outgoing* as *sympathetic*. Although these words can be used in literature interchangeably, the word *outgoing* reflects more having strong external relations and being comfortable in different environments. Since Item #37 is related to the Act-Ref dimension of the Felder-Silverman LSM, a word that

gives the meaning of the word *extrovert* will be more appropriate for translation of the word *outgoing*.

Table 3.7 Comparison of Different Translations of ILS Items

Item No	Dimensions	The Original ILS	Current translation	Samancı and Keskin's translation
3	Vis-Ver	When I think about what I did yesterday, I am most likely to get a) a picture. b) words	Dün ne yaptığım hakkında düşündüğüm zaman, daha çok a) bir resim b) kelimeler elde ediyorum.	Dün ne yaptığımı düşünmeye başladığımda, genellikle bunu a) bir film olarak canlandırırım b) kelimelerle ifade ederim.
9	Act-Ref	In a study group working on difficult material, I am more likely to a) jump in and contribute ideas. b) sit back and listen.	Çalışma grubunda, zor bir konu üzerine çalışırken, daha çok a) tartışmaya dâhil olur, görüşlerimle katkıda bulunurum. b) arkama yaslanır ve dinlerim.	Zor bir konu hakkında çalışan bir grupta, genellikle a) konuya hemen dahil olurum ve fikirlerimi söyleyerek katkıda bulunurum. b) arka planda kalır ve dinlerim.
14	Sen-Int	In reading nonfiction, I prefer a) something that teaches me new facts or tells me how to do something. b) something that gives me new ideas to think about.	Kurgusal olmayan düzyazıda a) bana yeni olgular öğreteni veya birşeyi nasıl yapacağımı anlatanı b) bana düşünmem için yeni fikirler vereni tercih ederim.	Edebi olmayan kitapları okurken a) bana bazı gerçekleri (olguları) veya bazı şeylerin nasıl yapılacağını anlatan kitapları okumayı tercih ederim. b) bana üzerinde düşünmem için yeni fikirler veren kitapları okumayı tercih ederim.
18	Sen-Int	I prefer the idea of a) certainty. b) theory.	a) Belirlilik b) Teori fikrini tercih ederim.	a) Kesin olan düşünceyi tercih ederim. b) Kuramsal düşünceyi tercih ederim.
24	Seq-Glo	I learn a) at a fairly regular pace. If I study hard, I will "get it." b) in fits and starts. I will be totally confused and then suddenly it all "clicks."	a) Oldukça düzenli adımlarla öğrenirim. Eğer çok çalışırsam, onu elde ederim. b) Rastgele çalışarak öğrenirim. Tamamen kafam karışır, daha sonra bir anda hepsi yerine oturur.	Genellikle a) düzenli eşit bir hızla öğrenirim. Eğer çok çalışırsam başarılı olurum. b) kısa sürede yoğun çalışırım. Kafam bazen tamamıyla karışır sonra bir anda her şeyi anlarım.
30	Sen-Int	When I have to perform a task, I prefer to a) master one way of doing it. b) come up with new ways of doing it.	Bir görev yerine getirmem gerektiğinde, genelde tercihim a) o işi yapmanın en iyi yolunu tam öğrenmektir. b) o işi yapmanın yeni yollarını bulmaktır.	Bir işi yapmam gerektiğinde a) genellikle bu işi yapmak için bir yolu kullanıp o konuda uzman olmayı tercih ederim b) bu işi farklı yollarla yapmayı tercih ederim.
32	Seq-Glo	When writing a paper, I am more likely to	Yazı yazarken, daha çok	Bir yazı yazarken genellikle

		a) work on (think about or write) the beginning of the paper and progress forward. b) work on (think about or write) different parts of the paper and then order them.	a) yazının başlangıcı üzerine çalışırım (düşünürüm veya yazarım) ve ileriye doğru geliştiririm. b) yazının farklı parçaları üzerine çalışırım (düşünürüm veya yazarım) ve sonra onları sıraya koyarım.	a) Konuyu başta bütünüyle düşünür ve daha sonra yazmaya başlarım. b) Konuyu parçalara bölerek, bunların üzerinde düşünür ve yazarım. Sonunda yazdıklarımı sıraya koyarım.
34	Sen-Int	I am more likely to be considered as a) outgoing. b) reserved.	Daha çok a) dışa dönük b) çekingen biri olarak nitelendirilirim.	Genelde a) sempatik olarak nitelendirilebilirim. b) çekingen olarak nitelendirilebilirim.

3.4 Overall Discussion and Conclusions

First, this chapter discussed why the Felder-Silverman LSM was selected as the LSM to be used in this research programme. A number of selection criteria were defined to decide on the LSM and the Felder-Silverman LSM was the only model that satisfied all the criteria required. In addition, some of the benefits of this model over the other LSMs were discussed. The Felder-Silverman LSM has been widely used with OLSs. Furthermore, the ILS is a free questionnaire for measuring the learning styles proposed by the model and it has been shown to have an acceptable degree of reliability and validity. Moreover, the ILS measures four dimensions of the model on values between +11 and -11. This facilitates a detailed description of learners' learning styles. As I discussed in section 3.2, the Felder-Silverman LSM covers most of the dimensions proposed by the other LSMs.

Second, this chapter presented the development of the (T)ILS, a Turkish version of the ILS, from Turkey, for use in this research programme. The ILS had already been translated into Turkish and studies on reliability and validity of that version had been performed (Samanci & Keskin, 2007). However, Samanci and Keskin (2007) translated the ILS into Turkish with the help of academics, some problems were found in the translations. In addition, most of the studies that translated any questionnaire into other languages applied one of the each translation techniques. Both multiple forward and back-translation techniques were applied in this study to prevent poor translation and to enable translations to be crosschecked. The (T)ILS has the highest Cronbach alpha values, a measure of internal consistency, among recent studies. In addition, the highest test-retest reliability coefficients were obtained for the (T)ILS. Moreover, no significant differences were found between the mean scores of the four dimensions of the (T)ILS on the two administrations. These results show that the (T)ILS has strong reliability. Lastly, the proposed factor structure gave evidence of the construct validity for the (T)ILS. Generally, weak or no inter-dimension correlations support the factor analysis findings.

Further studies could offer further validation by using the (T)ILS with larger sample sizes. In addition, further studies could establish the discriminant validity of the dimensions, if (T)ILS can be applied to the students majoring a different education department such as business students. Moreover, participants' perception of their learning styles could be gathered to assess whether their questionnaire of learning style matches their perception of their styles. Nonetheless I believe this is a definitive translation of the ILS into Turkish.

In the next chapter, the ILS and the (T)ILS will be used to measure learning styles of website users. The study presented learning style and cultural background to show differences in users'

categorizations and mental models of the information architectures (IAs) by using a card sort methodology.

Chapter 4: The Effects of Learning Style and Cultural Background on Understanding the Information Architectures (IAs) of Information Rich Websites[13]

4.1 Introduction

Information rich websites such as museum and news websites try to provide informal learning experiences for a wide range of users who have individual or group differences such as goals, interests, preferences, knowledge, backgrounds, demographic characteristics, experience, learning styles, and culture. To understand and support these users, individual differences can be addressed by focusing on learning styles and group differences can be addressed by focusing on cultural differences. The aim of the study presented in this chapter is to investigate learning styles and cultural differences to reveal differences in users' categorizations and mental models of the information architectures (IAs) in two website domains (museum and news sites) by using a card sort methodology. These informal learning domains were selected since people who visit museum websites may well be tourists coming from different cultures and many people visit news websites almost every day and people would seem to be familiar with their structure. Furthermore, museum and news websites present rich information for their users. Besides, the card sort technique was used since it is a simple, quick, cheap, and reliable method and can be used for numerous grouping tasks, for example to design and evaluate IAs of a website.

The card sort technique has been widely used in Human Computer Interaction (HCI) research (e.g. Fincher & Tenenberg, 2005; Rugg & McGeorge, 1997). In the card sort technique, participants are typically given a set of cards with items written on them and they are asked to put them in logical groupings, and to find a category name for each grouping. The groupings can be as large or as small as the participant chooses. While the task is simple for the participant, to analyze the results of this exercise can be difficult and time consuming. The technique can be conducted using physical cards (this will be referred as the "oncard" version) or by using online card sorting software tools (this will be referred as the "online" version) which make the analysis easier for the researchers.

One aim of UK part of the present study was to investigate whether there were differences between oncard and online administration of card sort studies. This aim was not relevant to the aims of this thesis, but was investigated in the UK part of the study.

[13] The UK part of the study has been written up as a paper and published in the INTERACT 2011 Conference (Petrie, Power, Cairns & Seneler, 2011).

The use of learning style models (LSMs) to enhance OLSs has become an important subject of research although there is still a scarcity of positive results. Some studies have indicated the contribution of such systems on improving user experiences (Carver et al., 1999; Popescu, 2010). Therefore, addressing learning style differences on websites may also enhance user experience. In this study, the Felder-Solomon Index of Learning Styles (ILS) and the Turkish version of this questionnaire, the Turkish Index of Learning Styles (T)ILS, were used to measure learners' learning styles.

Studies on cultural differences in card sort studies have been reported in the literature (Aykin, Quaet-Faslem & Milewski, 2006; Harper, Jentsch, Van Duyne, Smith-Jentsch & Sanchez, 2002). These studies have highlighted numerous differences between cultural groups. For example, Qu, Sun, Nawaz, Plocher and Clemmensen (2007) found cultural differences in the groupings of wedding related images between Chinese and Danish participants. Kralisch, Yeu and Jali (2006) found cultural differences between British, German, Malaysian and Russian participants in their understanding of medical terms that might be used in health information websites. In addition, Petrie, Power and Song (2009) used a card sort technique to reveal cultural differences between English and Chinese web users in preferences for different navigational layouts on websites. However, it is not clear whether this effect would extend to other aspects of the IA on websites.

Two website domains were selected for investigation in this study: museum and news websites. Both these domains provide rich information for users and informal learning experiences. Visitors to major museum websites will include tourists coming from various different cultures, so these websites should be trying to address multi-cultural audiences. In addition, news websites were chosen because many people visit these websites almost every day and people would seem to be familiar with their structure.

Due to the abovementioned reasons, this study was conducted to address the first research question of the programme of research:

Are there any differences in users' categorizations and mental models of the IAs based on their learning styles and cultural background?

4.2 Method

4.2.1 Participants

There were 214 participants in the UK part of the study and 90 participants in the Turkish part of the study.

The participants in the UK were students from two undergraduate modules and one graduate module on interactive systems in the Department of Computer Science at the University of

York. There were 184 male and 30 female participants, aged between 18 to 35 years, with a mean age of 21.3 years. As well as British participants, the participants came from a number of non-English speaking cultural backgrounds such as Chinese, Indian, and other European, and other participants from the Rest of the World group (see Table 4.1).

The Turkish participants were 52 male and 38 female participants, aged between 19 to 38 years, with a mean age of 22.1 years. These students were from two Turkish universities: Yeditepe University and Bogazici University.

Table 4.1 Number of Participants in each Group

Group	n	Men	Women	Min age	Max age	Mean age
British	107	100	7	18	35	19.6
Indian	27	20	7	19	31	24.2
Chinese	21	14	7	22	26	23.1
European	40	34	6	18	27	21.2
Turkish	90	52	38	19	38	22.1
Rest of the World	19	16	3	18	35	24.3

For each analysis the number of participants with all the data necessary for that analysis were included, the number of participants in each analysis differs. Therefore, the total number of participants that I used in any analysis is reported in this subsection.

To motivate participants, there was a lottery draw for three £10 gift vouchers for a major online book retailer in UK and for three 25 Turkish Lira gift vouchers for a popular online shop in Turkey for those who completed the study.

4.2.2 Materials

To create the words set for the card sorts, 18 museum websites and 10 news websites from countries with a national language of English (Australia, Canada, UK, and the USA) and five museum websites from Turkey were examined. These museum websites were chosen from the major national museums of each country, as these would be ones very likely to be visited by people from different cultures. The news websites were also chosen from the major news organizations in each country, as the ones which would lead the way in website organization. A list of these websites can be found in Appendix B.1.

First, the top level IA menu for each website was recorded. Next, for each website domain (museums or news), the most frequently occurring top seven menu items were chosen as main categories for collecting the word sets. Next, the IA menu under each of these seven main menu items was recorded from each website. All of these items were then categorized on the basis of their meanings. For example, if material on personal finance was labeled as "Finances" on one

news website while as "Your money" on another one, these were recorded under one group "Personal Finance" and as occurring on two distinct websites. Finally, the most frequent groups that occurred on most of the websites under the seven categories were selected as words for the card sort. This investigation produced 40 words from museum websites and 50 words from news websites. These groupings of these words will be referred to as the "A priori" groups here (see Appendix B.2 for a priori groups and words).

In the UK part of the study and the first phase of the Turkish part of the study, the card sorts conducted by using both physical cards (oncard version) and an online program (online version) to compare oncard and online versions of the card sort technique. In the oncard version, each card were printed on cards sized 89mm x 51mm and each word had a associated number (to facilitate data analysis) printed on the back of the card. Two different oncard sets were printed, one for one for museum websites and news websites. In the online version, the online card-sorting package WebSort[14] was used to present the "cards" to participants. Two different sets of online cards, one for museum websites and one for news websites, were created.

A questionnaire concerning the participants' demographic information was prepared in the online survey package, QuestionPro[15]. A lottery number was used to match participants' online sort with respective oncard sort and their responses to the questionnaire and also to enter them in the lottery draws for the motivational prizes (see Appendix B.3 for Websort screens illustrating the oncard version). In the second phase of the Turkish part of the study, only an online version was used for gathering card sorts since the findings of UK part of the study found that the use of different versions for gathering card sort data did not affect the results. However in the instance the questionnaire was paper-based rather than an online survey.

To detect participants' learning styles, UK participants took the online ILS[16] and Turkish participants took the paper based (T)ILS which was introduced in Chapter 3..

4.2.3 Procedure

In the UK part of the study, data were collected during practical sessions of the modules. Lottery numbers and a sheet of instructions were provided to participants at the beginning of the session. One of the researchers also verbally presented the instructions to the participants. First, participants were asked to do ILS and then complete the questionnaire about their demographic information. Then, participants were worked in pairs and asked to undertake two

[14] http://www.websort.net, Accessed 12th Aug 2014

[15] www.questionpro.com, Accessed 12th Aug 2014

[16] www.engr.ncsu.edu/learningstyles/ilsweb, Accessed 12th Aug 2014

sorts, one sort on the museum words and one sort on the news words. Half of the participants completed the museum sort first and the other half completed the news sort first. Half of the participants did the museum sort oncard and the other half did it online; the same division was made for the news sort. Participants were provided with a counterbalancing sheet which informed them of the order they should do the sorts in and sort they should undertake online and which sort they should undertake oncard.

For the oncard sorts, participants were given an envelope that contained a set of cards for the appropriate sort, museum or news. Participants were also given a set of blank slips of paper to write down category names in which they were grouping cards. Participants were asked to shuffle the cards at the beginning to ensure randomness of the set of cards (as several participants used each set). In addition, participants were asked to:

- Sort cards into categories and label these categories by means of blank slips of paper.
- They were assured that there was no correct answers or number of categories. However, they were asked to have more than one category and fewer categories than the maximum number of cards.
- One person in the pair timed how long it took to do the sort but participants were asked not try to be fast. However, they should also not go too slowly to avoid indecision about categories.

After having sorted cards, participants used a spreadsheet to record the following information:

- Label of each category
- Number of cards in each pile and the cards associated to with this pile
- Lottery number
- The time taken to complete the sort

A template of this sheet can be found in the Appendix B.3.

For the online sorts, participants were asked to go the web address that was provided. The website presented the similar instructions as those described for the oncard sorts, and participants were asked to provide their lottery number. The website automatically recorded the labels of the categories, the number of cards in each pile and pile names, lottery number and the time taken to complete the sort.

During the whole process, the participants were aware that they could withdraw any time without any academic penalty.

In the Turkish part of the study, data were collected during several modules in Yeditepe University and Bogazici University. The procedure for the Turkish part of the study was same as that followed in the UK except that the questionnaire used for detecting learning styles which in Turkey was the paper based (T)ILS. For the card sorts, only the online procedure was used.

4.2.4 Data Preparation and Analysis for Learning Styles

The distributions of scores on the four dimensions of the ILS and (T)ILS for the participants in the UK and Turkey respectively were inspected. For the Visual-Verbal (Vis-Ver) dimension, scores were heavily skewed towards the Visual end of the scale. To create appropriate groups on each dimension for analysis, participants were divided into three approximately equal sized groups on each dimension. An Excel spreadsheet of the card groupings for each ILS/(T)ILS dimension was created. That means 12 (4 dimensions x 3 groups per dimension) spreadsheets were prepared, for the data from all the participants for the UK and Turkish parts of the study for museum and news cards.

Cluster analyses were performed for each ILS/(T)ILS group for both the museum and news cards, separately for the UK and Turkish participants.

Clusters were compared calculating the minimum edit distances (MEDs) between the different groups within each ILS/(T)ILS dimension and with the a priori card groupings (see Appendix B.2 for the a priori groups and see subsection 4.2.2 for preparation of the a priori groups). As was defined before, the a priori groups refer to the groupings used on the actual museum and news websites. To calculate MEDs, a distance function is used to measure the distance between two card sorts. *Edit distance* is the minimum number of operations needed to adapt one card sort into another. For adaption, the basic operation is to move one card from a group to another (Deibel, Anderson & Anderson, 2005). For instance for two sorts, X and Y have the following groups:

X: X1={1,2}, X2={3,4,5,6}, X3={7,8}, X4={9,10}

Y: Y1={1,2,3,9}, Y2={4,5,6,7}, Y3={8}, Y4={10}

The MED between sort Y and sort X can be calculated by moving several cards. "3" should be moved from Y1 to Y2; "9" should be moved from Y1 to Y4 and "7" should be moved from Y2 to Y3. So, a minimum of three moves is needed to convert sort Y to sort X.

To investigate how participants' learning style affected their groupings of the menu items for museum and news websites, I compared the cluster analyses of the participants on each of the four ILS/(T)ILS dimensions. This analysis was conducted separately for the UK and Turkish

participants, as they had undertaken the ILS in different languages and viewed the cards in different languages.

4.2.5 Data Preparation and Analysis for Cultural Differences

To analyze the cultural differences, the groupings of the museum and news cards by the participants in the UK and Turkish parts of the study were compared. For this the following steps were taken:

- Excel spreadsheets were created for both the museum and news cards (2 spreadsheets for participants in UK (who comprised British, Chinese and Indian cultural groups) and 2 spreadsheets for participants in Turkey).
- Cluster analysis was performed for these 4 groups.

4.3 Results

4.3.1 Effects of Learning Styles on Card Groupings

Tables 4.2 - 4.9 present the MED results for the UK participants and Tables 4.10-4.17 present the MED results for the Turkish participants. Several abbreviations are used in the tables for the ILS/(T)ILS dimensions. Act-Ref stands for Active-Reflective, Sen-Int stands for Sensing-Intuitive, Vis-Ver stands for Visual-Verbal and Seq-Glo stands for Sequential-Global dimensions.

Table 4.2 and Table 4.3 show the groupings of UK participants on the Act-Ref dimension for the museum and news card sets, respectively. As illustrated in Table 4.2, participants who are Act in learning style on average group 27.5% of the cards differently from the a priori groups (see Appendix B.2 for the a priori groups and see subsection 4.2.2 for preparation of the a priori groups) for the museum card set. Furthermore, participants who are Act in learning style on average group 18.0% of the cards differently from the a priori groups for the news card set. Therefore, the UK Act participants' groupings for both museum and news card sets are more different from the a priori groups than the Balanced Act-Ref and Ref groups. In the museum card set, the Balanced Act-Ref participants' groupings are closer to the a priori groups than the Ref participants' groupings (15.0% for the Balanced Act-Ref, 17.5% for the Ref) whereas in the news sets, both the participants' groupings in Balanced Act-Ref and the Ref groups are closer to the a priori groups (16.0% for both the Balanced Act-Ref and the Ref).

Table 4.2 Minimum Edit Distance (MED) (%) for Museum Card Set for UK Data (Act-Ref Dimension)

	A priori	Act (n = 38)	Balanced Act-Ref (n = 38)	Ref (n = 36)
A priori	-	27.5	15.0	17.5
Act	27.5	-	12.5	15.0
Balanced Act-Ref	15.0	12.5	-	2.5
Ref	17.5	15.0	2.5	-

Table 4.3 MED (%) for News Card Set for UK Data (Act-Ref Dimension)

	A priori	Act (n = 31)	Balanced Act-Ref (n = 38)	Ref (n = 25)
A priori	-	18.0	16.0	16.0
Act	18.0	-	10.0	10.0
Balanced Act-Ref	16.0	10.0	-	4.0
Ref	16.0	10.0	4.0	-

The UK participants' groupings for museum and news card sets on the Sen-Int dimension are illustrated in Table 4.4 and Table 4.5. In the museum card set, participants who are in the Balanced Sen-Int group on average group 27.5% of the cards differently from the a priori groups. In the news card set, participants in the Sen group on average cluster 20.0% of the cards differently from the a priori groups. In the museum card set, the Sen participants' groupings are closer to the a priori groups than the participants' groupings in Balanced Sen-Int and the Int groups (17.5% for the Sen, 27.5%, for the Balanced Sen-Int and 20.0% for the Int). In the news sort, both participants' groupings in Balanced Sen-Int and Int groups are closer to the a priori groups than the participants' groupings in the Sen group (16.0% for both the Balanced Sen-Int and Int).

Table 4.4 MED (%) for Museum Card Set for UK Data (Sen-Int Dimension)

	A priori	Sen (n = 47)	Balanced Sen-Int (n = 35)	Int (n = 30)
A priori	-	17.5	27.5	20.0
Sen	17.5	-	15.0	5.0
Balanced Sen-Int	27.5	15.0	-	12.5
Int	20.0	5.0	12.5	-

Table 4.5 MED (%) for News Card Set for UK Data (Sen-Int Dimension)

	A priori	Sen (n = 41)	Balanced Sen-Int (n = 25)	Int (n = 28)
A priori	-	20.0	16.0	16.0
Sen	20.0	-	6.0	6.0
Balanced Sen-Int	16.0	6.0	-	2.0
Int	16.0	6.0	2.0	-

Table 4.6 and Table 4.7 show the groupings of UK participants on the Vis-Ver dimension for museum and news card sets, respectively. As demonstrated in Table 4.6, participants who are Very Strong Vis in learning style on average group 27.5% of the cards differently from the a priori groups for the museum card set. Nevertheless, in news card set participants who are in the Strong & Moderate Vis group on average group 22.0% of the cards differently from the a priori groups. In the news card set, the Balanced Vis-Ver & Ver participants' groupings are closer to the a priori groups than the Very Strong Vis and the Strong & Moderate Vis participants' groupings (20.0% for the Very Strong Vis, 22.0% for the Strong & Moderate Vis) whereas in the museum set both Strong & Moderate Vis and the Balanced Vis-Ver & Ver participants' groupings are closer to the a priori groups (22.5% for both the Strong & Moderate Vis and the Balanced Vis-Ver & Ver).

Table 4.6 MED (%) for Museum Card Set for UK Data (Vis-Ver Dimension)

	A priori	Very Strong Vis (n = 47)	Strong & Moderate Vis (n = 34)	Balanced Vis-Ver & Ver (n = 31)
A priori	-	27.5	22.5	22.5
Very Strong Vis	27.5	-	10.0	12.5
Strong & Moderate Vis	22.5	10.0	-	12.5
Balanced Vis-Ver & Ver	22.5	12.5	12.5	-

Table 4.7 MED (%) for News Card Set for UK Data (Vis-Ver Dimension)

	A priori	Very Strong Vis (n = 25)	Strong & Moderate Vis (n = 44)	Balanced Vis-Ver & Ver (n = 25)
A priori	-	20.0	22.0	14.0
Very Strong Vis	20.0	-	16.0	10.0
Strong & Moderate Vis	22.0	16.0	-	16.0
Balanced Vis-Ver & Ver	14.0	10.0	16.0	-

The UK participants' groupings for museum and news card sets on the Seq-Glo dimension are illustrated in Table 4.8 and Table 4.9. Participants who are Seq in learning style on average group

22.5% of the museum cards and 28.0% of the news cards differently from the a priori groups. Moreover, in both card sets, Glo participants' groupings are closer to the a priori groups than the Balanced Seq-Glo and the Seq participants' groupings (15.0% for the museum card set, 18.0% for the news card set).

Table 4.8 MED (%) for Museum Card Set for UK Data (Seq-Glo Dimension)

	A priori	Seq (n = 43)	Balanced Seq-Glo (n = 39)	Glo (n = 30)
A priori	-	22.5	17.5	15.0
Seq	22.5	-	5.0	7.5
Balanced Seq-Glo	17.5	5.0	-	2.5
Glo	15.0	7.5	2.5	-

Table 4.9 MED (%) for News Card Set for UK Data (Seq-Glo Dimension)

	A priori	Seq (n = 43)	Balanced Seq-Glo (n = 29)	Glo (n = 22)
A priori	-	28.0	20.0	18.0
Seq	28.0	-	10.0	12.0
Balanced Seq-Glo	20.0	10.0	-	2.0
Glo	18.0	12.0	2.0	-

Table 4.10 and Table 4.11 show the groupings of Turkish participants on the Act-Ref dimension for the museum and news card sets, respectively. As illustrated in Table 4.10, participants who are Ref in learning style on average group 52.5% of the cards differently from the a priori groups for the museum card set. Furthermore, participants who are Ref in learning style on average group 10.0% of the cards differently from the a priori groups for the news card set. In addition, participants who are Balanced Act-Ref in learning style on average group 10.0% of the cards differently from the a priori groups for the news card set. In the museum card set, the Act participants' groupings are closer to the a priori groups than the Balanced Act-Ref participants' groupings (17.5% for the Act, 40.0% for the Balanced Act-Ref). In the news set, the Act participants' groupings are closer to the a priori groups (8.0% for the Act) as well.

Table 4.10 MED (%) for Museum Card Set for Turkish Data (Act-Ref Dimension)

	A priori	Act (n = 27)	Balanced Act-Ref (n = 38)	Ref (n = 20)
A priori	-	17.5	40.0	52.5
Act	17.5	-	35.0	42.5
Balanced Act-Ref	40.0	35.0	-	37.5
Ref	52.5	42.5	37.5	-

Table 4.11 MED (%) for News Card Set for Turkish Data (Act-Ref Dimension)

	A priori	Act (n = 26)	Balanced Act-Ref (n = 41)	Ref (n = 20)
A priori	-	8.0	10.0	10.0
Act	8.0	-	10.0	6.0
Balanced Act-Ref	10.0	10.0	-	8.0
Ref	10.0	6.0	8.0	-

The Turkish participants' groupings for museum and news card sets on the Sen-Int dimension are illustrated in Table 4.12 and Table 4.11. In the museum card set, participants who are Sen in learning style on average group 47.5% of the cards differently from the a priori groups. In the news card set, both Sen and Int participants on average group 8.0% of the cards differently from the a priori groups. In the museum card set, the Int participants' groupings are closer to the a priori groups than the Sen and the Balanced Sen-Int participants' groupings (37.5% for the Balanced Sen-Int). In the news sort, the Balanced Sen-Int participants' groupings are closer to the a priori groups than the Sen and the Int participants' groupings (8.0% for both the Sen and 35.0% for the Int).

Table 4.12 MED (%) for Museum Card Set for Turkish Data (Sen-Int Dimension)

	A priori	Sen (n = 36)	Balanced Sen-Int (n = 32)	Int (n = 17)
A priori	-	47.5	37.5	35.0
Sen	47.5	-	22.5	22.5
Balanced Sen-Int	37.5	22.5	-	15.0
Int	35.0	22.5	15.0	-

Table 4.13 MED (%) for News Card Set for Turkish Data (Sen-Int Dimension)

	A priori	Sen (n = 36)	Balanced Sen-Int (n = 34)	Int (n = 17)
A priori	-	8.0	6.0	8.0
Sen	8.0	-	10.0	10.0
Balanced Sen-Int	6.0	10.0	-	10.0
Int	8.0	10.0	10.0	-

Table 4.14 and Table 4.15 show the groupings of the Turkish participants on the Vis-Ver dimension for the museum and news card sets, respectively. As illustrated in Table 4.14, participants who are Strong & Moderate Vis in learning style on average group 45.0% of the cards differently from the a priori groups for the museum card set. Furthermore, participants who are Strong & Moderate Vis in learning style on average group 10.0% of the cards differently from the a priori groups for the news card set. Therefore, the groupings of Strong & Moderate Vis Turkish participants for both museum and news card sets are more different from the a priori than the Very Strong Vis and Balanced Vis-Ver & Ver participants' groupings. In the museum card set, the Very Strong Vis participants' groupings are closer to the a priori groups than the Balanced Vis-Ver & Ver participants' groupings (37.5% for the Very Strong Vis, 40.0% for the Balanced Vis-Ver & Ver) whereas in the news set both the Very Strong Vis and the Balanced Vis-Ver & Ver participants' groupings are closer to the a priori groups (8.0% for both the Very Strong Vis and the Balanced Vis-Ver & Ver).

Table 4.14 MED (%) for Museum Card Set for Turkish Data (Vis-Ver Dimension)

	A priori	Very Strong Vis (n = 20)	Strong & Moderate Vis (n = 38)	Balanced Vis-Ver & Ver (n = 27)
A priori	-	37.5	45.0	40.0
Very Strong Vis	37.5	-	27.5	17.5
Strong & Moderate Vis	45.0	27.5	-	30.0
Balanced Vis-Ver & Ver	40.0	17.5	30.0	-

Table 4.15 MED (%) for News Card Set for Turkish Data (Vis-Ver Dimension)

	A priori	Very Strong Vis (n = 20)	Strong & Moderate Vis (n = 38)	Balanced Vis-Ver & Ver (n = 29)
A priori	-	8.0	10.0	8.0
Very Strong Vis	8.0	-	12.0	10.0
Strong & Moderate Vis	10.0	12.0	-	12.0
Balanced Vis-Ver & Ver	8.0	10.0	12.0	-

Table 4.16 and Table 4.17 show the groupings of Turkish participants on the Seq-Glo dimension for museum and news card sets, respectively. As illustrated in Table 4.16, participants who are Glo in learning style on average group 47.5% of the cards differently from the a priori groups for the museum card set. Furthermore, participants who are Balanced Seq-Glo and Glo in learning style on average group 12.0% of the cards differently from the a priori groups for the news card set. In the museum card set, the Seq participants' groupings are closer to the a priori groups than the Balanced Seq-Glo participants' groupings (32.5% for the Seq, 37.5% for the Balanced Seq-Glo) whereas in the news set the Seq participants' groupings are closer to the a priori groups (8.0% for the Seq).

Table 4.16 MED (%) for Museum Card Set for Turkish Data (Seq-Glo Dimension)

	A priori	Seq (n = 19)	Balanced Seq-Glo (n = 38)	Glo (n = 28)
A priori	-	32.5	37.5	47.5
Seq	32.5	-	27.5	40.0
Balanced Seq-Glo	37.5	27.5	-	15.0
Glo	47.5	40.0	15.0	-

Table 4.17 MED (%) for News Card Set for Turkish Data (Seq-Glo Dimension)

	A priori	Seq (n = 18)	Balanced Seq-Glo (n = 41)	Glo (n = 28)
A priori	-	8.0	12.0	12.0
Seq	8.0	-	6.0	10.0
Balanced Seq-Glo	12.0	6.0	-	12.0
Glo	12.0	10.0	12.0	-

4.3.2 Effects of Cultural Background on Card Groupings

To investigate the part of the first research question that is related to cultural background, MEDs between the cards sorts from the British, Chinese, Indian, and Turkish participants were compared. The card sorts from the different cultural groups were also compared with the a priori groups (see Appendix B.2 for the a priori groups and see subsection 4.2.2 for preparation of the a priori groups). Tables 4.18 and 4.19 present the results for the MEDs for the various cultural groups in the study, for the museum and news cards respectively[17].

[17] These tables have some differences from the tables in the INTERACT paper because there was an error in the calculation of the tables for the paper.

Table 4.18 MED between Card Sorts by British, Chinese, Indian, and Turkish Participants for the Museum Card Set

	A priori	British (n = 100)	Indian (n = 24)	Chinese (n = 16)	Turkish (n = 85)
A priori	-	30.0	32.5	25.0	52.5
British	30.0	-	12.5	5.0	52.5
Indian	32.5	12.5	-	10.0	52.5
Chinese	25.0	5.0	10.0	-	50.0
Turkish	52.5	52.5	52.5	50.0	-

For the museum card set, sorts by the Turkish participants are more different from the a priori than other sorts by any of the other cultural groups (52.5%) and Chinese sort is closer to the a priori groups than the other cultural groups (although the number of participants in this group is only 16, so less confidence can be placed in this cultural group than the others, for which the numbers are higher). In addition, the Indian sorts are more different from the a priori than the other cultural sorts in the news card set (30.0%) and the Turkish and Chinese sorts is closer to the a priori groups than the other cultural sorts for the news card set (10.0%).

For the museum card set, the number and general nature of the groups produced by the British, Indian and Chinese sorts are very similar. However, the particular cards grouped together are rather different for some of the groups. In particular, the cards in the groups "Collection" differ considerably among these three cultures. The Indian sorts typically produced a larger group for "Collection" with a number of cards from the a priori group "Shop" included in the group. Although the number of groups produced by the Turkish culture is the same with the other cultures, the general nature of the groups are very different. For example, the cards related to the "Shop" group are typically spread around other groups. This makes sense, since Turkish museums have only recently opened shops, so the concept of a museum shop is still very new in Turkey.

Table 4.19 MED between Card Sorts by British, Chinese, Indian, and Turkish Participants for the News Card Set

	A priori	British (n = 82)	Indian (n = 21)	Chinese (n = 20)	Turkish (n = 87)
A priori	-	18.0	30.0	20.0	10.0
British	18.0	-	16.0	8.0	16.0
Indian	30.0	16.0	-	14.0	22.0
Chinese	10.0	8.0	14.0	-	20.0
Turkish	10.0	16.0	22.0	20.0	-

In the news card set, the number and nature of the groups produced by the four cultural groups varied considerably. The Turkish sorts produced the highest number of groups, seven. In addition, the British and Chinese sort produced six groups each, whereas the Indian sort produced only five groups. All sorts produced almost the same groups for "Opinion" and

"Sports". For "Money and Business", the British, Chinese and Indian sorts were also very similar. However, the Turkish sort splits this category into two as "Money" and "Business". The British, Turkish and Chinese sorts also produced "Life style" with rather different groupings of particular cards whereas the Indian sort even does not have this group. The British and Turkish sorts produced "Entertainment" with almost the same cards whereas the Chinese and Indian sorts produced this group with more cards. The British and Chinese sorts produced "News" with almost same cards whereas the Turkish and Indian sorts produced this group with more cards. Nonetheless, the British sort produced groups for "Opinion", and "News", whereas the Indian and Chinese sorts produced "Entertainment" and "Non-factual" with rather different groupings of particular cards.

4.4 Discussion and Conclusions

This study illustrated interesting and meaningful differences between users with different learning styles and among different cultural groups. Firstly, interesting and meaningful differences were found between British, Chinese, Indian and Turkish participants in their average groupings of card relating to IAs of both museum and news websites. Particularly, in the museum domain Turkish participants' groupings produced substantially different groups compared to the a priori groups and in the news domain Indian participants produced substantially different groups compared to the a priori groups. Therefore, it might be useful if website designers study their audiences more carefully based on their cultural differences, possibly by using card sort studies to extract the mental models of these audiences.

A further valuable result demonstrated that participants with different learning styles produced different groups compared to the a priori groups. According to the results, a minimum 6.0% of the cards were grouped differently. This study also made a methodological contribution, showing that the card sort method could be used to show learning styles and cultural differences.

From these results, it is clear that there are differences in users' categorizations and mental models of the IAs of websites based on their learning styles and cultural backgrounds. Therefore, there is a value to investigating the impact of learning styles and cultural background on website in more detail. I was particularly interested to investigate museum websites, as these provide rich informal learning environments for a wide range of users, quite possibly from many cultural backgrounds. To investigate whether the results of such research would have practical use to museums, first I conducted a series of interviews with museum personnel to get their perceptions of visitor needs for the adaptation of websites in relation to both learning styles and cultural differences and to find out whether they are interested in these issues. This study will be explained in the next chapter.

Chapter 5: Interviews with Museum Personnel on Learning Styles and Cultural Background

5.1 Introduction

The card sort study presented in Chapter 4 showed that there are differences in users' categorizations and mental models of the information architectures (IAs) based on their learning styles and cultural backgrounds. Therefore, it was worthwhile to investigate these differences in more detail. Museum websites were chosen as an interesting domain as major museum websites will undoubtedly have many visitors from a wide range of cultural backgrounds. In addition, museums websites now provide much information about their collections and related information, so they provide rich informal learning environments that might benefit from adaptation to different learning styles. It is fairly clear that museum personnel should be interested in the cultural backgrounds of their visitors, given the highly international nature of tourism and museums, it is not clear that they would be interested in trying to address differences in learning styles amongst the visitors to their websites. Furthermore, it was interesting to learn their efforts on how they are trying to accommodate the wide range of user preferences, including potentially learning styles or cultural differences.

To obtain the views of museum personnel, interviews were conducted in Turkey, UK and the USA. Five Turkish museums, being two private and three public museums, were selected for the study. Four UK museums, being one of the large national museums and three smaller museums of different types, and a large USA museum were selected.

For the above-mentioned reasons, this study was conducted to address the second research question:

What are museums trying to do with their websites and how are they trying to accommodate the wide range of user preferences (such as learning styles or cultural background) and are museums interested in using concepts such as learning style to make their online materials more engaging to users?

5.2 Participants

5.2.1 Turkish Participants

The Turkish participants in the study were an information technology responsible, a manager of marketing and public relations department, a culture and tourism specialist assistant, a general coordinator of development projects and, a manager of film, video and communication programmes. Although Turkish interviewees had different job positions, they either worked on

a website development team or were still a member of a website team at a museum. There were two male and three female interviewees. The Turkish participants were in their 30s and 40s and their job experience was a minimum of eight years.

5.2.2 UK and USA Participants

The UK and USA participants in the study were a head of web team, a web editor, a digital resources manager, a visitor services manager and an education and access coordinator at a museum. There were three male and two female interviewees. The UK and USA participants were in their 30s and 40s and their job experience was a minimum of seven years.

A table with detailed demographic information about the individual interviewees can be found in Appendix C.1.

5.3 Interview Schedule

To obtain the views of museum personnel on the relevant several sets of questions were devised. The first set of questions was about the purpose/vision for the website, the second set of questions was about the organization of the work on the website, the third set of questions was about personalization of the website, the fourth set of questions was about learning styles as a concept, the fifth set of questions was about cultural differences and the last set of questions was about accessibility (the last set of questions were asked for another project, not as part of this thesis).

The full interview schedule is listed in Appendix C.2.

5.4 Procedure

For the UK interviews, an e-mail with an interview request including the study details and information about the authors was posted to an online discussion list for museum computer personnel (my supervisor was already a member of this discussion list). Approaches were also made to personal contacts in the museum world, and this resulted in the USA interview. For the Turkish interviews, an e-mail with an interview request including the study details and information about the authors were posted to contact mail addresses of a number of museums. Positive responses were received from all the museums within a short period of time. Details of interview times and locations were decided with interviewees in subsequent e-mails, interviews were generally at the museum or at a museum conference in the case of the USA participant.

All the Turkish museum websites had been online at least for two years. The Turkish interviewees indicated that three of them would be restructured in the near future not only to

handle some problems but also to keep up to date with technological advances. Homepages of the museum websites of all the participants in this chapter can be found in Appendix C.3.

5.4.1 Data Preparation and Analysis

Interviews were recorded with the permission of the interviewees. They were transcribed and all comments relevant to the different topics of interest were gathered in an Office Excel document. A content analysis was then performed. *Content analysis* can be defined as "any technique for making inferences by systematically and objectively identifying special characteristics of messages" (Holsti, 1968, p. 608). In the content analysis, a set of categories is needed to code the material. This set can be either pre-defined or can emerge from the data itself. In this study, categories mainly emerged from the data itself.

Inter-coder reliability was calculated to ensure the reliability of the analysis. To do this calculation, my supervisor and I performed the coding separately and then I compared our efforts. The following simple formula was used to calculate the agreement between us:

% agreement = (number of cases agreed on/total number of cases)*100

On a sample of approximately 10% of the material, the inter-coder reliability was 100%. This high inter-coder reliability was not unexpected as the coding of this particular dataset was quite straightforward.

5.5 Results

5.5.1 Purpose/Vision for the Website

All of the museum personnel, except for one in the UK, stated that the purpose of their websites is to support visitors with information about the museum including its collections, visiting hours, etc. The UK interviewee who was the exception, stated that the main aim of their website is to publicize the existence of the museum since the museum is not very well known. One Turkish interviewee added that they intend to support visitors who do not physically visit the museum. Further, another Turkish interviewee said that they aim to be a part of the Internet which is vital for a company or an organization in today's world. None of the Turkish museum websites have a website mission/vision document. On the other hand, three of the UK and USA museums stated that they have such a document. One of the UK interviewees stated that they have such a document but their document is not up to date. Moreover, another UK interviewee mentioned that they do not have such a specific document since their website is a part of another website. Most of the Turkish interviewees pointed out that they use Google Analytics to obtain statistics about the use of the website. However, only one of them noted that they use these statistics to create targets such as number of visitors to the website.

One of the UK and USA interviewees preferred not to answer the question about targets for number of visitors since they stated that this is confidential information. The rest of the UK and USA interviewees indicated that they do not have specific targets for numbers of visitors to the website. One of the UK interviewees and the USA interviewee stated that they are monitoring the number of visitors. However, several of the UK interviewees think that they should be more serious in the way they do this and the USA interviewee stated that they are happy with the information provided and added that they do not experience any problem with the number of visitors but if they did, they would do something about it. Another UK interviewee mentioned that this is something that they will probably do in the future. The last UK interviewee thought that it would be very useful to know more about the types of visitors coming to the website.

5.5.2 Organization of the Work

For three of the Turkish museums, the website design and development were out-sourced. For these websites, the interviewees stated that the out-source companies were chosen based on tendering procedures and also their expertise in the web development area. The Turkish interviewees listed the following as selection criteria for choosing the company: project budget, company references, company awards if any, and company expertise in the museum world. Another Turkish website was created by using both out-sourced and in-house techniques. Since the museum and the out-source company are both in the same holding structure, the interviewee said that they did not need any criteria for choosing that company and added that there were only two persons in the in-house development team. The last Turkish museum website was created in-house and developed by the interviewee.

The website design and development was conducted in-house in two UK museums, out-sourced in one UK museum and both out-sourced and in-house developed (but mainly in-house developed) in another UK and in the USA museum. One of the UK interviewees indicated that the out-source company was chosen using tendering procedures. The UK interviewee listed innovation, price and quality as selection criteria for choosing the out-source company. The other UK and USA interviewees did not comment on these questions.

Only one Turkish interviewee said that they do research about what visitors want from the website, based on information they gather through their Facebook page and through conducting surveys. However, all the Turkish interviewees believed that they should do studies about visitor needs, wants, and expectations for the website. Three of the Turkish interviewees said that they evaluate visitors' feedback if the visitors submit information by using the form or message box on the museum website. Except for one UK museum, the rest of this group stated that they do research about what visitors want from the website based on methods such as online surveys, focus groups, interviews, questionnaires, etc. The one exception of the UK

museums mentioned that they have plans about doing such research. They are planning to hire a student or look for a volunteer to do the research.

None of the Turkish interviewees stated that they did visitor testing with the website when it was being developed. Four Turkish interviewees did say that they do some tests in-house with museum staff. The USA interviewee indicated that they did several tests but solely with museum staff. Two UK interviews mentioned that they did not perform any tests. One UK interviewee mentioned that they evaluated visitors' views by conducting several online surveys and doing phone interviews. The final UK interviewee could not answer this question.

5.5.3 Personalization

On the topic of personalization, the Turkish interviewees emphasized that they are either trying or planning to provide different experiences on the website for children. One Turkish interviewee said that they also have a different website for their special club users. They are all aware of the importance of personalizing websites, especially for children and family groups. Only one UK interviewee mentioned that they do not try to offer different experiences on the website for different groups of people. The UK and USA interviewees stated that they are provide different sections on the websites for different types of visitors.

5.5.4 Learning Styles

At first the Turkish interviewees did not understand the term "learning style". When the term was explained to them all but one of the Turkish interviewees liked the idea of personalizing their museum website based on visitors' learning styles. They emphasized that unknowingly they are already personalizing the website based on visitors' learning styles in some dimensions. Three interviewees mentioned that they give importance to the balance between visual information and text and have plans in the near future about balancing it if there is an unbalanced situation. Two Turkish interviewees also mentioned the example of the virtual tour. They gave this example, as they understand that active or visual visitors will like it. Four interviewees of the UK and USA group stated that they do not have attempt to do this but three of this group stated that they are interested in learning styles after the concept has been explained to them.

5.5.5 Cultural Background

Most of the Turkish interviewees said that they know what proportion of visitors to their museum and to their website are from overseas. All the Turkish museums offer their print guides and audio guides in different languages. However, they present the website content only in Turkish and English. Mostly, they are aware of the importance of offering web content in

various languages but they find this too difficult, time-consuming and expensive. Although they are all interested in the idea of dealing with culture, these are only the ways that they try to accommodate the needs of visitors from different cultures.

Only one UK interviewee said that they know what proportion of visitors to their museum and their website are from overseas. The USA interviewee could not answer this question. The rest of the group mentioned that they do not know what proportion of visitors to their museum and their website is from overseas. In addition, one UK interviewee indicated that they are not even interested in overseas visitors (stating that their target audience is currently UK visitors and that they want to concentrate on meeting their needs well). Only one UK museum and the USA museum attempted to accommodate the needs of visitors from different cultures. The UK interviewee said that they provide website information in a number of different languages (they have special parts of the website in Chinese and Arabic). Moreover, The USA interviewee mentioned that they are offering both information and audio guide in a number of languages. Almost of all interviewees stated that they are interested in the idea of dealing with culture in other ways than their current strategy of merely translating texts.

5.5.6 Accessibility

Although all the Turkish museums are suitable for disabled persons physically, they do not have any consideration for them on the websites. Three of the interviewees think that they have more important things to worry about before accessibility of the website.

All the UK and USA museums' authorities mentioned that they are considering the needs of visitors with disabilities on the website. Only one UK interviewee said that they are trying to meet a particular Web Content Accessibility Guidelines (WCAG)[18] standard on the website. However, the other UK interviewees and the USA interviewee were particularly interested in the concept.

5.6 Discussion and Conclusions

This study was conducted to investigate whether the results of research on the impact of visitors' learning styles would have practical use to museums. It also explored a number of related topics around the development and personalization of museum websites. A series of interviews were conducted with museum personnel from Turkey, UK and USA to investigate their perceptions of visitor needs for adaptation of websites in relation to both learning styles and cultural background and to find out whether they were interested in these issues.

[18] http://www.w3.org/TR/WCAG20/, Accessed 17th October 2014

Interestingly, almost none of the interviewees were aware of the concept of learning styles, but the majority were very interested when they were told about it. In addition, the majority of interviewees thought learning styles had potential for how to make their website more appealing to a wider range of visitors. Moreover, museums are usually aware that they are trying to accommodate very diverse audiences with their websites. In addition, most museums are trying to accommodate international audiences from a variety of cultures - only two UK museums saw their brief as "national" rather than "international". Again, most museum personnel interviewed were interested in the idea of dealing with culture in other ways than simply translating the text on the website into other languages, although only one museum as gone to the extent of creating separate parts of their site dedicated to visitors from different cultures. For these reasons, it is valuable to conduct the final study of the research programme which investigates how learning styles and cultural background affect users' experience, performance and perception of the usability of museum websites. The final study will be presented in the next chapter.

Chapter 6: Investigating the Effects of Learning Styles and Cultural Background on Users' Experience, Performance and Perception of Two Museum Websites

6.1 Introduction

This study was designed to address the third research question of this research programme:

How do learning styles and cultural background affect users' experience, performance and perceived usability of informal learning websites such as large museum websites?

The card sort study (see Chapter 4) revealed meaningful differences in users' categorizations and mental models of the information architectures (IAs) of information rich websites. In addition, the interview study (see Chapter 5) demonstrated that museum personnel in a number of countries, although they were not aware of the concept of learning style, were very interested when they were told about it. Furthermore, the majority of museum interviewees thought learning styles had potential for making their websites more appealing to a wider range of visitors. Most of the museum interviewees were interested in the idea of dealing with culture in ways other they what they typically do now, which is simply translating the text of the website into different languages. In the light of findings from these studies, it is obvious that there is value in investigating the effects of learning styles and cultural background on users' experience, performance and perception of the usability of museum websites. Therefore, this study was designed to examine these effects in detail.

As discussed in the literature review (see subsection 2.2.4), there have been numerous efforts to investigate the effects of learning styles on online learning systems (OLSs) by artificially manipulating web material and developing different versions of OLSs that match people's learning styles (Brown et al., 2006; Brown et al., 2007a; Brown et al., 2007b; Popescu, 2008; Wang et al., 2006). However, in this study a different but complementary approach was chosen, to design a study with greater ecological validity. Any real museum website is very unlikely to have a whole version that is optimized for each learning style. Nevertheless, the discussions with museum personnel (see Chapter 5) showed that they are interested in providing materials suitable for people with different learning styles on their websites. Thus, rather than trying to construct a website fully suited to a particular learning style, two real museum websites were analyzed for pages and functionality that would particularly suit people with particular learning styles. Then, tasks were constructed which would guide people to these different pages on the websites that would suit/not suit to their learning styles. Hence, the experience of people with

different learning styles in realistic museum website environments could be assessed and the effects of elements of the website that suit different learning styles could be investigated.

As also discussed in the literature review (see section 2.3), serving the needs of website visitors with diverse cultural backgrounds is gaining importance as a topic for both research and practice. Thus, organizations now give importance to customizing websites based on cultural differences (Singh & Pereira, 2005). There are a number of studies that emphasize the importance of cultural differences during the development of OLSs (Simon, 2001; Smith et al., 2004). In addition, several studies have found that culturally customized OLSs enhance usability, accessibility and interactivity (Dholakia & Rego, 1998, Luna et al., 2002; Simon, 2001; Tsikriktsis, 2002; Yeo et al., 1998). However, there are not many OLSs that address the needs of users by customizing interfaces based on their cultural backgrounds (Daniel et al., 2013).
In summary, this study investigated whether users' learning styles and cultural background, affect their experience, performance and the perception of the usability of two real museum websites.

6.2 Method

6.2.1 Design

A mixed design was used, with some between-participant variables and some within-participant variables.

The between-participant independent variables were (a) participants learning style profile (a score on each of the four dimensions measured by the Felder-Solomon Index of Learning Styles (ILS) (Felder, Silverman & Solomon, 1996): Active-Reflective, Sensing-Intuitive, Visual-Verbal, Sequential-Global (see subsection 2.2.4.4 for the details of the questionnaire); and (b) their cultural background as measured by their country of origin.

Each participant undertook a series of tasks on two museum websites. These tasks were carefully constructed to guide participants to elements of the website that would suit people with particular learning styles. After completing the tasks on each website, they completed a series of short questionnaires: (a) their immediate emotional reaction to the website (using the Emotional Word Rating Scale, EWRS); (b) their preferences for specific features on the website (as measured by the Specific Feature Questionnaire, SFQ); (c) their like/dislike on the website (as measured by the Overall Reactions Questionnaire, ORQ) and (d) their perception of the usability of the website (as measured by the System Usability Scale, SUS, Brooke, 1996; Finstad, 2006; Tullis & Stetson, 2004). In addition, the time spent on each web page within the museum websites was logged.

Thus there were three groups of dependent variables:

(a) User experience (measured by using the EWRS, the SFQ and the ORQ)

(b) Performance (measured by the time spent on each web page within the museum websites and users' performances on tasks)

(c) Perceived usability (measured by the SUS)

Two museum websites, the British Museum (BM) website and the Wellcome Collection Museum (WC) website, were used in the study. These two museum websites were chosen since they have rich and varied material on their pages, which provided sources for different elements that would support and appeal to participants with different learning styles (see subsection 6.2.4 for further details). In addition, these informal learning domains present rich multimedia information for their users.

6.2.2 Participants

210 people started the study, but data from 146 people was eventually analyzed for investigating learning style differences and data from 129 people was eventually analyzed for investigating cultural background differences due to missing data on one or more of the independent or dependent variables (see section 6.4). In the first sample, there were 119 male and 27 female participants, aged between 18 to 35 years, with a mean age of 20.7 years. In the second sample, there were 108 male and 21 female participants, aged between 18 to 31 years, with a mean age of 20.4 years. All were students at the University of York, on undergraduate and post-graduate courses. The participants in the first sample came from a variety of country groups including Europe, China and the Rest of the World. However, the participants in the second sample came from only Europe and China groups (see subsection 6.4.2 for number of participants in each country group). Participants from the Rest of the World group were not included to analyses for investigating cultural background differences since participants in this group were too culturally diversified to make sense.

6.2.3 Equipment

The study took place in computer labs within the Department of Computer Science, with participants undertaking the tasks in their preferred web browser (e.g. Firefox, Internet Explorer, Opera) on PC workstations running Windows 7. Each computer ran a logging application, which collected the pages visited by the participants and the time spent on each page. A colleague from the University of York wrote this application.

6.2.4 Websites and Tasks

Participants were asked to complete a set of tasks on each of two websites, the BM[19] and the WC[20]. Any website in the real world is very unlikely to have a whole version that is optimized for each learning style. Therefore, rather than trying to construct a website fully suited to a particular learning style, these two real museum websites were analyzed for pages and functionality that would particularly suit people with particular learning styles. Then, tasks were constructed which would guide participants to these different pages on the websites that would suit/not suit to their learning styles. Thus the experience of participants with different learning styles in realistic museum website environments could be assessed and the effects of elements of the website that suit different learning styles and cultures could be investigated.

To define tasks, a set of appropriate pages was chosen on each website. Pages were chosen if they presented elements, materials or objects that appear to support people with different learning style preferences. For example, pages with large pictures would appear to address the needs of Visual people[21] more than pages with only small pictures, or no pictures at all.

Tasks were then defined that would lead participants to these pages, so their reactions to these key elements could be measured. Four tasks were defined for each museum website. Table 6.1 and Table 6.2 summarize the tasks for the BM and WC websites. The tasks and how they relate to different elements that appear to support people with different learning styles are described in detail in the next two subsections.

[19] http://www.britishmuseum.org, Accessed 11th Oct 2014

[20] http://www.wellcomecollection.org, Accessed 11th Oct 2014

[21] In this chapter, when I use terms such as Visual people/participants, I am referring to people at Visual end of the Visual-Verbal dimension of the ILS.

Table 6.1 Tasks on BM Website

Task Number	Task and Context	Answer and Page/s with the Correct Answer
1	Start by going to the Money theme: http://www.britishmuseum.org/explore/themes/money.aspx (see Figure 6.1) Browse the Money theme to answer these questions: How have coins helped us understand the history of Gandhara (modern Pakistan) and Northwest India when there are no written records?	Answer: Coins are only evidence that survives of the existence of the particular rulers. The answer is found at: http://www.britishmuseum.org/explore/themes/money/communicating_through_coins.aspx (see Figure 6.2)
2	What materials other than metal have currencies traditionally been made from?	Answer: Stone, feather, shells, copper, jade and paper The answer is found at: http://www.britishmuseum.org/explore/themes/money/tradition_and_innovation.aspx (see Figure 6.5) http://www.britishmuseum.org/explore/themes/money/merchants_and_the_world.aspx (see Figure 6.6) http://www.britishmuseum.org/explore/themes/money/the_beginnings_of_money.aspx (see Figure 6.7) http://www.britishmuseum.org/explore/themes/money/currency_in_the_modern_world.aspx (see Figure 6.8) N.B. When this task was designed, it was not realized that appropriate answers could be found on all these pages. This emerged when coding the data.
3	Now go to the Time Theme: http://www.britishmuseum.org/explore/themes/time/introduction.aspx What evidence does the museum have that the Romans held personal birthday parties? (see Figure 6.9)	Answer: The Roman tablets The answer is found at: http://www.britishmuseum.org/explore/themes/time/personal_time.aspx (see Figure 6.10)
4	What invention made time keeping at sea more accurate and hence made marine navigation faster?	Answer: Marine chronometer The answer is found at: http://www.britishmuseum.org/explore/themes/time/mechanical_time.aspx (see Figure 6.11)

Table 6.2 Tasks on WC Website

Task Number	Task and Context	Answers and Page/s with the Correct Answer
1	Start with to the Sickness and Health topic: http://www.wellcomecollection.org/explore/sickness--health.aspx (see Figure 6.12) What are the most and least common malaria parasites?	The answer is: The most common malaria parasite is P. vivax. Infections are rarely fatal. Least common is P. ovale, which is restricted to West Africa and also produces a mild illness. This page has the answer for the task: http://www.wellcomecollection.org/explore/sickness--health/topics/malaria/articles/the-malaria-parasite.aspx (see Figure 6.13)
2	What three Wellcome medicines did the Apollo space missions carry?	The answer is: "Apollo Spaceships carried the Wellcome product 'Marzine' as a precaution against motion sickness. On space missions 'Actifed' relieved astronauts' nasal congestion and 'Neosporin' cleared up any bacterial eye infections". This page has the answer for the task: http://www.wellcomecollection.org/explore/sickness--health/topics/tonics-and-curatives/images.aspx?view=packaging-for-marzine (see Figure 6.14)
3	Now go to Exhibitions area: http://www.wellcomecollection.org/whats-on/exhibitions.aspx (see Figure 6.15) In Georgie Meadows artworks, what problem is illustrated for Mrs Shaw?	The answer is: "The woman got a name for being a difficult resident because she would not join in with the social activities. She had always been a private person. No one had asked her if she wanted to come to the party or wear the ridiculous hat". This page has the answer for the task: http://www.wellcomecollection.org/whats-on/exhibitions/georgie-meadows/image-gallery.aspx?view=georgie-meadows-78 (see Figure 6.17)
4	Now go to Genetics topic: http://www.wellcomecollection.org/explore/life-genes--you/topics/genetics.aspx (see Figure 6.18) What are the symptoms of the most severe form of haemophilia?	The answer is: "In the most severe cases, where factor VIII or IX are reduced to below 1 percent of their normal levels, there is a significant delay in clotting resulting in protracted bleeding, and there may be spontaneous haemorrhaging into joints in muscles, resulting in swelling and pain and eventual deformation of joints". This page has the answer for the task: http://www.wellcomecollection.org/explore/life-genes--you/topics/genetics/articles/haemophilia-a-and-b.aspx (see Figure 6.19)

6.2.4.1 British Museum (BM) Tasks

For the BM website, two tasks were defined for each of Money and Time themes which are part of the Explore section of the BM website (see Table 6.1).

BM Task 1: How have coins helped us understand the history of Gandhara (modern Pakistan) and Northwest India when there are no written records?

Participants were asked to start by going to the Money page (see Figure 6.1) and to browse the Money theme to answer BM Task 1. The "Communicating through coins" page illustrated in Figure 6.2 has the answer: "Coins are only evidence that survives of the existence of the particular rulers" and participants could find this answer by simply clicking on the "Communicating through coins" link or the image below this link on the right side of the Money page.

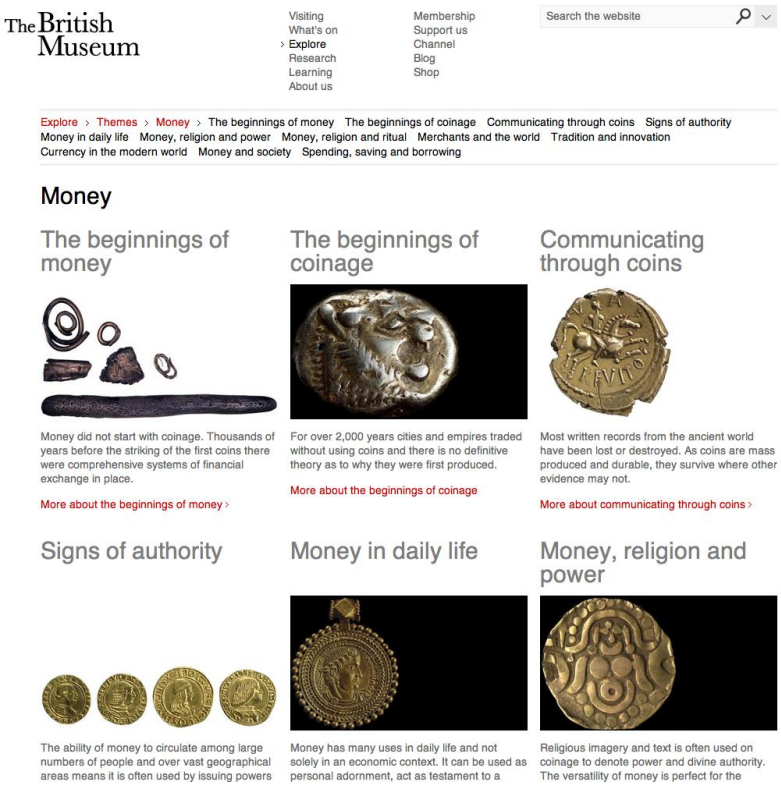


Figure 6.1 BM Website Money Page

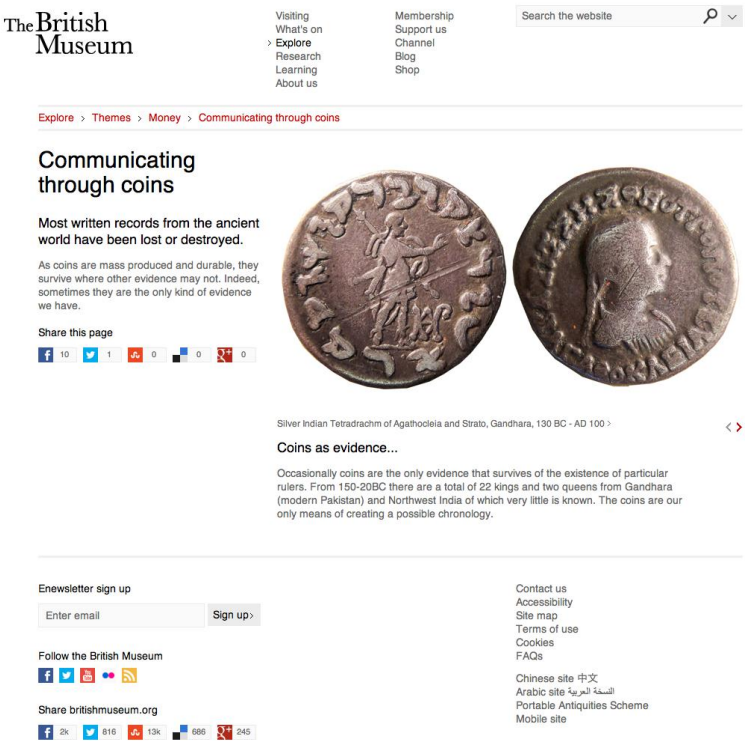


Figure 6.2 BM Website Communicating Through Coins Page

On the Money page, the top navigation bar (see Figure 6.3) is more suitable for Global people because it gives them all the navigational possibilities together in a compact list, whereas the main navigation (see Figure 6.4) in the middle of the page is more suitable for Sequential people because they can work through the navigational possibilities one after the other with quite a lot of information. The top navigation bar is also more suitable for Verbal people as it is only text, whereas the main navigation in the middle of the page is more suitable for Visual people as it includes quite large pictures. Moreover, the top navigation bar is more suitable for Intuitive people as the items are quite abstract, whereas the main navigation is more suitable for Sensing people because it includes concrete pictures. Furthermore, the main navigation consists of small snippets of information. In this view, you need to follow the links to find more information. Since you have to be active for further learning, the main navigation in the middle of the page appeals to Active people more, whereas the top navigation bar appeals to Reflective people because they like annotated links.

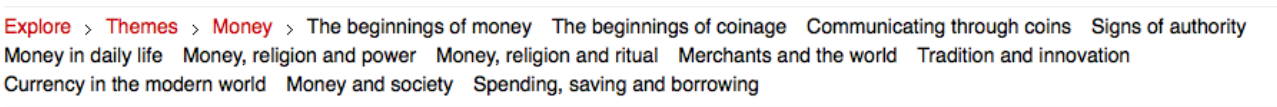


Figure 6.3 BM Website Top Navigation Bar on the Money Page

Figure 6.4 BM Website Main Navigation on the Money Page

The "Communicating through coins" page (see Figure 6.2) is a very visual oriented page, although the answer to the question posed to the participants is actually in the text. So Visual people will like it more than Verbal people. In addition, this page is more suitable for Visual people since they find large images attractive. Moreover, these pages will appeal more to Active people because users have to use an arrow to see more information. Also, Sequential people will like these pages because the information flows in a stepwise manner. Lastly, Sensing people will find the images more attractive than Intuitive people since they like concrete things.

BM Task 2: What materials other than metal have currencies traditionally been made from?

The answer to BM Task 2 is "Stone, feather, shells, copper, jade and paper". A number of pages have the answer, although this was not realized when the task was originally devised – it only emerged from the answers given by participants in the study (see Figure 6.5 to Figure 6.8). Participants can find the answer by clicking on "Tradition and innovation", "Money, merchants and the world", "The beginnings of money", "Currency in the modern world" links or the images below these links on the Money page, illustrated in Figure 6.1.

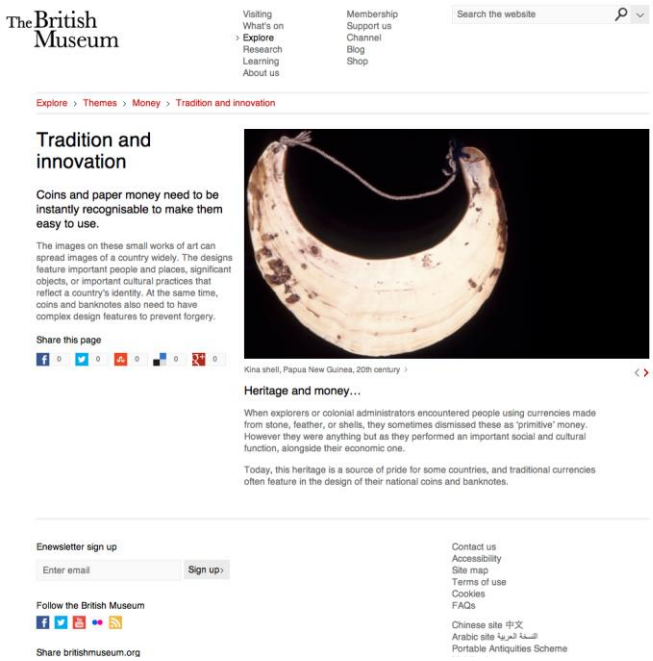


Figure 6.5 BM Website Tradition and Innovation Page

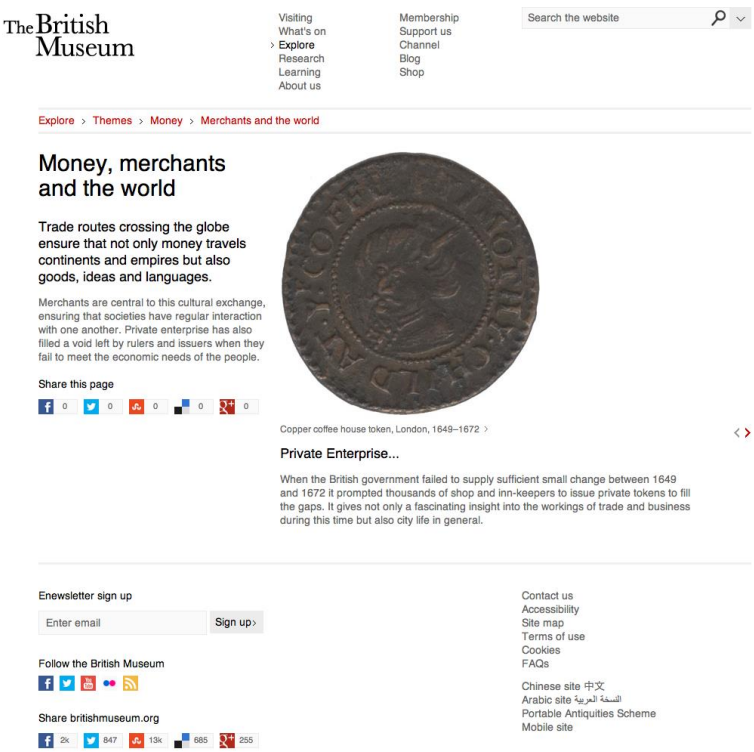


Figure 6.6 BM Website Money, Merchants and the World Page

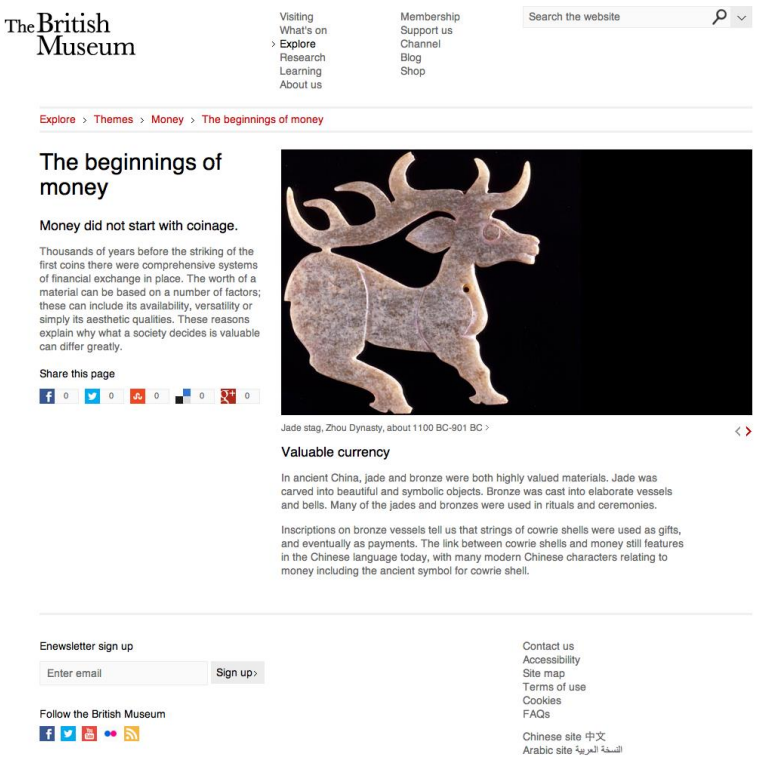


Figure 6.7 BM Website The Beginnings of Money Page

Figure 6.8 BM Website Currency in the Modern World Page

To get to the answer, participants have to move through different pictures and captions with the navigation buttons on the bottom right side of the images. Therefore, it will suit Active people rather than Reflective people, since Active people like to be dynamic during their learning experiences. It is a very visually oriented page, although the answer is actually in the text. So Visual people will probably like it more than Verbal people. Besides, this page is more suitable for Visual people since they find large images attractive. Also, Sequential people may like these pages because the information flows in a stepwise manner. Lastly, Sensing people may find the images more attractive than Intuitive people since they like concrete things.

Next, participants were asked to go to a specific page as a start point, which is illustrated in the Figure 6.9 to answer two tasks on the Time theme, which are given in Table 6.1.

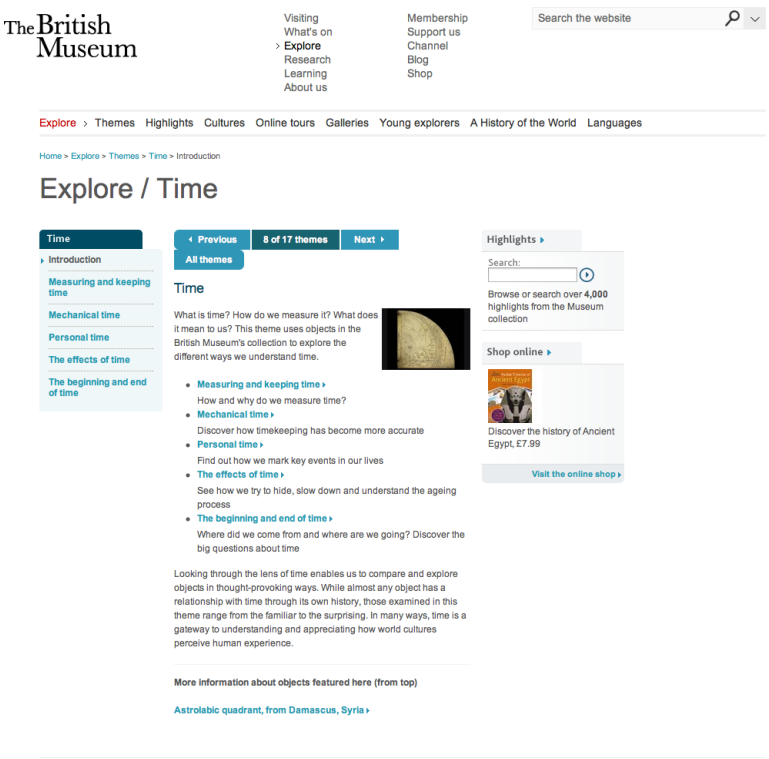


Figure 6.9 BM Website Time Introduction Page

The "Time introduction" page is mainly text, so it suits Verbal people more than Visual people. Also, the lack of pictures and somewhat abstract language means this page is more suitable for Intuitive people in comparison to Sensing people. The navigational elements are arranged in a list, but are both in the text and in a bar on the left side. So, it is difficult to make a prediction about whether Sequential or Global people will prefer either type of navigational element. However, the Previous and Next buttons allow Sequential people to see items serially and there is also an "All themes" option for Global people who want to see the big picture. Furthermore, there are links embedded in the text, but it is mainly a long text to read through. For that reason, it will appeal more to Reflective people than to Active ones.

BM Task 3: What evidence does the museum have that the Romans held personal birthday parties?

The answer to BM Task 3 is: "The Roman tablets". The page that has the answer to this task is illustrated in the Figure 6.10. Participants can find this answer by simply clicking on "Personal time" link on the left side of the "Time introduction" page, illustrated in Figure 6.9.

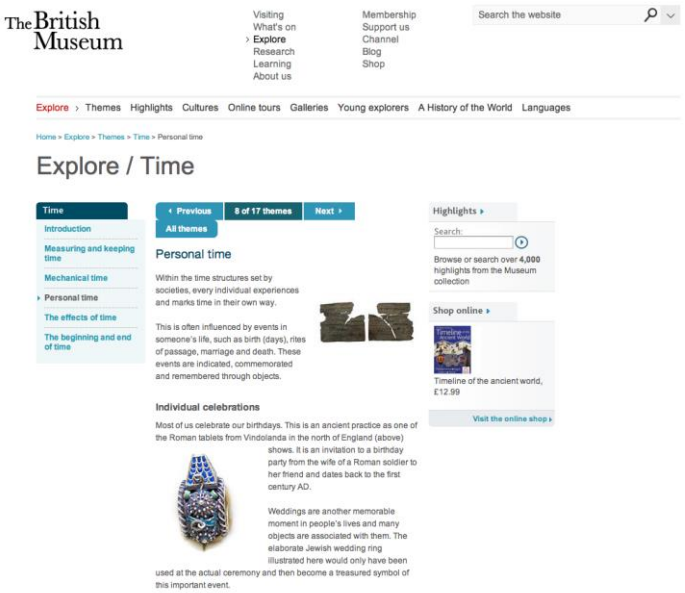


Figure 6.10 BM Website Personal Time Page

The "Personal time" page has almost the same characteristics with the previous page, the "Time introduction" page. This page has lots of text and small images so it suits Verbal people more than Visual people. Also, the lack of pictures and somewhat abstract language means this page is more suitable for Intuitive people in comparison to Sensing people. The navigational elements are arranged in a list on a bar on the left side. So, the page is more attractive for Global people who like to see the big picture. Also, the Previous and Next buttons allow Sequential people to see items serially and there is also an "All themes" option for Global people who want to see the whole picture. Furthermore, there are images embedded in the text, but it is mainly a long text to read through. For that reason, it will appeal more to Reflective people rather than Active ones.

BM Task 4: What invention made time keeping at sea more accurate and hence made marine navigation safer?

The answer to BM Task 4 is: "The marine chronometer". The page that has the answer for this task is illustrated in the Figure 6.11. Participants can find this answer by clicking on the "Mechanical time" link on the left side of the "Time introduction" page illustrated in Figure 6.9.

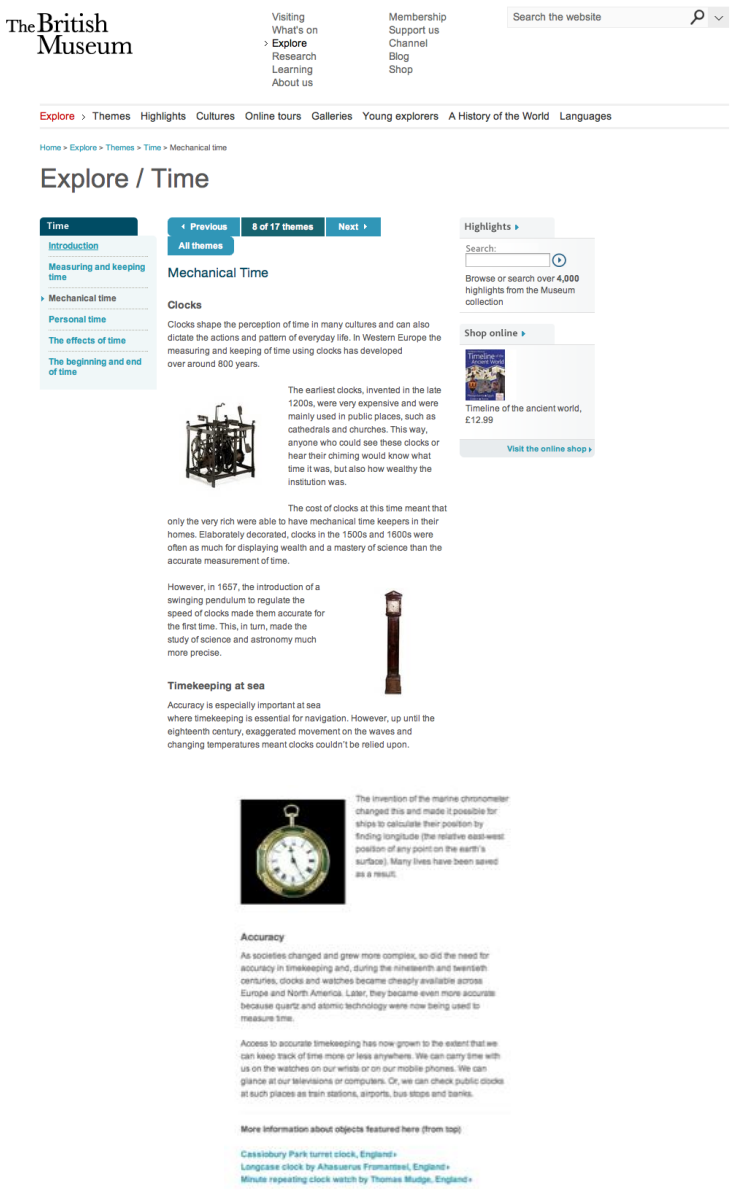


Figure 6.11 BM Website Mechanical Time Page

The "Mechanical time" page consists of mainly text, so it suits Verbal people more than Visual people. Besides, the lack of pictures and somewhat abstract language means this page is more suitable for Intuitive people in comparison to Sensing people. In addition, the Previous and Next buttons allow Sequential people to see items serially and there is also an "All themes" option for Global people that want to see the whole picture. This page is mainly a long text to read through. Therefore, it appeals more to Reflective people compared to Active ones.

6.2.4.2 Wellcome Collection Museum (WC) Tasks

As listed in Table 6.2, two tasks were defined on the WC website for the "Sickness and health" theme and a single task was defined for each Exhibitions and Genetics themes.

Participants were asked to go to a specific page as a start point and to answer two tasks on the "Sickness and health" theme (see Figure 6.12).

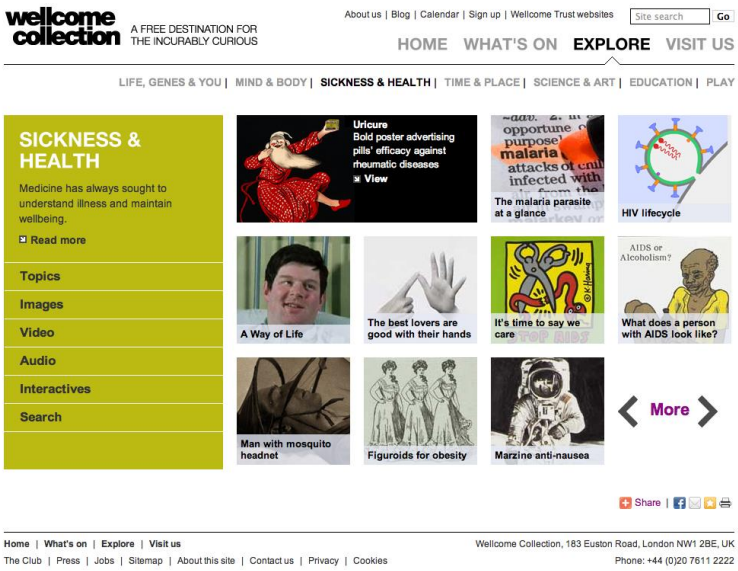


Figure 6.12 WC Website Sickness and Health Page

The "Sickness and health" page is suitable for Active people rather than Reflective people, because they have to roll their mouse over the pictures to get the captions. Likewise, the page is suitable for Visual people rather than Verbal people because the pictures are quite prominent. In addition, the page is suitable for Global people rather than Sequential people since it presents information at a glance. Besides, the page appeals to Sensing people cause it has a concrete appearance.

WC Task 1: What are the most and least common malaria parasites?

The answer to WC Task 1 is: "The most common malaria parasite is P. vivax. Infections are rarely fatal. Least common is P. ovale, which is restricted to West Africa and also produces a mild illness". The "Malaria Parasite" page illustrated in the Figure 6.13 has the answer for this task and participants can find this answer by clicking on "The malaria parasite at a glance" link or the image of this link on the "Sickness and Health" page, illustrated in Figure 6.12.

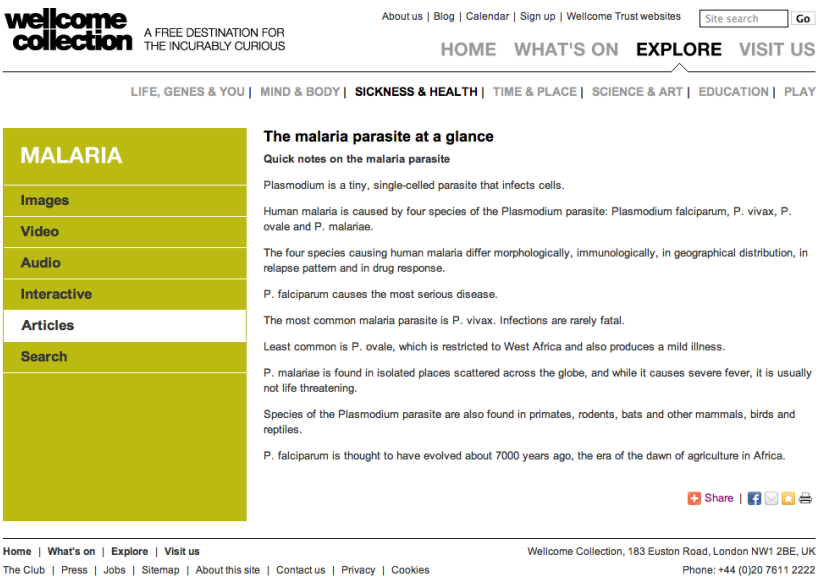


Figure 6.13 WC Website Malaria Parasite at a Glance Page

The "Malaria parasite at a glance" page is suitable for Verbal people rather than Visual people because it consists of text only with no pictures. In addition, it is suitable for Sequential people rather than Global people since they have to read through the page to find the answer. It is also suitable for Reflective people rather than Active people since they are more comfortable with long texts. Furthermore, Sensing people feel more comfortable with this page compared to Intuitive people since the page is about a concrete subject.

WC Task 2: What three Wellcome medicines did the Apollo space missions carry?

The answer to WC Task 2 is: "Apollo Spaceships carried the Wellcome product 'Marzine' as a precaution against motion sickness. On space missions 'Actifed' relieved astronauts' nasal congestion and 'Neosporin' cleared up any bacterial eye infections". The 'Packaging for Marzine" page, illustrated in Figure 6.14, has the answer for this task and participants can find this answer by clicking on the "Marzine anti-nausea" link or the image of this link on the "Sickness and Health" page, illustrated in the Figure 6.12.

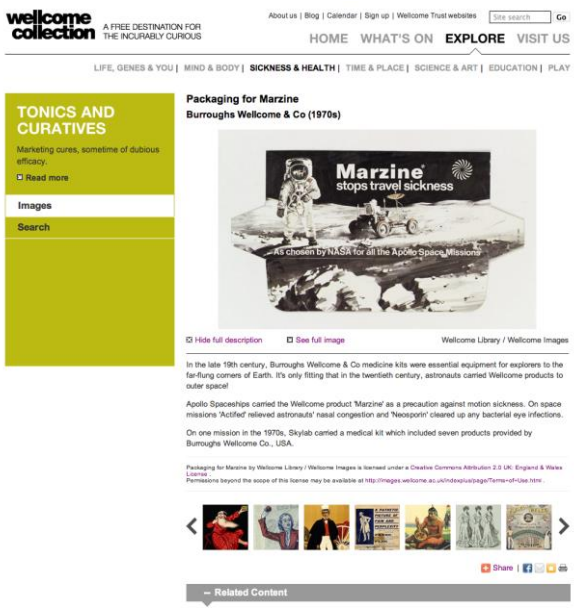


Figure 6.14 WC Website Packaging for Marzine Page

The "Packaging for Marzine" page is suitable for Visual people as it has a big picture although it also has some text underneath the picture. Also, it is suitable for Sequential people because they need to read through the text to get the answer. It is also suitable for Reflective people because they are comfortable with long texts. Finally, Sensing people feel more comfortable with this page rather than Intuitive people because it has concrete information.

Next, participants were asked to go to the specific page illustrated in Figure 6.15 as a start point and to answer a task on the Exhibitions theme.

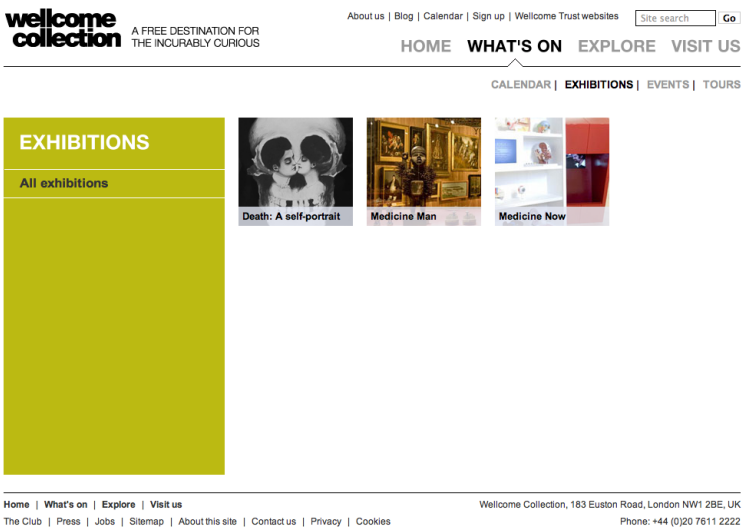


Figure 6.15 WC Website Exhibitions Page

The Exhibitions page lists all exhibitions held at the WC and consists mainly of pictures, so it is more suitable for Visual people rather than Verbal people. The page allows visitors to see all

exhibitions at a glance. Therefore, this page is more attractive for Global people than Sequential people. To get more information about the pictures and to get captions for the pictures, participants have to roll their mouse over the pictures. Thus, this page is suitable for Active people rather than Reflective people. The page has concrete information in the form of pictures so the page is suitable for Sensing people rather than Intuitive ones.

WC Task 3: In Georgie Meadows' artworks, what problem is illustrated for Mrs Shaw?

The answer to WC Task 3 is: "The woman got a name for being a difficult resident because she would not join in with the social activities. She had always been a private person. No one had asked her if she wanted to come to the party or wear the ridiculous hat". The screenshot of the Exhibitions page was taken later but when the study was performed, there was also an annotated image link for the "Georgie Meadows" page that is illustrated in the Figure 6.16. The "Georgie Meadows" page has the link to an image gallery that has the answer to the task and participants can find this answer by clicking the first image on the bottom side of the "Georgie Meadows image gallery" page (see Figure 6.17).

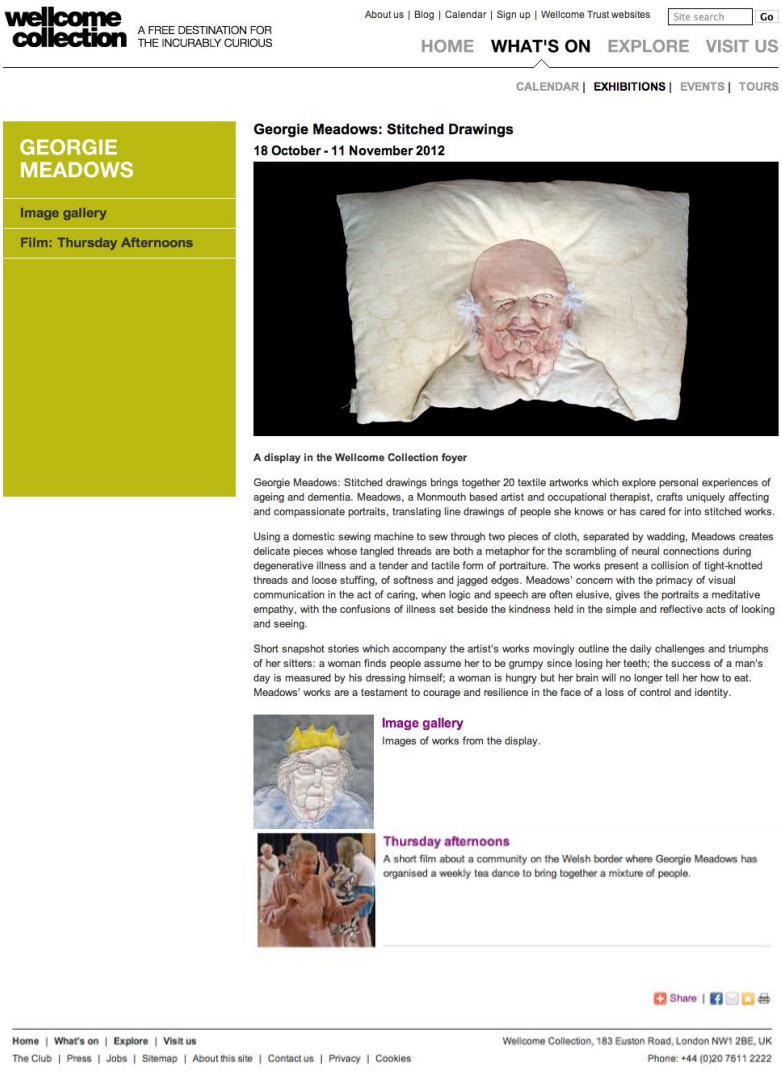


Figure 6.16 WC Website Georgie Meadows Page

The "Georgie Meadows" page is suitable for Sequential people because they have to scroll down to get to the "Georgie Meadows image gallery" page that has the answer to the task. Furthermore, it is suitable for Reflective people since they do not have to perform lots of actions for further information.

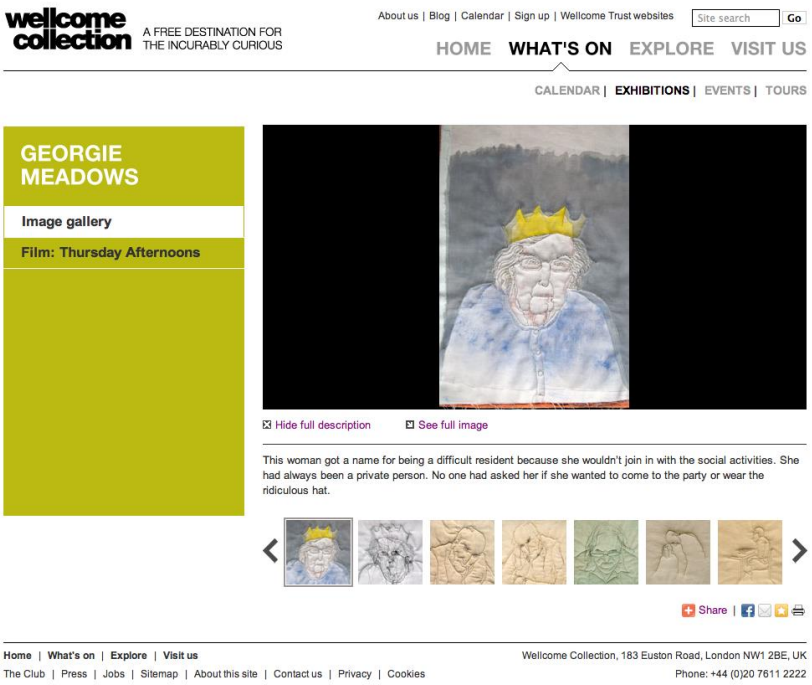


Figure 6.17 WC Website Georgie Meadows Image Gallery Page

Participants have to click on the small images to get the bigger ones and the accompanying text, so that the page is more suitable for Active people rather than for Reflective people. The page consists mainly of pictures so that it is more attractive for Visual people than Verbal ones. In addition, the concrete information in the pictures will be more meaningful for Sensing people rather than for Intuitive people. To find the answer, participants have to go through the images one by one. Therefore, Sequential people like this page more than Global ones.

Lastly, participants were asked to go to a specific page as a start point and to answer a task on the Genetics theme (see Figure 6.18).

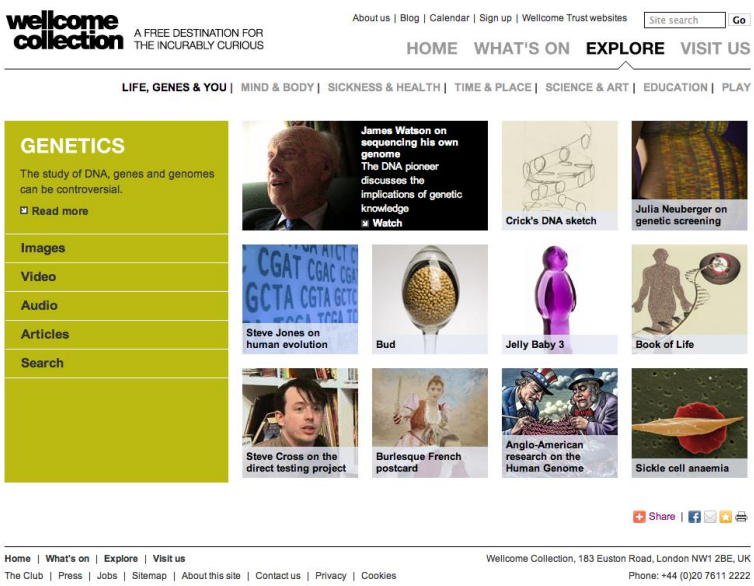


Figure 6.18 WC Website Genetics Page

The Genetics page consists mainly of pictures, which means it is more attractive to Visual people than Verbal people. The page has an overview of all the information on genetics, which makes the page more suitable for the Global people rather than Sequential people. To get captions, participants have to roll their mouse over the pictures. For that reason, the page is more suitable for Active people than for Reflective people. Sensing people will like the page more than Intuitive ones because the page has much concrete information in the form of pictures.

WC Task 4: What are the symptoms of the most severe form of haemophilia?

The answer to WC Task 4 is: "In the most severe cases, where factor VIII or IX are reduced to below 1 percent of their normal levels, there is a significant delay in clotting resulting in protracted bleeding, and there may be spontaneous haemorrhaging into joints in muscles, resulting in swelling and pain and eventual deformation of joints". The screenshot of the Genetics page was taken after the study was finished, but when the study was performed there was also an annotated image link for the "Haemophilia A and B" page that is illustrated in Figure 6.19. The "Haemophilia A and B" page has the answer to the task and participants can access this page from the Genetics page by clicking on the annotated image link.

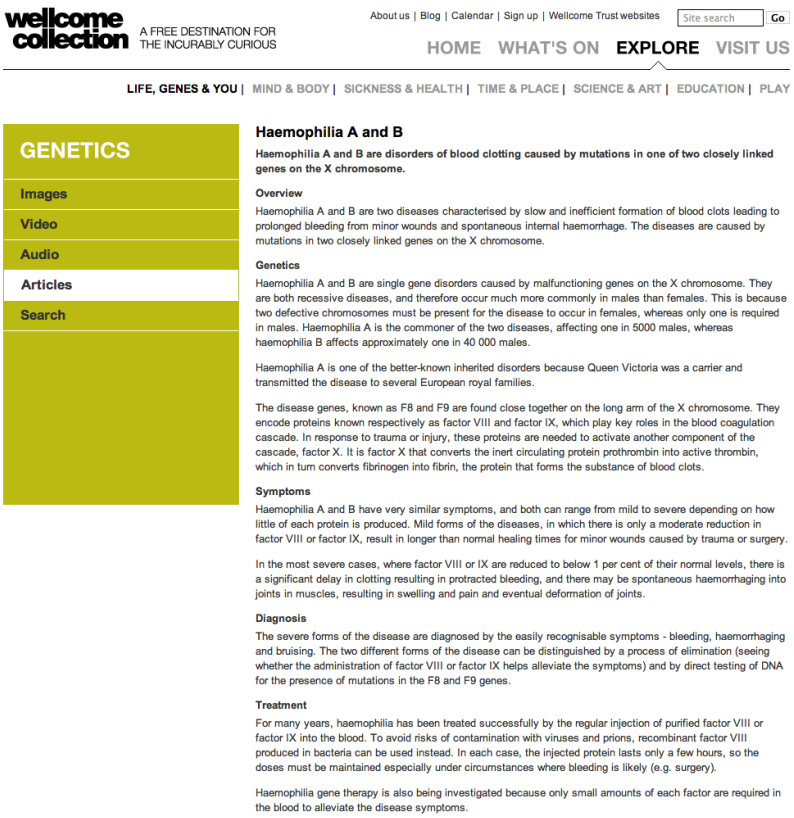


Figure 6.19 WC Website Haemophilia A and B Page

This page is mainly text so Verbal people will like it. To find the answer, participants have to read through the text, although there is a heading Symptoms. Hence, the page is suitable for Sequential people rather than Global ones. On this page participants simply read through, they do not have to interact with the page which means Reflective people will find this page more attractive compared to Active ones. Lastly, the page has quite abstract material. Consequently, this page is more suitable for Intuitive people than for Sensing people.

6.2.5 Questionnaires

Before undertaking the tasks on the websites, participants completed an online version of Felder-Solomon Index of Learning Styles (ILS) [22] (1996) which yielded their learning style scores on the four dimensions.

After undertaking the tasks on each website, participants completed a series of questionnaires about their experience of the website, delivered via QuestionPro[23], an online survey package.

When the participants had completed the tasks and questionnaires on both websites, they completed a demographic questionnaire.

[22] http://www.engr.ncsu.edu/learningstyles/ilsweb.html, Accessed 16th Jan 2014.

[23] www.questionpro.com, Accessed 16th Jan 2014.

The details of all these questionnaires will be explained in the following subsections. Full listings of the questionnaires can be found in Appendix D.2.

6.2.5.1 Felder-Solomon Index of Learning Styles (ILS)

Participants' learning styles were measured by using the online version of Felder-Solomon Index of Learning Styles (ILS)[24] (1996). The ILS yields four scores, each on a scale from -11 to 11. The four scores are for the four dimensions: Active-Reflective (Act-Ref), Sensing-Intuitive (Sen-Int), Visual-Verbal (Vis-Ver), and Sequential-Global (Seq-Glo) (for an explanation of what the dimensions mean, see subsection 2.2.4.4). Table 6.3 shows the scoring of each of the dimensions.

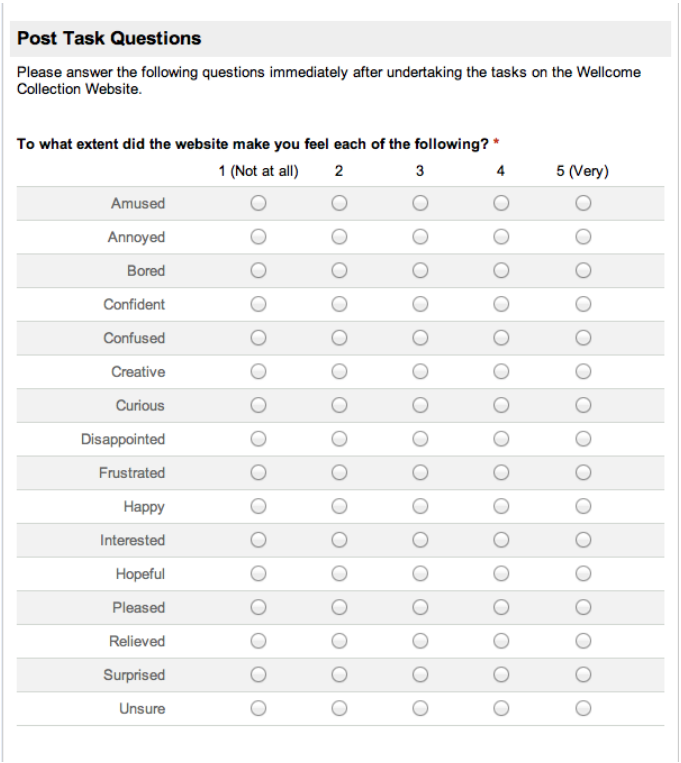
Table 6.3 Scoring of each of the ILS Dimensions

Highly Act	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Highly Ref
Highly Sen	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Highly Int
Highly Vis	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Highly Ver
Highly Seq	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	Highly Glo

6.2.5.2 Emotional Words Rating Scale (EWRS)

Participants' immediate emotional reactions to the website were measured using a 16 item scale of emotion words commonly used to describe reactions to web sites, the Emotional Words Rating Scale (EWRS). Participants rated each emotion word in response to the question "To what extent did the website make you feel each of the following?" on a 5 point scale (from 1 = Not at all to 5 = Very). This scale is based on the work of Petrie and Harrison (2009) and Petrie and Precious (2010) for measuring user experience of websites. Petrie and Harrison (2009) developed and evaluated an Emotion Words Priming List (EWPL) in their work. The evaluation study produced a list of 16 commonly used emotion words that consists of 9 positive, 6 negative and 1 ambiguous words. EWPL was the one of two techniques that Petrie and Precious (2010) used in their studies to develop simple yet effective methods for obtaining user experience of websites and other interactive technologies. It was found that the use of EWPL helps users to express their emotional reactions to websites. The EWRS was presented to participants in QuestionPro, as can be seen in Figure 6.20.

[24] http://www.engr.ncsu.edu/learningstyles/ilsweb.html, Accessed 4th July 2014.



Post Task Questions

Please answer the following questions immediately after undertaking the tasks on the Wellcome Collection Website.

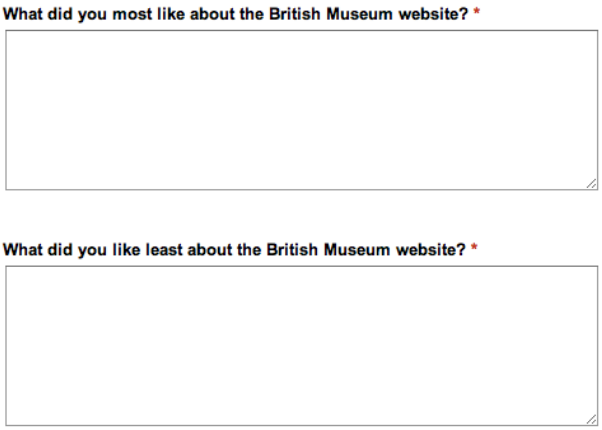
To what extent did the website make you feel each of the following? *

	1 (Not at all)	2	3	4	5 (Very)
Amused	○	○	○	○	○
Annoyed	○	○	○	○	○
Bored	○	○	○	○	○
Confident	○	○	○	○	○
Confused	○	○	○	○	○
Creative	○	○	○	○	○
Curious	○	○	○	○	○
Disappointed	○	○	○	○	○
Frustrated	○	○	○	○	○
Happy	○	○	○	○	○
Interested	○	○	○	○	○
Hopeful	○	○	○	○	○
Pleased	○	○	○	○	○
Relieved	○	○	○	○	○
Surprised	○	○	○	○	○
Unsure	○	○	○	○	○

Figure 6.20 Emotional Word Rating Scale (EWRS) for the WC Website

6.2.5.3 Overall Reactions Questionnaire (ORQ)

Participants were asked open-ended questions about the websites to see whether they mentioned things that match their learning styles. For each website participants were asked what they most liked and least liked about the website. Figure 6.21 illustrates these general questions for the BM website.



What did you most like about the British Museum website? *

What did you like least about the British Museum website? *

Figure 6.21 BM Website Overall Reactions Questionnaire (ORQ)

6.2.5.4 Specific Feature Questionnaire (SFQ)

Participants were asked a set of questions to probe their reactions to the different elements and materials on the websites that were thought to be suitable for people with different learning style profiles. Five questions were asked about features on the BM website and four questions were asked about features on the WC website.

One of the difficulties with posing these questions was that it could not be guaranteed that participants would visit particular pages, in spite of the fact that the questions attempted to direct them towards these pages. So rather than ask about specific pages, forms of words "On pages such as X" or "Did you prefer pages with feature A or feature B?" were used. Participants were encouraged to (re)visit pages to remind themselves of what they were like in order to answer these questions. An exception to this form of question was for the Money page, which was where participants were asked to start the task, so they had definitely visited that page and could simply be asked "On the Money page…". The specific feature questions along with a brief explanation on which dimension it was probing can be found in Table 6.4.

Table 6.4 Specific Feature Questionnaire (SFQ) for BM and WC Websites

	Details	Scale	Probed ILS Dimensions
BM Website	BMSpQ1: On the Money page (http://www.britishmuseum.org/explore/themes/money.aspx) Did you prefer to navigate using the menu at the top of the page or through the images and links under the images?	Scale from 1 to 9: 1=Prefer menus to 9=Prefer images/links	Active vs. Reflective Sensing vs. Intuitive Visual vs. Verbal Sequential vs. Global
	BMSpQ2: On pages such as "Communicating through coins" (http://www.britishmuseum.org/explore/themes/money/communicating_through_coins.aspx) and "Tradition and innovation" (http://www.britishmuseum.org/explore/themes/money/tradition_and_innovation.aspx, did you find the large images distracting or attractive?	Scale from 1 to 9: 1=Very distracting to 9=Very attractive	Active vs. Reflective Sensing vs. Intuitive Visual vs. Verbal Sequential vs. Global
	BMSpQ3: Did you prefer pages with lots of text and small pictures (http://www.britishmuseum.org/explore/themes/time/personal_time.aspx) or the pages with large pictures and a small amount of text (e.g. http://www.britishmuseum.org/explore/themes/money/communicating_through_coins.aspx)?	Scale from 1 to 9: 1=Lots of text to 9=Small amount of text	Sensing vs. Intuitive Visual vs. Verbal
	BMSpQ4: Did you prefer the pages that had rather abstract discussion of concepts (e.g. http://www.britishmuseum.org/explore/themes/time/measuring_and_keeping_time.aspx) or pages, which had concrete examples (e.g. http://www.britishmuseum.org/explore/themes/time/mechanical_time.aspx)?	Scale from 1 to 9: 1=Abstract concepts to 9=Concrete examples	Sensing vs. Intuitive
	BMSpQ5: Did you prefer short pages where you had to click through frequently to get further information (e.g. http://www.britishmuseum.org/explore/themes/money/tradition_and_innovation.aspx) or pages where a lot of information was on one page and you needed to read through the page (http://www.britishmuseum.org/explore/themes/time/mechanical_time.aspx)?	Scale from 1 to 9: 1=Short pages to 9=Long pages	Active vs. Reflective Sequential vs. Global

WC Website	WCSpQ1: Did you prefer the pages with text only (e.g. http://www.wellcomecollection.org/explore/sickness--health/topics/malaria/articles/the-malaria-parasite.aspx) or the pages with numerous images (http://www.wellcomecollection.org/explore/sickness--health/topics/tonics-and-curatives/images.aspx?view=packaging-for-marzine)?	Scale from 1 to 9: 1=Lots of images to 9=Text only	Sensing vs. Intuitive Visual vs. Verbal
	WCSpQ2: Did you like pages where you could see a number of options at once (e.g. http://www.wellcomecollection.org/whats-on/exhibitions.aspx) or pages where you see one item at a time (e.g. http://www.wellcomecollection.org/whats-on/exhibitions/georgie-meadows.aspx)?	Scale from 1 to 9: 1=Lots of options to 9=One item at a time	Active vs. Reflective Sequential vs. Global
	WCSpQ3: Did you prefer pages with abstract discussion of topics (e.g. http://www.wellcomecollection.org/explore/life-genes--you/topics/genetics/articles/haemophilia-a-and-b.aspx) or pages with facts and figures (e.g. http://www.wellcomecollection.org/explore/sickness--health/topics/malaria/articles/the-malaria-parasite.aspx)?	Scale from 1 to 9: 1=Abstract discussion to 9=Facts and figures	Sensing vs. Intuitive
	WCSpQ4: Did you prefer the pages where you needed to click through to get further information (e.g. http://www.wellcomecollection.org/explore/sickness--health.aspx) or pages where a lot of information was on one page and you needed to read through the page (http://www.wellcomecollection.org/explore/life-genes--you/topics/genetics/articles/haemophilia-a-and-b.aspx)?	Scale from 1 to 9: 1=Click through to 9=All on one page	Active vs. Reflective Sequential vs. Global

The **first specific feature question** about the BM website (BMSpQ1) (Figure 6.1 illustrates the page relevant to BMSpQ1) asked participants about their preference for navigating using the menu at the top of the page (top navigation) or through the images and links under the images (inpage navigation). It was predicted that Global people would prefer the top navigation and that Sequential people would prefer the inpage navigation. Global people like to see the whole picture. In this case, with the help of top navigation, Global people will be able to see every navigation option. On the other hand, Sequential people like to proceed in steps. At this point, inpage navigation supports Sequential people by presenting only several navigation options at a time. Participants have to scroll down to see other navigation options. To a lesser extent, this question also probes whether Verbal people like the top navigation and Visual people like the inpage navigation, since the top navigation consists of text whereas the inpage navigation consists mainly of images. Also, this question probes whether Intuitive people like the top navigation and Sensing people like the inpage navigation, because the inpage navigation presents more concrete content such as images with related captions and texts. However, the top navigation is more abstract, given that it consists of only text. Finally, this question also probes whether Active people like the inpage navigation and Reflective people like the top navigation. Active people like to be dynamic during their learning experience but Reflective ones like to sit back and think or just read. Therefore, Active people will feel more comfortable with the inpage navigation whereas Reflective people will feel more comfortable with the top navigation.

The **second specific feature question** about the BM website (BMSpQ2) (Figure 6.22 illustrates two pages relevant to BMSpQ2), asked participants whether they find large images attractive or distractive. It probed whether Visual people will find large images attractive and Verbal people will find large images distracting. Visual people learn better with images while Verbal people prefer texts. To a lesser extent, this question also probes whether Sensing people will find the large images attractive and Intuitive people will find the large images distracting because Sensing people like concrete things compared to Intuitive people. In addition, this question will also probe whether Active people find the large images attractive and Reflective people find the large images distracting. Participants have to click on arrows to navigate through the images. As a result, Active people will find the large images attractive since they like to be dynamic during their learning experience. Lastly, this question will also probe whether Sequential people find the large images attractive and Global people find them distracting. Large images will lead to information flow in a step wise manner. To see the next image, participants must click on the Next button. For this reason, this page will be more attractive for Sequential people rather than Global ones who want to see the information as a whole.

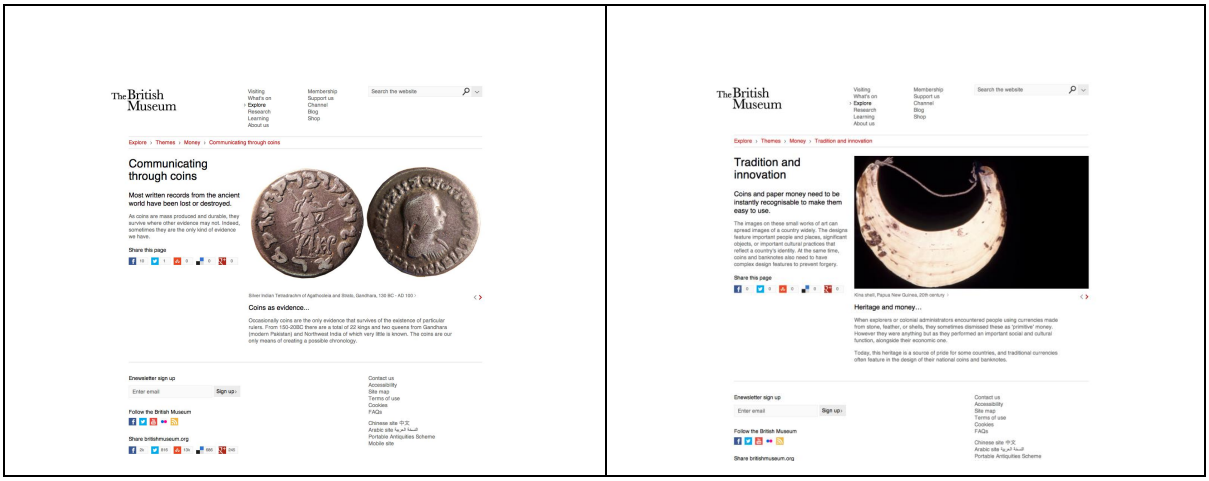


Figure 6.22 Pages Relevant to BMSpQ2

In the **third specific feature question** about the BM website (BMSpQ3) (Figure 6.23 illustrates pages relevant to the BMSpQ3) asked participants whether they prefer pages with lots of text and small pictures or pages with large pictures and a small amount of text, because Visual people prefer the pages with large pictures and a small amount of text and Verbal people prefer pages with lots of text and small pictures was probed. Visual people prefer to learn with images while Verbal people prefer to learn from texts. To a lesser extent, this question also probes whether Sensing people prefer pages with large pictures and a small amount of text and Intuitive people prefer pages with lots of text and small pictures, because Sensing people like concrete things compared to Intuitive people.

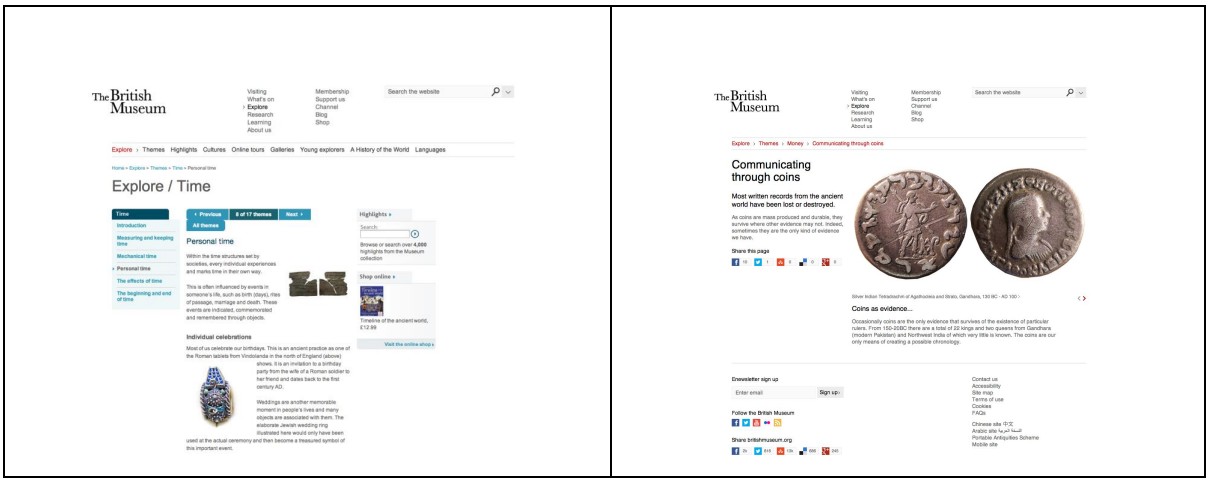


Figure 6.23 Pages Relevant to BMSpQ3

In the **fourth specific feature question** about the BM website (BMSpQ4) (Figure 6.24 illustrates the pages relevant to the BMSpQ4) asked participants whether they prefer pages that have an abstract discussion of concepts or pages that have concrete examples, because Sensing people prefer pages that have concrete examples and Intuitive people prefer pages that have abstract discussion of concepts.

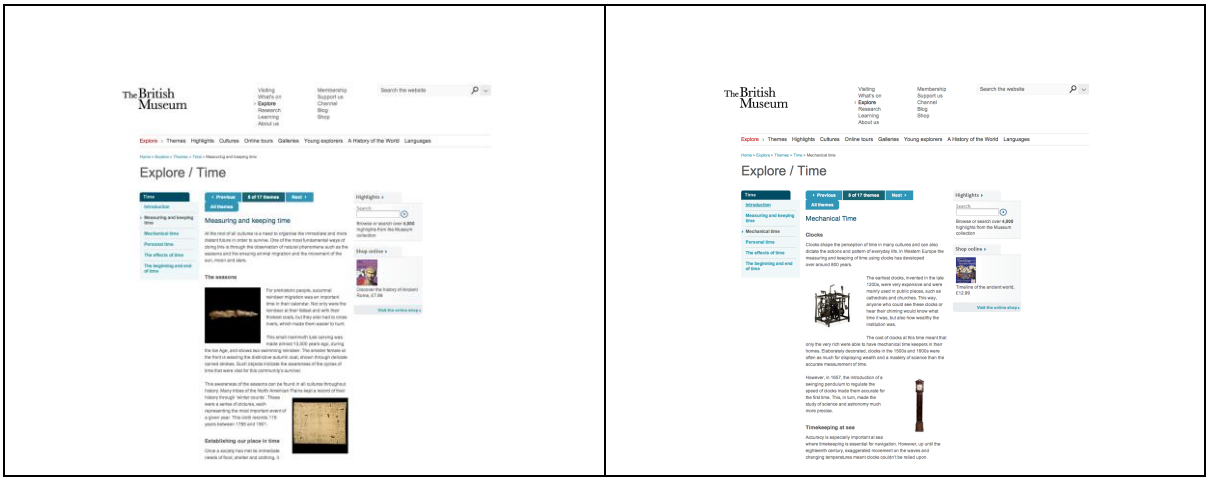


Figure 6.24 Pages Relevant to BMSpQ4

In the **fifth specific feature question** about the BM website (BMSpQ5) (Figure 6.25 illustrates pages relevant to the BMSpQ5) asked participants whether they prefer short pages where they had to click through frequently to get further information or pages where a lot of information was on one page and they needed to read through the page. This question probes whether Active people prefer short pages where they have to click through frequently to get further information and Reflective people prefer pages where a lot of information is on one page and they need to read through the page. Active people prefer to be active in processing new information. However, Reflective people prefer to think about new information and they feel comfortable with long texts. To a lesser extent, this question also probes whether Sequential people prefer short pages where they had to click through frequently to get further information and Global people prefer pages where a lot of information was on one page and they needed to read through the page. Sequential people are more likely to learn in small progressive steps, not in large jumps.

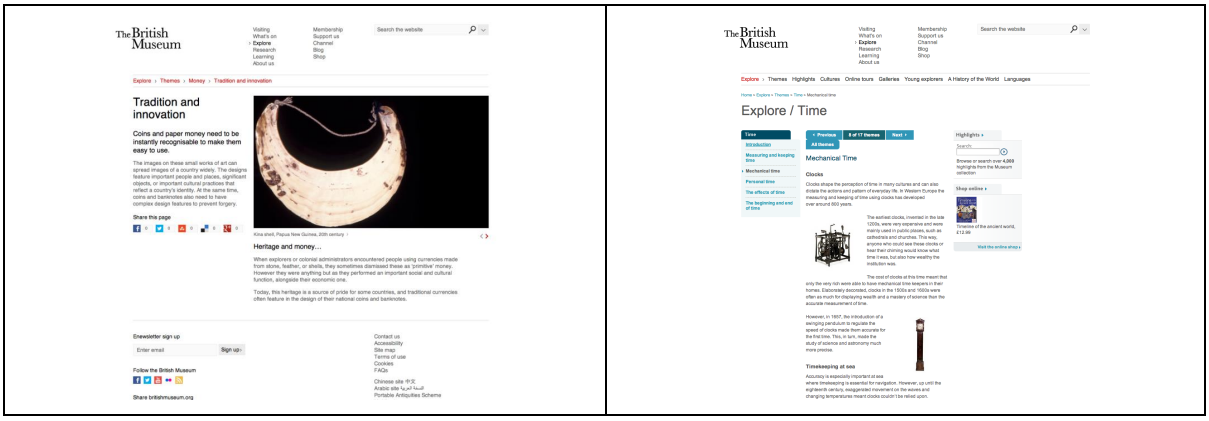
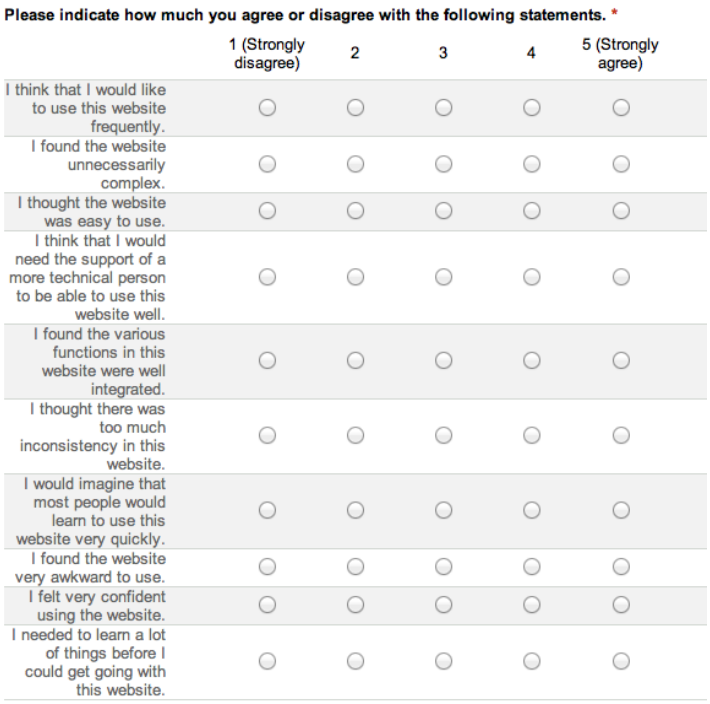


Figure 6.25 Pages Relevant to BMSpQ5

In the same manner, four specific feature questions were defined for the WC website to probe participants' reactions to the different elements and pages that were thought to be suitable for them (see Table 6.4 for specific feature questions for the WC website).

6.2.5.5 System Usability Scale (SUS)

The aim of asking about usability was to see whether people with different learning styles rated the usability of the two museum websites differently. The System Usability Scale (SUS) is a basic, ten-item scale questionnaire which was used for the measurement of usability of each website (see Figure 6.26). As Brooke (1996) indicated, the SUS is a valuable and reliable tool for evaluating usability. Moreover, Tullis and Stetson (2004) compared five usability questionnaires with 123 participants and concluded that although the SUS is the simplest questionnaire among the all the questionnaires they studied, it gave the most reliable results. The original questionnaire was used except for one item. The 8th item was changed as Finstad (2006) noted that it is hard for non-native speakers to understand it and there were numerous participants who were non-native speakers of English in the study. In the original scale, the word "cumbersome" was used but for the current study this was changed to "awkward".



Please indicate how much you agree or disagree with the following statements. *

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
I think that I would like to use this website frequently.	○	○	○	○	○
I found the website unnecessarily complex.	○	○	○	○	○
I thought the website was easy to use.	○	○	○	○	○
I think that I would need the support of a more technical person to be able to use this website well.	○	○	○	○	○
I found the various functions in this website were well integrated.	○	○	○	○	○
I thought there was too much inconsistency in this website.	○	○	○	○	○
I would imagine that most people would learn to use this website very quickly.	○	○	○	○	○
I found the website very awkward to use.	○	○	○	○	○
I felt very confident using the website.	○	○	○	○	○
I needed to learn a lot of things before I could get going with this website.	○	○	○	○	○

Figure 6.26 System Usability Scale (SUS)

6.2.5.6 Demographic Questionnaire

Lastly, participants completed a demographic questionnaire that gathered information on age, sex and country of origin.

6.3 Procedure

The study was conducted as part of the practical work associated with two modules taught in the Department of Computer Science at the University of York: Human Aspects of Computer Science (an introductory course on human-computer interaction, taken by first year undergraduate students in Computer Science) and User-Centred Design (an introductory course on human-computer interaction, taken by postgraduate students on a range of taught masters programmes in the Department of Computer Science).

The study was conducted in three different sessions, corresponding to the practical sessions for the students (two sessions for the undergraduate students, one session for the postgraduate students). At the beginning of the session, the lecturer (one of the supervisors of this thesis) introduced the study and outlined the procedure. Participants were also given a written copy of the instructions to guide them.

The procedure for the participants was:

- Install the logging application on one of the PCs in the practical lab
- Complete the Felder-Solomon Index of Learning Styles (ILS)

- Do the tasks with the first website (half the participants did the BM website first, the other half did the WC website first)
- Complete the Emotional Word Rating Scale (EWRS) for the first website
- Complete the Specific Feature Questionnaire (SFQ) for the first website
- Complete the Overall Reactions Questionnaire (ORQ) for the first website
- Complete the System Usability Scale (SUS) for the first website
- Repeat the procedure with the other website
- Complete the demographic questionnaire

6.4 Data Analysis

210 people participated in the study. After removing participants who did not complete sufficient portions of the study, valid data from 146 participants remained for investigating learning styles differences and valid data from 129 participants remained for investigating cultural background differences.

Appendix D.5 shows an example of the all the data from one participant. An Excel spreadsheet with the data from all participants in available on the CD accompanying this thesis.

All the statistical tests in this chapter were conducted with two-tailed tests with an alpha level of 0.05, unless otherwise stated. The alpha value (or p value - p stands for probability) is the mechanism in statistics for rejecting a null hypothesis and for demonstrating statistical significance. The statistical significance shows the difference in the results is very unlikely to have occurred by chance. An alpha level of 0.05 means there is only a 5% probability that the findings were the result of chance. In other words, the findings would only occur by chance less than 5 in 100 times. Conversely, there is a probability of 0.95 or 95 in 100 times chance that the findings were due to the manipulation made or the variable being observed. In the last step of the hypotheses testing process, results were interpreted. Thus, the null hypothesis was rejected if the p value is less than the significance level that is 0.05.

The first step of the hypotheses testing process in this research was that a number of hypotheses were generated based on previous research and on my intuitions about the effects of learning styles and cultural differences on the use of museum websites. The second step was to collect the relevant data from participants using the museum websites. The third step was to evaluate the hypotheses, and this called for the use of different statistical tests such as analysis of variance (ANOVA), chi-square, and regression analysis. The intention of applying a statistical test is to provide enough evidence to retain or reject the null hypothesis. In the fourth step, statistical

tests were conducted for each hypothesis and the appropriate conclusion drawn as to whether the null hypothesis should be retained or rejected.

The next subsections will present data preparation on each independent and dependent variable as required.

6.4.1 Felder-Solomon Index of Learning Styles (ILS) Scores

The frequency distributions of scores on the four learning styles dimensions were plotted (Figures 6.27-6.30). As expected from any complex human measure, the distributions for the Active-Reflective (Act-Ref), Sensing-Intuitive (Sen-Int) and Seq-Glo (Sequential-Global) dimensions are approximately normal, however, the distribution for the Visual-Verbal (Vis-Ver) dimension was strongly skewed towards the Visual end of the dimension. Given that the sample of participants consists of computer science students, many of whom have a strong mathematical background (students require an A at A-level Mathematics to enter the BSc/BEng degrees at the University of York, about half the participants are on these degrees), this suggests that computer science students, particularly mathematically oriented computer science students, are more Visual than a random sample of the population.

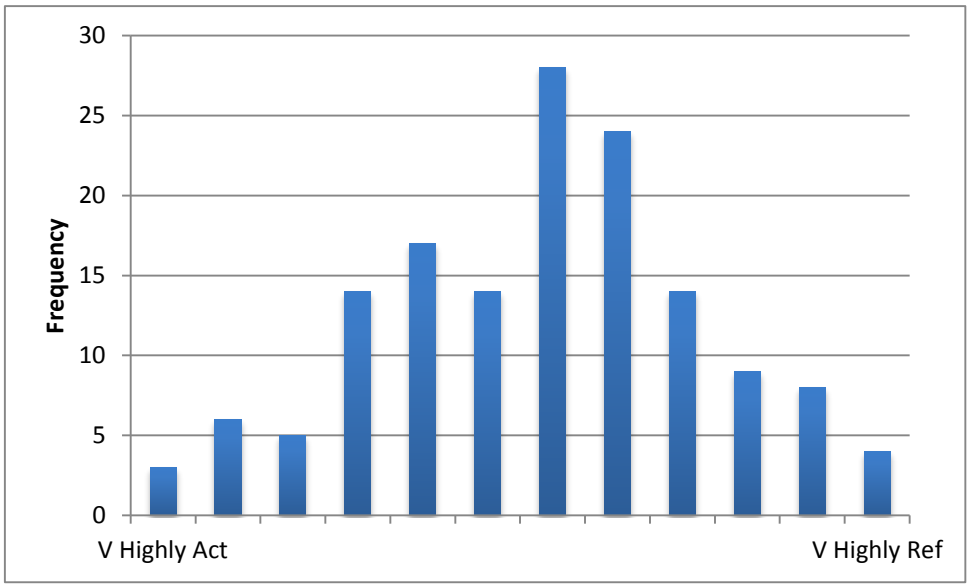


Figure 6.27 Frequency Distribution for Participants on the Act-Ref Dimension of the ILS

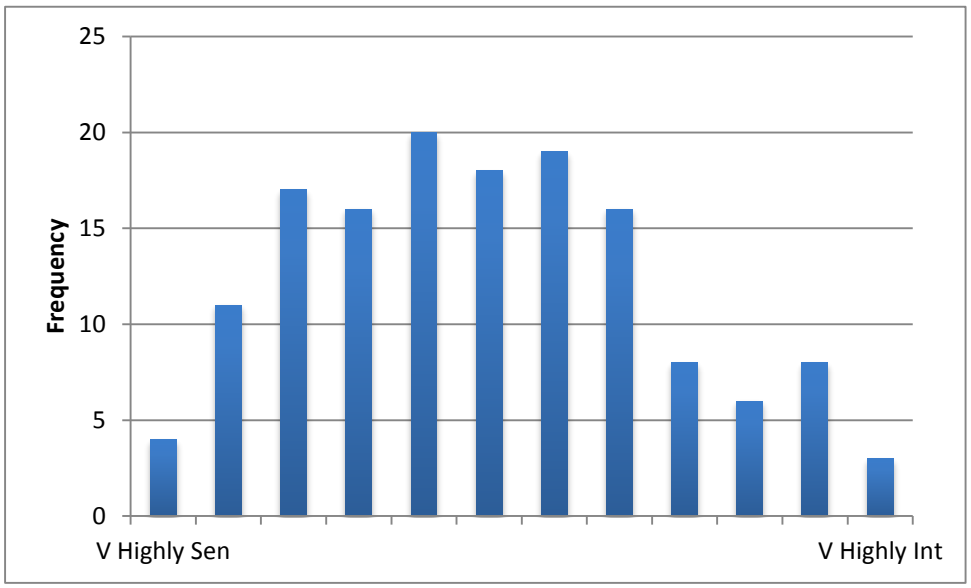


Figure 6.28 Frequency Distribution for Participants on the Sen-Int Dimension of the ILS

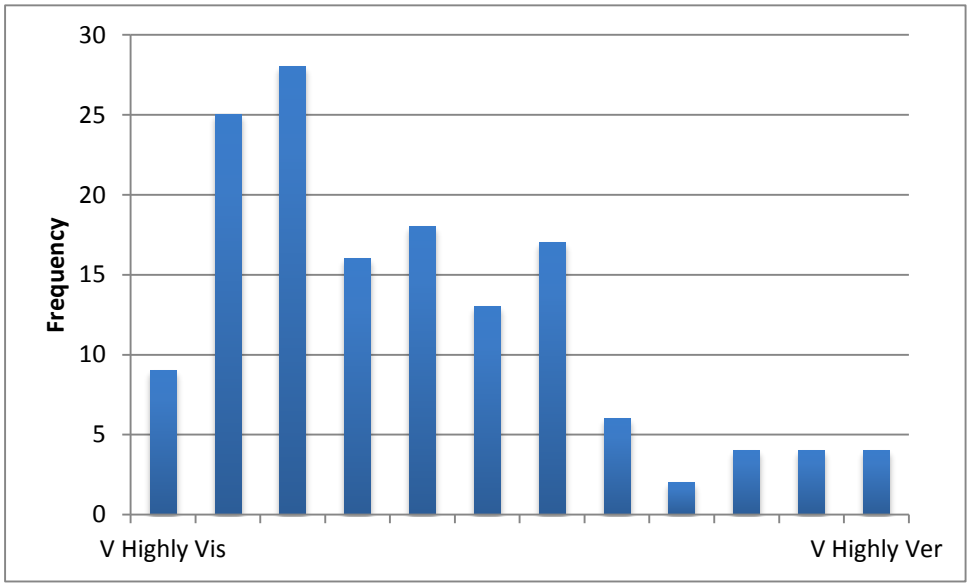


Figure 6.29 Frequency Distribution for Participants on the Vis-Ver Dimension of the ILS

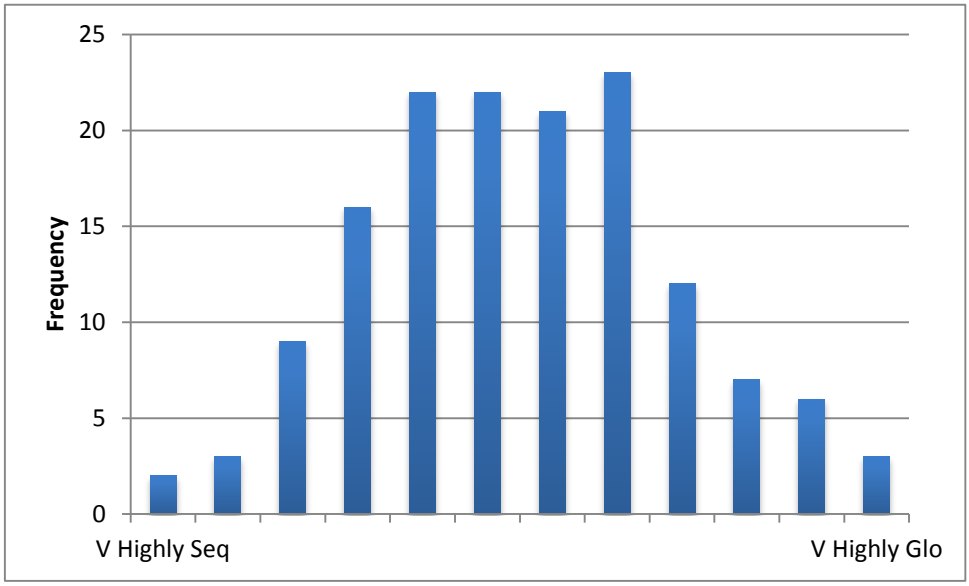


Figure 6.30 Frequency Distribution for Participants on the Seq-Glo Dimension of the ILS

As using the raw ILS scores in analyses of variance would result in very small cell numbers for the extreme groups, participants' learning style scores were grouped into larger categories across the scales, in particular taking into account the skew of the Vis-Ver dimension (see Tables 6.5 - 6.8).

Table 6.5 Final Categories and Frequencies for Act-Ref Dimension of ILS

Score/s	-7 or less	-5	-3	-1	1	3	5	7	9 or more
Label	Highly/Very Strongly Act	Strongly Act	Moderately Act	Slightly Act	Slightly Ref	Moderately Ref	Strongly Ref	Very Strongly Ref	Highly/Very Highly Ref
Frequency	14	14	17	14	28	24	14	9	12

Table 6.6 Final Categories and Frequencies for Sen-Int Dimension of ILS

Score/s	-9 or less	-7	-5	-3	-1	1	3	5 or more
Label	Highly Sen	Very Strongly Sen	Strongly Sen	Moderately Sen	Slightly Sen	Slightly Int	Moderately Int	Strongly/Highly Int
Frequency	15	17	16	20	18	19	16	25

Table 6.7 Final Categories and Frequencies for Vis-Ver Dimension of ILS

Score/s	-9 or less	-7	-5	-3	-1	1	3
Label	Highly/Very Highly Vis	Very Strongly Vis	Strongly Vis	Moderately Vis	Slightly Vis	Slightly Ver	Moderately Ver
Frequency	34	28	16	18	13	17	20

Table 6.8 Final Categories and Frequencies for Seq-Glo Dimension of ILS

Score/s	-7 or less	-5	-3	-1	1	3	5	7
Label	Highly/Very Strongly Seq	Strongly Seq	Moderately Seq	Slightly Seq	Slightly Glo	Moderately Glo	Strongly Glo	Very Strongly Glo
Frequency	14	16	22	22	21	23	12	16

6.4.2 Cultural Background

There were sufficient participants with valid data from different groups to create three groups of countries. Table 6.9 illustrates these groups along with the countries included in each group and number of participants in each group.

Table 6.9 Numbers of Participants with Valid Data from Different Country Groups

Group Name	Countries	Number of participants	Number of participants in the group
Europe	Bulgaria	5	108
	Cyprus	1	
	France	1	
	Germany	1	
	Greece	5	
	Italy	1	
	Latvia	1	
	Lithuania	5	
	Netherlands	1	
	New Zealand	1	
	Norway	1	
	Poland	1	
	Romania	1	
	Russia	1	
	Spain	1	
	United Kingdom	81	
China	China		21
Rest of the World	Brunei Darussalam	1	17
	India	7	
	Iraq	1	
	Mexico	1	
	Nigeria	4	
	Philippines	1	
	Taiwan	1	
	Vietnam	1	
Total			146

Participants from the Rest of the World group were too culturally diversified to make sense. Thus, only data from Europe and China groups were used for investigating cultural background effects.

6.4.3 Correctness of Answers to Task Questions

Participants' answers to the questions posed in the tasks on the website consisted of short free texts. To assess the correctness of participants' answers to the questions, one of my supervisors and I evaluated the first 25 participants' answers separately. We only disagreed on two answers, which means we had 92% agreement. That is a very adequate level of agreement, since over 80% agreement is considered good. Therefore I continued to assess the task performances of the participants and checked those that I was not sure about with one of my supervisors.

6.4.4 Emotional Words Rating Scale (EWRS) Data

Ratings on the 16 emotional words (10 positive and 6 negative) in the EWRS were coded from 1 to 5. A principal components analysis (see Glossary section for the definition of the term) was performed on the ratings of emotional words for each website to investigate the grouping of answers on these questions. For both websites a clear 2 factors solution emerged for the questions, with all questions loading on either a positive and a negative factor. Factor loadings over 0.50 were taken to indicate a question loaded on a particular factor. Tables 6.10 summarizes the two factors with the factor loadings for each question on each website. Full details of the principal components analyses can be found in Appendix D.3 and Appendix D.4.

Table 6.10 Summary of Positive and Negatives Factors from the Principal Components Analysis of EWRS on BM and WC websites
(* = question included on this factor)

EWRS item	Results for BM Website		Results for WC Website	
	Loading on Factor 1 Positive	Loading on Factor 2 Negative	Loading on Factor 1 Positive	Loading on Factor 2 Negative
Amused	0.746*	-0.084	0.743*	-0.047
Annoyed	0.014	0.876*	-0.075	0.827*
Bored	-0.361	0.532*	-0.209	0.663*
Confident	0.651*	-0.047	0.678*	-0.119
Confused	-0.004	0.767*	0.094	0.811*
Creative	0.702*	-0.040	0.713*	-0.063
Curious	0.615*	-0.287	0.641*	-0.256
Disappointed	-0.023	0.820*	0.001	0.851*
Frustrated	-0.014	0.876*	-0.065	0.859*
Happy	0.858*	-0.051	0.804*	-0.054
Hopeful	0.622*	-0.379	0.869*	0.053
Interested	0.843*	0.095	0.641*	-0.391
Pleased	0.829*	-0.151	0.859*	-0.050
Relieved	0.795*	0.167	0.797*	0.182
Surprised	0.607*	0.277	0.681*	0.129
Unsure	0.036	0.751*	0.027	0.765*

6.4.5 Overall Reactions Questionnaire (ORQ) Answers

Participants' answers to overall reactions to the website consisted of free text. For that reason, content analysis was performed to analyze this free text and a set of categories of reactions was extracted. Firstly, an initial set of categories was developed. Since this effort produced many categories for analysis, using the card sort technique (see Glossary for the definition of the term) a further higher-level categorization was performed. This effort produced 10 categories for positive reactions and 9 categories for negative reactions. However, when the data is coded, very unbalanced frequencies resulted, which made analysis difficult. It was found that the same set of categories could be used for both positive and negative reactions. Therefore, a refined set of categories was used, as illustrated in Table 6.11.

Table 6.11 Category Set for Overall Reactions

Category No	Category Name
1	Use images, animations, multimedia
2	Content – type of content (e.g. interesting, factual, ranged, useless, or informative content)
3	Content – amount of content (too little, too much)
4	Design of the pages/website
5	Organization of the pages/website
6	Navigation (includes on menus)
7	Search facilities (or lack of)
8	Miscellaneous (speed, language option, not suited to tasks) – not enough examples for coding or not relevant (not suited to tasks)
9	Comments on balance between text and images

To assess the accuracy of categorization of participants' comments to overall reactions to the website, one of my supervisors and I categorized first 25 participants' answers separately. We only disagreed on three categorizations, which means we had 88% agreement. That is an adequate agreement, since over 80% agreement is considered good. Therefore I continued categorizing the comments and checked those that I was not sure about with one of my supervisors.

6.4.6 Total Time on the Website and Time of Pages Suited to a Particular Learning Style Profile

Time data was gathered through the logging application previously mentioned (see subsection 6.2.3). The logging application provided data for each participant along with their participant number, visited web page addresses and time spent on these web pages.

To prepare the time data, the following steps were performed:

1. First, the time data were cleaned up in the following ways:
    a. A web page was omitted if the address was not correctly or completely recorded.
    b. A web page was omitted if it is not related to the study (e.g. if participants visited Facebook during the study).
    c. Participants' collected web page addresses were omitted if they do not have full data for the other questionnaires of the study.

2. For each participant, the Web pages for each museum website were collated and the number of different pages and the total time spent on each museum website was calculated.

3. Each webpage visited by any participant was inspected and the dominant learning style of the page determined. Thus, each webpage was labelled as Active or Reflective, Sensing or Intuitive, Visual or Verbal, Sequential or Global.

4. For each participant, the number of pages of different learning styles and the time spent on web pages of particular learning styles was calculated. Thus, for each participant there were eight values for page visits and eight values for time spent on pages, one each for Active, Reflective, Sensing, Intuitive, Visual, Verbal, Sequential or Global pages.

   To summarize, the time variables available for each participant are, for each website:

   a. Total number of visited web pages

   b. Total number of visited web pages of each learning style type

   c. Percentage of web pages visited of each learning style type

   d. Total time spent on website

   e. Total time spent on web pages of each learning style type

   f. Percentage of time spent on web pages of each learning style type

6.4.7 System Usability Scale (SUS) Scores

To calculate the SUS scores for each participant, the following steps were performed, following the procedure given by Brooke (1996):

1. First, calculate score contribution for each of the ten items

   a. For items 1, 3, 5, 7 and 9 calculate the score contributions as the scale position minus 1

   b. For items 2, 4, 6, 8 and 10 calculate the score contributions as 5 minus the scale position

2. Sum score contributions of all ten items

3. Multiply the sum of score with 2.5 to get the overall value

SUS values can range from 1 to 100 with higher values indicating higher usability.

6.5 Results

The effects of learning styles and cultural background on users' experience, performance and perceived usability of museum websites were investigated. Results related with learning styles (see subsection 6.5.1 to 6.5.3), results on cultural background (see subsection 6.5.4 to 6.5.6) and other interesting and important findings that emerged from the study (see subsection 6.5.7) will be presented in this section. Results of the study were summarized in tables in Appendix D.6.

6.5.1 Effects of Learning Styles on User Experience

6.5.1.1 Effects of Learning Styles on EWRS Scores

***H_1**: Participants' emotional reactions to websites will differ significantly depending on their learning styles*

To test this hypothesis, a series of one-way between participants Analysis of Variances (ANOVAs) was conducted. The independent variables (IVs) were learning style categories on the four ILS dimensions and the dependent variables (DVs) were the positive and negative EWRS scores.

For the BM website, the H_0 is rejected on the Seq-Glo dimension for both positive and negative EWRS scores (for positive EWRS: $F = 2.79$, $df = 7, 134$, $p < 0.01$; for negative EWRS: $F = 2.13$, $df = 7, 134$, $p < 0.05$). This means there is a significant difference between the various groups of Seq-Glo participants in both their positive and negative emotional reactions to the BM website. The means for each group are illustrated in Figure 6.31 (for positive EWRS) and Figure 6.32 (for negative EWRS). To investigate these differences further, Least Significant Difference (LSD) post hoc comparisons were made. These are summarized in Tables 6.12 and 6.13.

The post hoc comparisons show that for the positive EWRS scores, the Highly/Very Strongly Seq participants have the least positive reaction and the Very Strongly Glo participants have the most positive reaction. The Highly/Very Strongly Seq participants are significantly less positive about the BM website than all the other groups, apart from the Moderately Glo participants. Apart from this group, there is a general trend from less positive for Seq participants to more positive for Glo participants.

For the negative EWRS scores, Very Strongly Glo, Strongly Glo and Moderately Glo participants being significantly more negative than the Slightly Glo participants, and the Strongly Glo participants being significantly more negative than the Slightly Glo, Moderately Seq and Strongly Seq groups. So, the tendency is for Glo participants to be more negative about the BM website than the other groups apart from the Highly/Very Strongly Seq group.

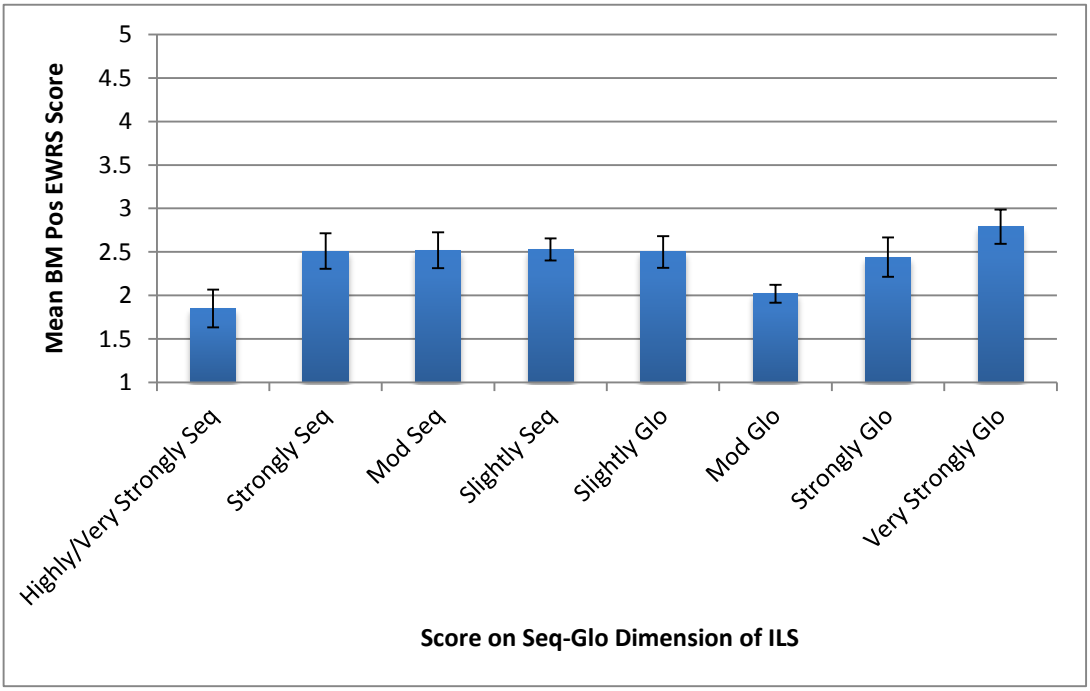


Figure 6.31 Mean positive EWRS Scores for BM Website for Seq-Glo Participants

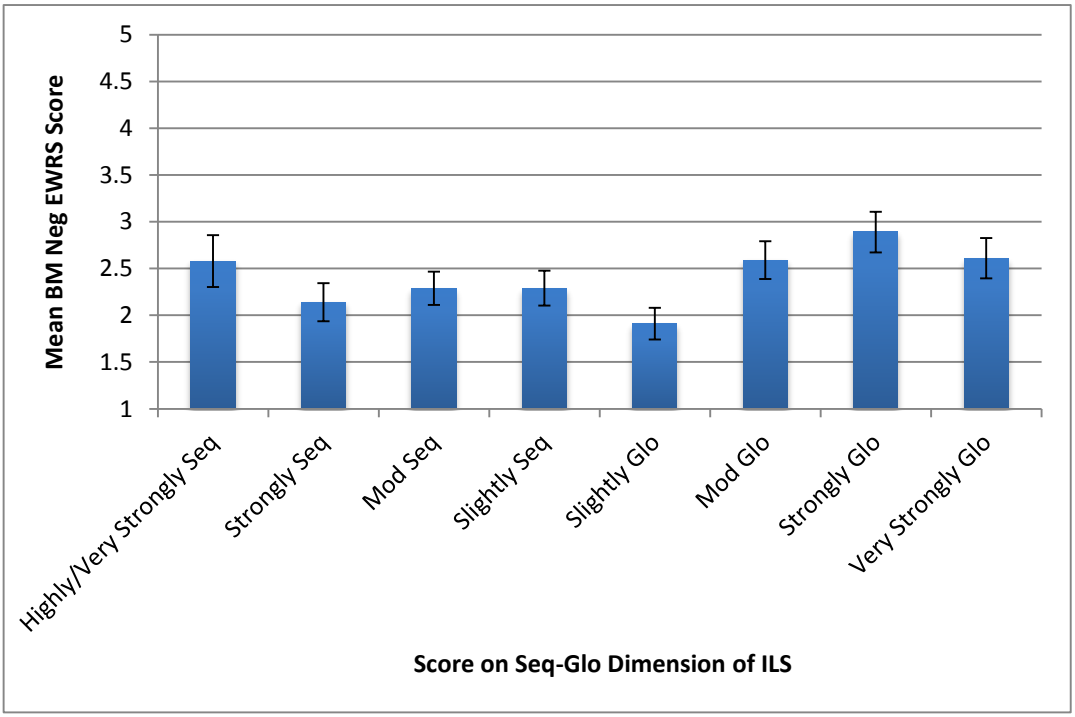


Figure 6.32 Mean Negative EWRS Scores for BM Website for Seq-Glo Participants

Table 6.12 LSD Post Hoc Analysis for Positive EWRS Scores for BM Website for Participants on the Seq-Glo Dimension

(*: $p < 0.05$; **: $p < 0.01$)

	Highly/ Very Strongly Seq	Strongly Seq	Moderately Seq	Slightly Seq	Slightly Glo	Moderately Glo	Strongly Glo	Very Strongly Glo
	-7 or less	-5	-3	-1	1	3	5	7 or more
-7 or less	-	* p = 0.020	* p = 0.011	** p = 0.009	* p = 0.014		* p = 0.047	** p = 0.001
-5		-						
-3			-			* p = 0.028		
-1				-		* p = 0.023		
1					-	* p = 0.037		
3						-		** p = 0.002
5							-	
7 or more								-

Table 6.13 LSD Post Hoc Analysis for Negative EWRS Scores for BM Website for Participants on the Seq-Glo Dimension

(*: $p < 0.05$; **: $p < 0.01$)

	Highly/ Very Strongly Seq	Strongly Seq	Moderately Seq	Slightly Seq	Slightly Glo	Moderately Glo	Strongly Glo	Very Strongly Glo
	-7 or less	-5	-3	-1	1	3	5	7 or more
-7 or less	-				* p = 0.027			
-5		-					* p = 0.028	
-3			-				* p = 0.049	
-1				-				
1					-	* p = 0.037	** p = 0.002	* p = 0.019
3						-		
5							-	
7 or more								-

There were no significant results for this hypothesis for the WC website.

6.5.1.2 Effects of Learning Styles on ORQ Answers

H_2: *The aspects of the website that participants like/dislike will differ significantly depending on their learning styles*

To test this hypothesis, a series of chi-square tests was conducted on the number of participants on the four learning style dimensions who mentioned each of the categories extracted from the content analysis of the Overall Reactions Questionnaire (ORQ) (see section 6.4.4). The categories were:

1. Use of images, animations, multimedia
2. Content – type of content (e.g. interesting, factual, ranged, useless, or informative content)
3. Content – amount of content (too little, too much)
4. Design of the pages/website
5. Organization of the pages/website
6. Navigation (includes on menus)
7. Search facilities (or lack of)
8. Miscellaneous (speed, language option, not suited to tasks) – not enough examples for coding or not relevant (not suited to tasks)
9. Comments on balance between text and images

For this analysis the learning style scores were categorized into three major groups e.g. Active (Act), Balanced Active-Reflective (Balanced Act-Ref) and Reflective (Ref) participants to create frequencies suitable for the chi square analysis. The following analyses produced significant results.

On the BM website, there was a significant difference on the Active-Reflective (Act-Ref) dimension (chi-square = 6.43, df = 2, $p < 0.05$) in the number of participants who liked the use of images, animations, and multimedia (1st category). 32.6% (14 out of 43 participants) of Act participants mentioned images, animations and/or multimedia as a positive aspect of the BM website, compared to only 14.6% (6 out of 41) of Balanced Act-Ref participants and 13.8% (8 out of 58) of Ref participants. There was also a significant difference on the Visual-Verbal (Vis-Ver) dimension (chi-square = 11.0, df = 2, $p < 0.05$). 31.7% (19 out of 60) of Vis participants mentioned images, animations and/or multimedia as a positive aspect of the BM website, compared to only 17.6% (6 out of 34) of Balanced Vis-Ver participants and 6.3% (3 out of 48) of Ver participants.

On the number of participants who did not like the type of content (2nd category) on the BM website, there was a significant difference on the Act-Ref dimension (chi-square = 8.07, df = 2, $p < 0.05$). 16.3% (7 out of 43) of Act participants mentioned type of content as a negative aspect of the BM website, compared to only 2.4% (1 out of 41) of Balanced Act-Ref participants and 3.5% (2 out of 58) of Ref participants.

There were no significant differences on what participants with different learning styles liked/disliked about the amount of content (3rd category) on BM website or liked/disliked about this category on the WC website.

On the number of participants who did not like the design of the pages/website (4th category) on the WC website, there was a significant difference on the Act-Ref dimension (chi-square = 11.4, df = 2, $p < 0.05$). 30.2% (13 out of 43) of Act participants and 35.0% (14 out of 40) of Balanced Act-Ref participants mentioned design of the pages/website as a negative aspect of the WC website, compared to only 8.6% (5 out of 58) of Ref participants.

On the number of participants who did not like the organization of the pages/website (5th category) on the BM website, there was a significant difference on the Act-Ref dimension (chi-square = 6.76, df = 2, $p < 0.05$). 29.3% (17 out of 58) of Ref participants mentioned the organization of the pages/website as a negative aspect of the BM website, compared to only 12.2% (5 out of 41) of Balanced Act-Ref participants and 11.6% (5 out of 43) of Act participants. On the number of participants who mentioned that they like the organization of the pages/website they for the BM website, there was a significant difference on the Sensing-Intuitive (Sen-Int) dimension (chi-square = 7.64, df = 2, $p < 0.05$). 33.3% (12 out of 36) of the Balanced Sen-Int participants mentioned the organization of the pages/website as a positive aspect of the BM website, compared to only 14.9% (10 out of 67) of Sen participants and 10.3% (4 out of 39) of Int participants.

On the number of participants who did not like the navigation (6th category) on the BM website, there was a significant difference on the Vis-Ver dimension (chi-square = 8.32, df = 2, $p < 0.05$). 52.1% (25 out of 48) of the Ver participants mentioned the navigation as a negative aspect of the BM website, compared to 41.7% (25 out of 60) of Vis participants and 20.6% (7 out of 34) of Balanced Vis-Ver participants.

On the number of participants who did not like the search facilities (7th category) on the BM website, there was a significant difference on the Act-Ref dimension (chi-square = 14.4, df = 2, $p < 0.05$). 17.1% (7 out of 41) of Balanced Act-Ref participants mentioned the search facilities as a negative aspect of the BM website, compared to only 2.3% (1 out of 43) of Act participants; and none of the Ref participants mentioned this category. On the number of participants who did not like the search facilities on the WC website, there was a significant difference on the Vis-

Ver dimension (chi-square = 7.38, df = 2, $p < 0.05$). 1.7% (1 out of 59) of Vis participants mentioned the search facilities as a negative aspect of the WC website, compared to 9.1 % (3 out of 33) of Balanced Vis-Ver participants and 16.3% (8 out of 49) of the Ver participants.

On the number of participants who mentioned miscellaneous things (speed, language option, not suited to tasks or not enough examples for coding or not relevant, not suited to tasks) (8th category) as they did not like on the BM website, there was a significant difference on the Sen-Int dimension (chi-square = 7.33, df = 2, $p < 0.05$). 10.3% (4 out of 39) of Int participants mentioned miscellaneous things as a negative aspect of the BM website, compared to only 1.5% (1 out of 67) of Sen participants; and none of the Balanced Sen-Int participants mentioned this category.

6.5.1.3 Effects of Learning Styles on SFQ Answers

The following set of hypotheses relate to preferences for methods of navigation, investigated on the BM website with first question of the Specific Features Questionnaire (SFQ) (BMSpQ1: On the 'Money page' did you prefer to navigate using the menu at the top of the page or through the images and links under the images? Answers: 1 = prefer menus to 9 = prefer images/links).

H_3: *Active participants will prefer to navigate using images whereas Reflective participants prefer to navigate using text menus*

H_4: *Sensing participants will prefer to navigate using images whereas Intuitive participants will prefer to navigate using text menus*

H_5: *Visual participants will prefer to navigate using images whereas Verbal participants will prefer to navigate using text menus*

H_6: *Sequential participants will prefer to navigate using images whereas Global participants will prefer to navigate using text menus*

For this set of hypotheses a series of one-way between participants ANOVAs was conducted. The learning style scores on the four ILS dimensions were the IVs. For the BM website, for the first set of analyses, the answers on the BMSpQ1 were the DVs (see above or subsection 6.2.5.4 for the details of BMSpQ1). For these hypotheses in the set, the H_0 is retained. There are no significant differences between the Act-Ref, Sen-Int, Vis-Ver and Seq-Glo groups on their preference for navigating using the menu at the top of the page or through the images and links under the images.

The second set of hypothesis in this group related to preferences for images, investigated on the BM website with the second question of the SFQ (BMSpQ2: On pages such as

"Communicating through coins" and "Tradition and innovation" did you find the large images distracting or attractive? Answers: 1 = very distracting to 9 = very attractive).

***H_7**: Active participants will find large images very attractive whereas Reflective participants will find them very distracting*

***H_8**: Sensing participants will find large images very attractive whereas Intuitive participants will find them very distracting*

***H_9**: Visual participants will find large images very attractive whereas Verbal participants will find them very distracting*

***H_{10}**: Sequential participants will find large images very attractive whereas Global participants will find them very distracting*

For this set of hypotheses a series of one-way between participants ANOVAs was conducted. The learning style scores on the four ILS dimensions were the IVs. For the BM website answers on the BMSpQ2 were the DVs (see above or section 6.2.5.4 for the details of BMSpQ2).

For H_8 and H_{10}, the H_0 is retained. This means there are no significant differences between the Sen-Int and Seq-Glo groups on their preferences about large images. However, for H_7 the ANOVA showed a significant difference on the Act-Ref dimension ($F = 2.26$, $df = 8, 133$, $p < 0.05$).

It was predicted that Act participants would give high scores on this question, as they would find large images attractive since to navigate through the images participants have to click on arrows and Act people like to be dynamic during their learning experience. In contrast, it was predicted that Ref participants would have low scores on this question, as they would find large images distracting since they like to be inactive during their learning experience. A set of planned comparisons on the ANOVA investigated these predictions. However, contrary to the prediction, this analysis did not show any significant linear or quadratic component. To see what the difference that the ANOVA shows, the data is plotted (see Figure 6.33). To investigate these differences further, LSD post hoc comparisons were made; these are summarized in Table 6.14. These show that both the Balanced Act-Ref participants found the large images significantly more attractive than the Strongly Act, Moderately Ref, Strongly Ref and Highly/Very Strongly Ref participants.

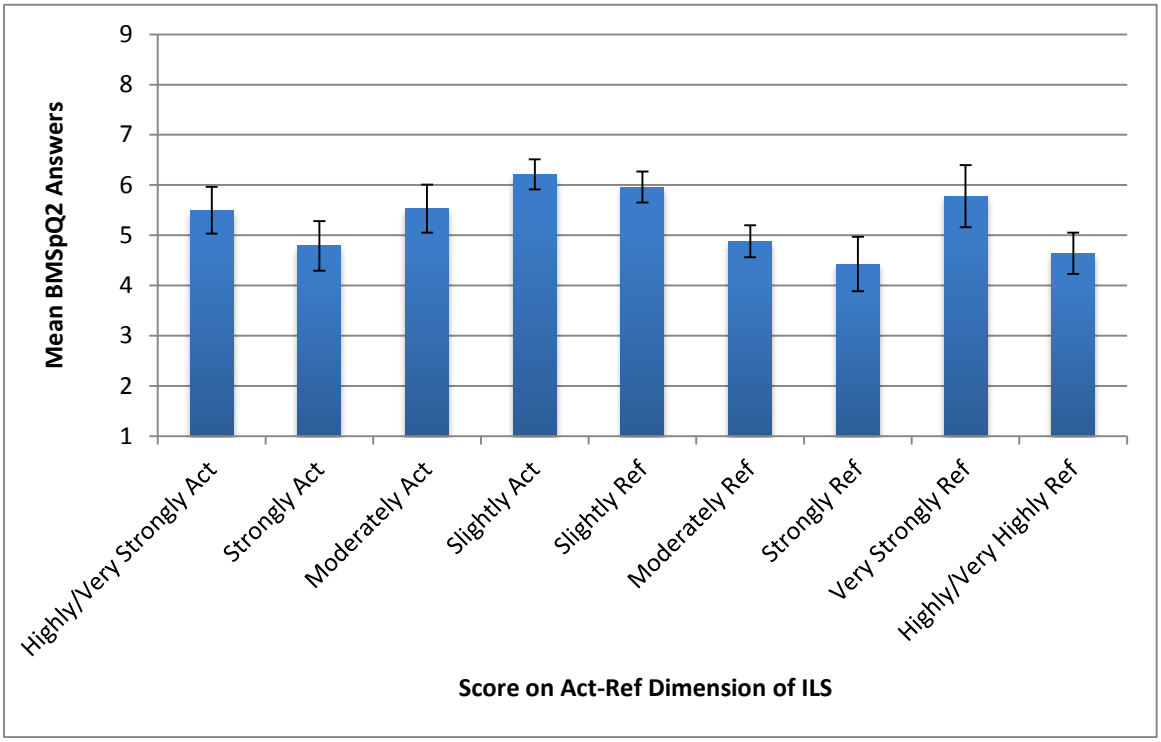


Figure 6.33 Mean Scores on BMSpQ2 for Act-Ref Participants

Table 6.14 LSD Post Hoc Analysis for BMSpQ2 for Participants on the Act-Ref Dimension

(*: $p < 0.05$; **: $p < 0.01$)

	Highly/ Very Strongly Act	Strongly Act	Moderately Act	Slightly Act	Slightly Ref	Moderately Ref	Strongly Ref	Very Strongly Ref	Highly/Very Strongly Ref
	-7 or less	-5	-3	-1	1	3	5	7	9 or more
-7 or less	-								
-5		-		* p = 0.025	* p = 0.034				
-3			-						
-1				-		* p = 0.019	** p = 0.005		* p = 0.021
1					-	* p = 0.022	** p = 0.006		* p = 0.028
3						-			
5							-		
7								-	
9 or more									-

The next hypothesis investigated preferences for the amount of text on a page, investigated on the BM website with the third question of the SFQ (BMSpQ3: Did you prefer pages with lots of text and small pictures or the pages with large pictures and a small amount of text? Answers: 1 = prefer lots of text to 9 = prefer small amount of text).

H_{11}: *Visual participants will prefer a small amount of text per web page whereas Verbal participants will prefer lots of text per page*

For this hypothesis a one-way between participants ANOVA was conducted. The learning style scores for Vis-Ver dimension were the IVs. For the BM website answers on the BMSpQ3 were the DVs (see above or subsection 6.2.5.4 for the details of BMSpQ3). The ANOVA showed that the ***H_0*** is retained. Thus, there is no significant difference between Vis-Ver participants on their preference about the amount of text per page.

The next hypotheses investigated preferences for the total amount of images on a webpage, investigated on the WC website with the first question of the SFQ (WCSpQ1: Did you prefer the pages with text only or the pages with numerous images? Answers: 1 = prefer lots of images to 9 = prefer text only).

H_{12}: *Visual participants will prefer lots of images on web pages whereas Verbal participants prefer text only web pages*

H_{13}: *Sensing participants will prefer lots of images on web pages whereas Intuitive participants prefer text only web pages*

For the above hypotheses a series of one-way between participants ANOVAs was conducted. The learning style scores for Vis-Ver and Sen-Int dimensions were the IVs. For the WC website answers on the WCSpQ1were the DVs (see above or subsection 6.2.5.4 for the details of WCSpQ1). For both hypotheses, the ***H_0*** retained. This means there are no significant differences between the Vis-Ver and Sen-Int groups on their preference for lots of images on web pages versus text only web pages.

The next hypotheses investigated preferences for the length of pages, investigated on the BM website with the fifth question of the SFQ (BMSpQ5: Did you prefer short pages where you had to click through frequently to get further information or pages where a lot of information was on one page and you needed to read through the page? Answers (1 = prefer short pages to 9 = prefer long pages).

H_{14}: *Active participants will prefer short web pages whereas Reflective participants will prefer long ones*

H_{15}: *Sequential participants will prefer short web pages whereas Global participants will prefer long ones*

For the above hypotheses a series of one-way between participants ANOVAs was conducted. The learning style scores for Act-Ref and Seq-Glo ILS dimensions were the IVs. For the BM website answers on the BMSpQ5 were the DVs (see above or subsection 6.2.5.4 for the details of BMSpQ5). For both these hypotheses the ***H_0*** retained. This means there are no significant differences between the Act-Ref and Seq-Glo participants about their preferences on page length.

The next hypotheses investigated preferences for the style of presentation of information on a webpage, investigated on the WC website with the second question of the SFQ (WCSpQ2: Did you like pages where you could see a number of options at once or pages where you see one item at a time? Answers: 1 = like pages with lots of options to 9 = like pages with one item at a time).

H_{16}: *Active participants will prefer to see one item at a time on web pages whereas Reflective participants will prefer to have lots of options to be available simultaneously*

H_{17}: *Sequential participants will prefer to see one item at a time on web pages whereas Global participants will prefer to have lots of options to be available simultaneously*

For the above set of hypotheses a series of one-way between participants ANOVAs was conducted. The learning style scores for Act-Ref and Seq-Glo ILS dimensions were the IVs. For the WC website answers on the WCSpQ2 were the DVs (see above or subsection 6.2.5.4 for the details of WCSpQ2). For these two hypotheses the H_0 were retained. This means there were no significant differences between the Act-Ref and Seq-Glo participants on their preference of seeing one item at a time versus having lots of options to be available on pages.

The next hypotheses investigated preferences for the organization of information on a website, clicking through to get further information or having all the information on one page, investigated on the WC website with the fourth question of the SFQ (WCSpQ4: Did you prefer the pages where you needed to click through to get further information or pages where a lot of information was on one page and you needed to read through the page? Answers: 1 = prefer click through to 9 = prefer all the information on one page).

H_{18}: *Active participants will prefer to click through for information whereas Reflective participants will prefer to have all the information on one page*

H_{19}: *Sequential participants will prefer to click through for information whereas Global participants will prefer to have all the information on one page*

For the above set of hypotheses a series of one-way between participants ANOVAs was conducted. The learning style scores for the Act-Ref and Seq-Glo ILS dimensions were the IVs. For the WC website answers on the WCSpQ4 were the DVs (see above or subsection 6.2.5.4 for the details of WCSpQ4). For these two hypotheses the H_0 were retained. This means there were no significant differences between the Act-Ref and Seq-Glo participants on their preferences about the organization of the information on the website.

The next hypothesis investigated preferences for the types of text presented on web pages, either abstract or concrete. This was tested with answers to the fourth question of the SFQ (BMSpQ4: Did you prefer the pages, which had rather abstract discussion of concepts, or pages,

which had concrete examples? Answers: 1 = prefer abstract concepts to 9 = prefer concrete examples).

H_{20}: *Sensing participants will prefer concrete examples of concepts on web pages whereas Intuitive participants will prefer abstract text on web pages*

For this hypothesis a one-way between participants ANOVA was conducted. The learning style scores for Sen-Int ILS dimension were the IVs. For the BM website answers on the BMSpQ4 were the DVs (see above or subsection 6.2.5.4 for the details of BMSpQ4). For this hypothesis the H_0 were retained. This means there were no significant differences between the Sen-Int participants on their preferences about the concrete examples of concepts or abstract text on the website.

The next hypothesis investigated preferences for the style of information on a webpage, facts and figures or abstract discussion, investigated on the WC website with the third question of the SFQ (WCSpQ3: Did you prefer pages with abstract discussion of topics or pages with facts and figures? Answers: 1 = prefer abstract discussion to 9 = prefer facts and figures).

H_{21}: *Sensing participants will prefer pages with facts and figures whereas Intuitive participants will prefer pages with abstract discussion of topics*

For the above hypothesis a one-way between participants ANOVA was conducted. The learning style scores for the Sen-Int ILS dimension were the IVs. WC website answers on the WCSpQ3 were the DVs (see above or subsection 6.2.5.4 for the details of WCSpQ3). For this hypothesis the H_0 was retained. This means that there is no significant difference between Sen-Int participants on their preference for the pages with abstract discussion of topics or for pages with facts and figures.

The next hypothesis investigated whether it is possible to predict participants' preferences for specific features on the websites from their overall learning style profile, that is their scores on all four ILS dimensions.

H_{22}: *Participants' preferences for specific features on websites can be predicted from their learning styles*

To test the above hypothesis, a series of linear regressions was conducted on SFQ questions that were predicted to relate to learning style scores. On participants' preference for pages which had abstract discussion of concepts or pages which had concrete examples on the BM website (BMSpQ4), there was a significant overall linear regression ($r^2 = 0.86$, $F = 3.20$, $df = 4, 137$, $p < 0.05$), with the Sen-Int dimension being the only significant predictor ($p < 0.005$).

On participants' preference for pages which had click through for information or pages which had all the information on one page on the WC website (WCSpQ4), there was a significant overall linear regression ($r^2 = 0.29$, $F = 2.05$, $df = 4, 136$, $p < 0.01$), with Seq-Glo dimension

being the only significant predictor ($p < 0.05$). Further investigation of the data shows that Seq people like to learn in steps so it is meaningful that they like to click through for information whereas Glo like to have an overview of information, so it is meaningful that they prefer all the information on one page. This result was not found in the analysis of variance conducted on the WCSpQ4 answers, reported above.

Although I tested other specific features (BMSpQ1, BMSpQ2, BMSpQ3, BMSpQ5, WCSpQ1, WCSpQ2, WCSpQ3), the $\boldsymbol{H_0}$ were retained for these variables.

6.5.2 Effects of Learning Styles on Performance

The next hypothesis investigated whether participants spend longer times on pages that match their learning styles.

H_{23}: *Participants will spend longer times on pages that match their learning styles*

To test this hypothesis, two variables, the number of visited pages suited to a specific learning style and the percentage of time spent on pages suited to a specific learning style, were correlated with participant's score on this specific learning style. For this hypothesis, $\boldsymbol{H_0}$ is retained for all variables. The finding showed that there is no correlation between these two variables.

H_{24}: *Participants' task performances will differ significantly depending on their learning styles*

For the above hypothesis a one-way between participants ANOVA was conducted. H_0 is retained. There are no significant differences between participants' task performances based on their learning styles.

6.5.3 Effects of Learning Styles on Perceived Usability

The next hypothesis investigated whether participants ratings on website usability differ based on their learning styles.

H_{25}: *Participants' ratings of the usability of the website will differ significantly depending on their learning styles*

To test this hypothesis, a series of one-way between participants ANOVAs was conducted. Learning style scores on the four ILS dimensions were the IVs and the SUS scores were the DVs.

For the BM website, the $\boldsymbol{H_0}$ is rejected for participants on the Seq-Glo dimension ($F = 2.31$, $df = 7, 134$, $p < 0.05$). This means there is a difference between the various groups of Seq-Glo participants in their perception of the usability of the BM website. The means for each group are illustrated in Figure 6.34. To investigate these differences further, LSD post hoc comparisons were made; these are summarized in Table 6.15.

The post hoc analysis shows that the Slightly Glo participants have the highest scores and the Moderately Glo participants have the lowest scores. The Moderately Glo participants have significantly lower scores about usability of the BM website than all the other groups apart from Highly/Very Strongly Seq, Slightly Seq and Strongly Glo groups.

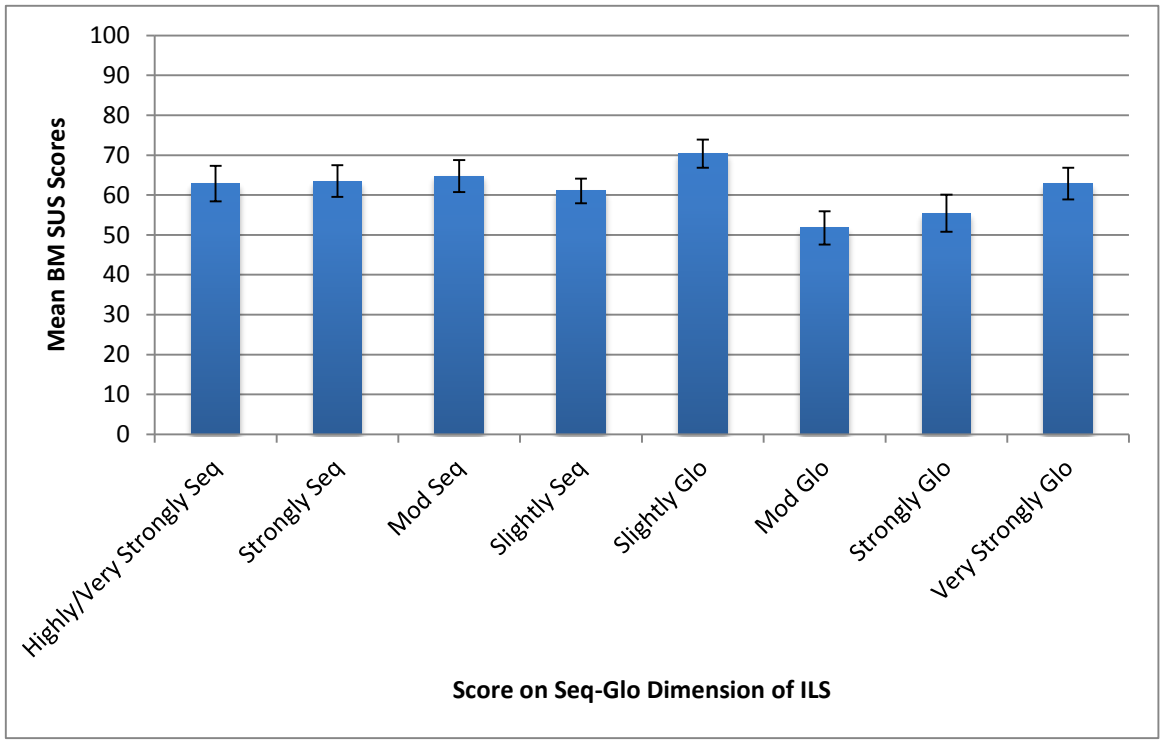


Figure 6.34 Mean SUS Scores for BM Website for Seq-Glo Participants

Table 6.15 LSD Post Hoc Analysis for SUS Scores for BM Website for Participants on the Seq-Glo Dimension (*: $p < 0.05$; **: $p < 0.01$)

	Highly/Very Strongly Seq	Strongly Seq	Moderately Seq	Slightly Seq	Slightly Glo	Moderately Glo	Strongly Glo	Very Strongly Glo
	-7 or less	-5	-3	-1	1	3	5	7 or more
-7 or less	-							
-5		-				* p = 0.037		
-3			-			* p = 0.011		
-1				-				
1					-	** p = 0.000	* p = 0.016	
3						-		* p = 0.048
5							-	
7 or more								-

6.5.4 Effects of Cultural Background on User Experience

The Rest of the World group was too diverse to culturally make sense. Thus, only data from Europe and China groups were used for investigating cultural background effects.

6.5.4.1 Effects of Cultural Background on EWRS Scores

The next hypothesis investigated whether participants emotional reactions to websites differ based on their cultures.

H_{26}: *Participants' emotional reactions to websites will differ significantly depending on their cultural background*

To test this hypothesis, independent sample t-tests were conducted to compare participants from the Europe and China groups on their positive and negative EWRS scores. The H_0 is rejected for participants for both positive and negative EWRS scores on both the BM and WC websites (see Table 6.16). There was a significant difference in the European and Chinese groups on their positive EWRS scores. The Chinese participants' mean EWRS positive scores were higher for both the BM and WC websites compared to the European participants. In addition, there was a significant difference between the European and Chinese groups on their negative mean EWRS scores. The Chinese participants' mean EWRS negative scores were higher for both BM and WC websites compared to the participants from the Europe (see Figure 6.35 to Figure 6.38).

Table 6.16 European and Chinese Participants' EWRS Mean Scores and Tests of Significance

Positive EWRS for BM Website					
Group	Mean	SD	t value	df	Significance
European	2.28	0.76	-2.24	124	$p < 0.05$
Chinese	2.68	0.65			
Positive EWRS for WC Website					
Group	Mean	SD	t value	df	Significance
European	2.16	0.78	-2.47	123	$p < 0.05$
Chinese	2.63	0.69			
Negative EWRS for BM Website					
Group	Mean	SD	t value	df	Significance
European	2.28	0.88	-2.36	124	$p < 0.05$
Chinese	2.76	0.63			
Negative EWRS for WC Website					
Group	Mean	SD	t value	df	Significance
UK	2.53	0.98	-2.17	123	$p < 0.05$
Chinese	3.06	0.94			

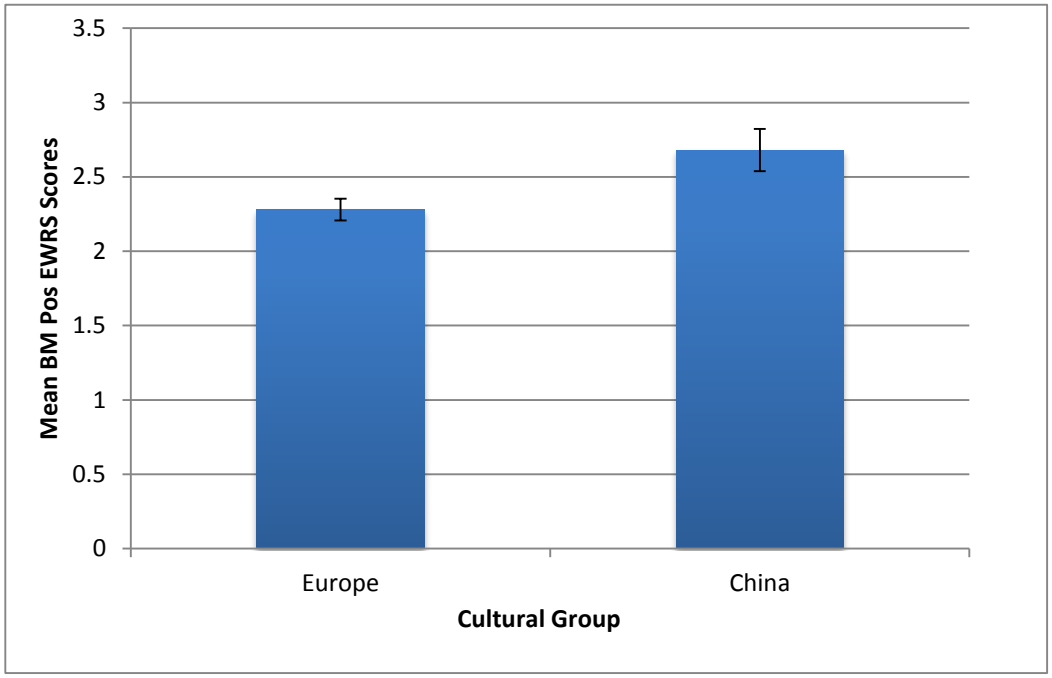


Figure 6.35 Mean Positive EWRS Scores for BM Website for Participants from Europe and China

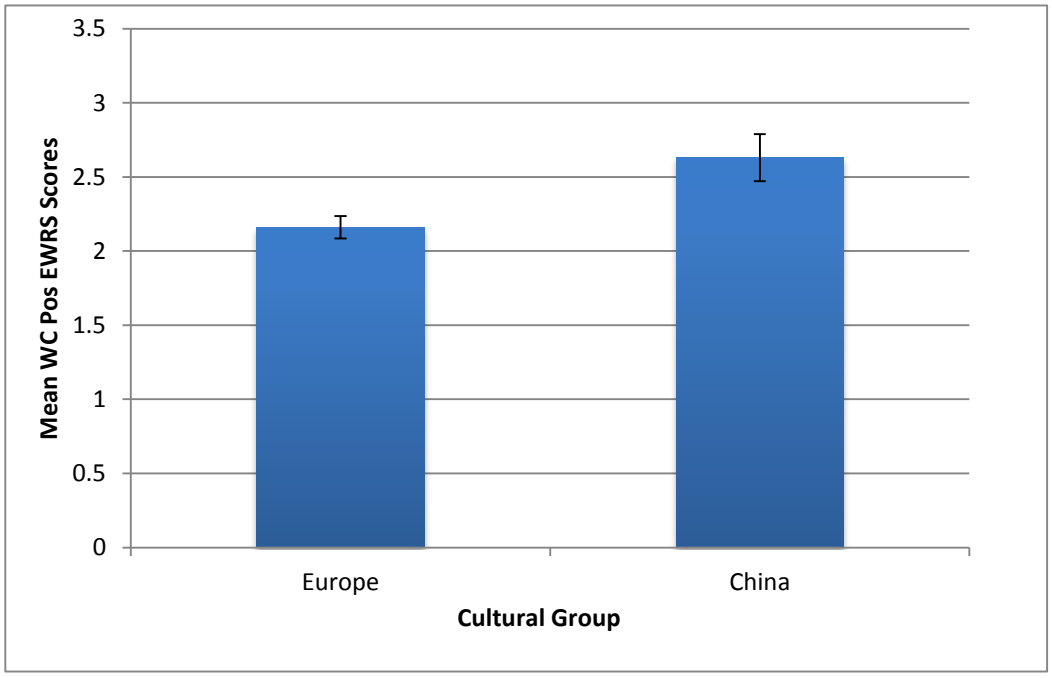


Figure 6.36 Mean Positive EWRS Scores for WC Website for Participants from Europe and China

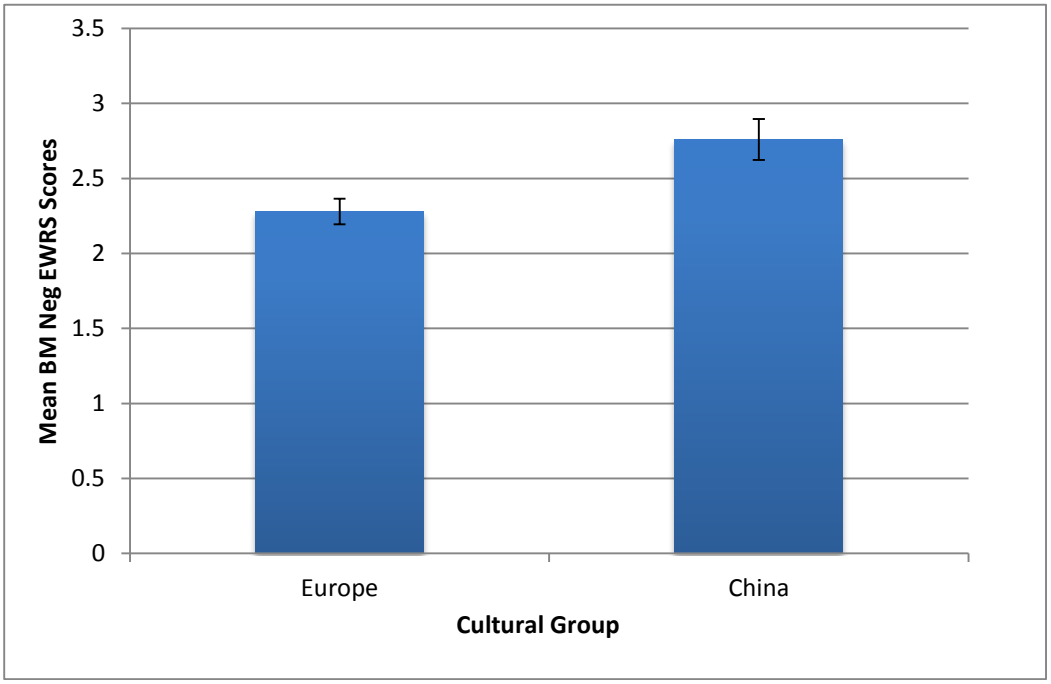


Figure 6.37 Mean Negative EWRS Scores for BM Website for Participants from Europe and China

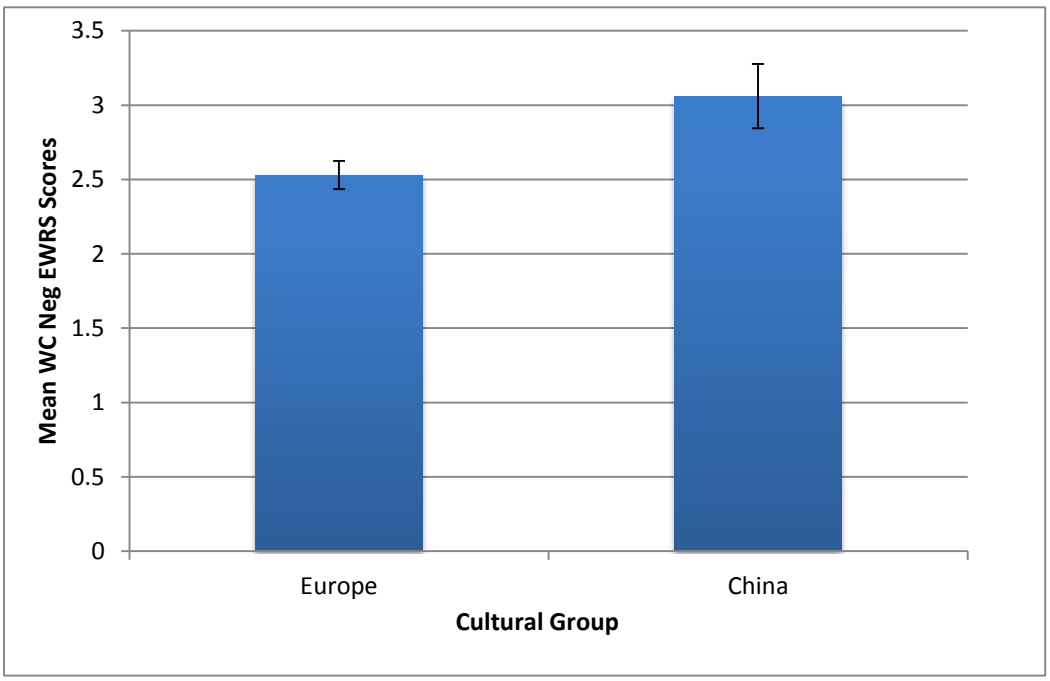


Figure 6.38 Mean Negative EWRS Scores for WC Website for Participants from Europe and China

6.5.4.2 Effects of Cultural Background on ORQ Answers

H_{27}: *The aspects of the website that participants like/dislike will differ significantly depending on their cultural background*

To test this hypothesis, a series of chi-square tests was conducted on the cultural groups of participants who mentioned particular categories on the Overall Reactions Questionnaire (ORQ), the categories being:

1. Use images, animations, multimedia
2. Content – type of content (e.g. interesting, factual, ranged, useless, or informative content)
3. Content – amount of content (too little, too much)
4. Design of the pages/website
5. Organization of the pages/website
6. Navigation (includes on menus)
7. Search facilities (or lack of)
8. Miscellaneous (speed, language option, not suited to tasks) – not enough examples for coding or not relevant (not suited to tasks)
9. Comments on balance between text and images

The following analyses produced significant results.

On the WC website, there was a significant difference between participants from Europe and China groups (chi-square = 9.16, df = 1, $p < 0.01$) who liked the use of images, animations, and multimedia (1st category). 36.8% (7 out of 19 participants) of Chinese participants mentioned the use of images, animations, and multimedia as a positive aspect of the WC website compared to only 10.4% (11 out of 106 participants) of the European participants. Chinese participants may prefer the use of images, animations, and multimedia since their native is not English.

On the WC website, there was a significant difference between participants from UK and China groups (chi-square = 4.87, df = 1, $p < 0.05$) who liked type of content (2nd category). 29.2% (31 out of 106 participants) of the European participants mentioned the type of content as a positive aspect of the WC website compared to only 5.3% (1 out of 19 participants) of the Chinese participants.

There are no significant results on the WC website related with the other categories on cultural groups. On the BM website, there are no significant results related with any categories on cultural groups.

6.5.4.3 Effects of Cultural Background on SFQ Answers

The next hypothesis investigated whether participants' preferences on websites differ based on their cultural backgrounds.

H_{28}: *Participants' preferences for specific features on websites will differ significantly depending on their cultural group*

To test this hypothesis, independent sample t-tests were conducted to compare participants from the Europe and China on their SFQ answers. The ***H_0*** is rejected for participants for some of the SFQ answers on both the BM and WC websites (see Table 6.17).

Table 6.17 European and Chinese Participants' SFQ Mean Scores and Tests of Significance

BMSpQ1					
Group	Mean	SD	t value	df	Significance
Europe	7.51	2.22	2.83	124	$p < 0.01$
Chinese	6.00	2.30			
BMSpQ3					
Group	Mean	SD	t value	df	Significance
Europe	4.75	1.92	-3.50	124	$p < 0.01$
Chinese	6.33	1.71			
BMSpQ5					
Group	Mean	SD	t value	df	Significance
Europe	5.93	2.13	2.72	124	$p < 0.05$
Chinese	4.84	1.85			
WCSpQ1					
Group	Mean	SD	t value	df	Significance
Europe	4.94	2.06	3.13	123	$p < 0.01$
Chinese	3.42	1.22			
WCSpQ2					
Group	Mean	SD	t value	df	Significance
Europe	3.84	2.26	-2.37	123	$p < 0.05$
Chinese	5.16	2.04			
WCSpQ4					
Group	Mean	SD	t value	df	Significance
Europe	6.27	2.25	2.54	123	$p < 0.05$
Chinese	4.84	2.34			

For the BMSpQ1 (Did you prefer to navigate using the menu at the top of the page or through the images and links under the image?), low scores indicate preference on navigating using the menu at the top of the page (top menu) and high scores indicate preference on navigating through the images and links under the images (inpage menu). The European participants have higher mean scores compared to Chinese participants. The European participants preferred navigating using inpage menu more than the Chinese participants (see Figure 6.39).

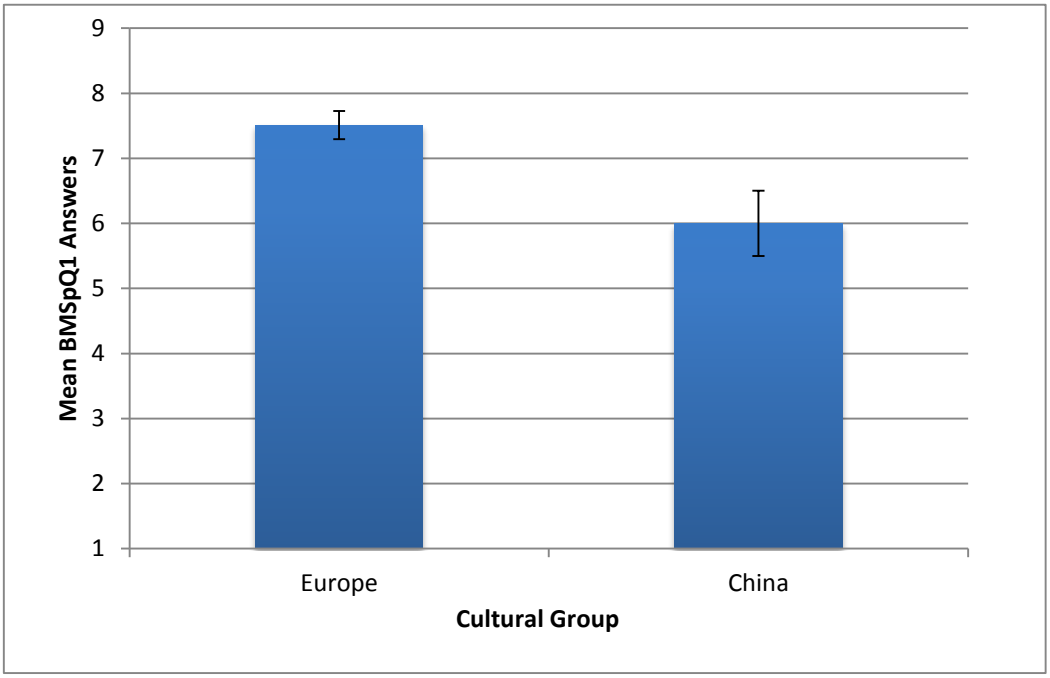


Figure 6.39 Mean Scores on BMSpQ1 for Participants from Europe and China

For BMSpQ3 (Did you prefer pages with lots of text and small pictures or pages with large pictures and a small amount of text?) low scores indicate preference on pages with lots of text and small pictures and high scores indicate preference on pages with large pictures and a small amount of text. The European participants have lower mean scores compared to the Chinese participants. The European participants preferred pages with lots of text and small pictures more than the Chinese participants (see Figure 6.40). Chinese participants may prefer pages with large pictures and a small amount of text since their native is not English.

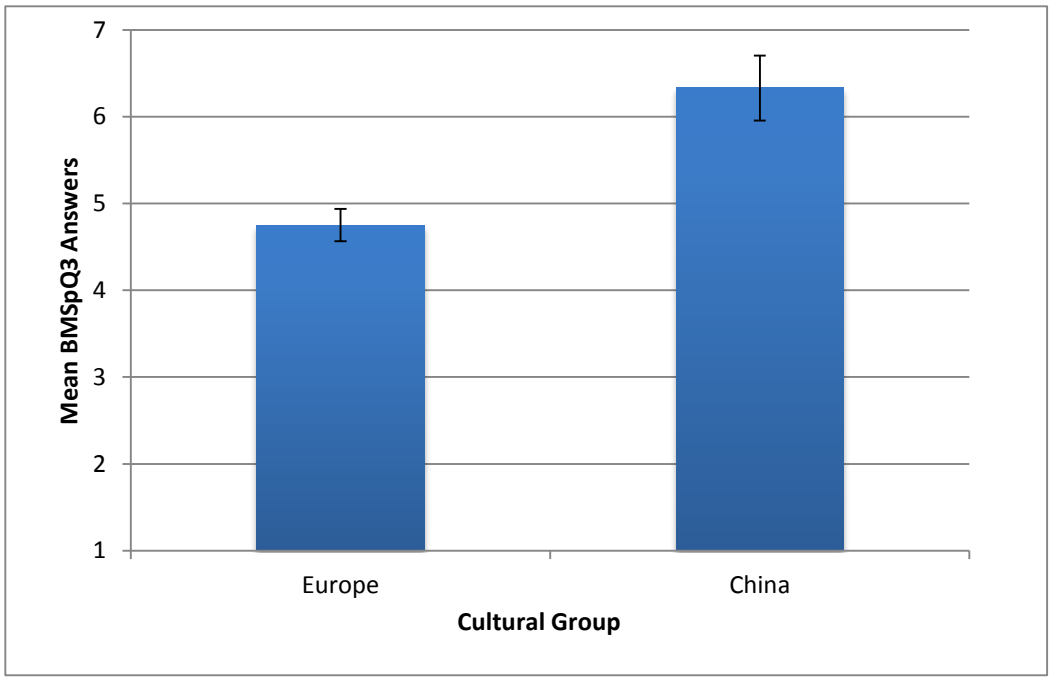


Figure 6.40 Mean Scores on BMSpQ3 for Participants from Europe and China

For BMSpQ5 (Did you prefer short pages where you had to click through frequently to get further information or pages where a lot of information was on one page and you needed to read through the page?) low scores indicate preference on short pages where you had to click through frequently to get further information and high scores indicate preference on pages where a lot of information was on one page and you needed to read through the page. The European participants have higher mean scores compared to the Chinese participants. The European participants preferred long pages where a lot of information was on one page and you needed to read through the page more than the Chinese participants (see Figure 6.41).

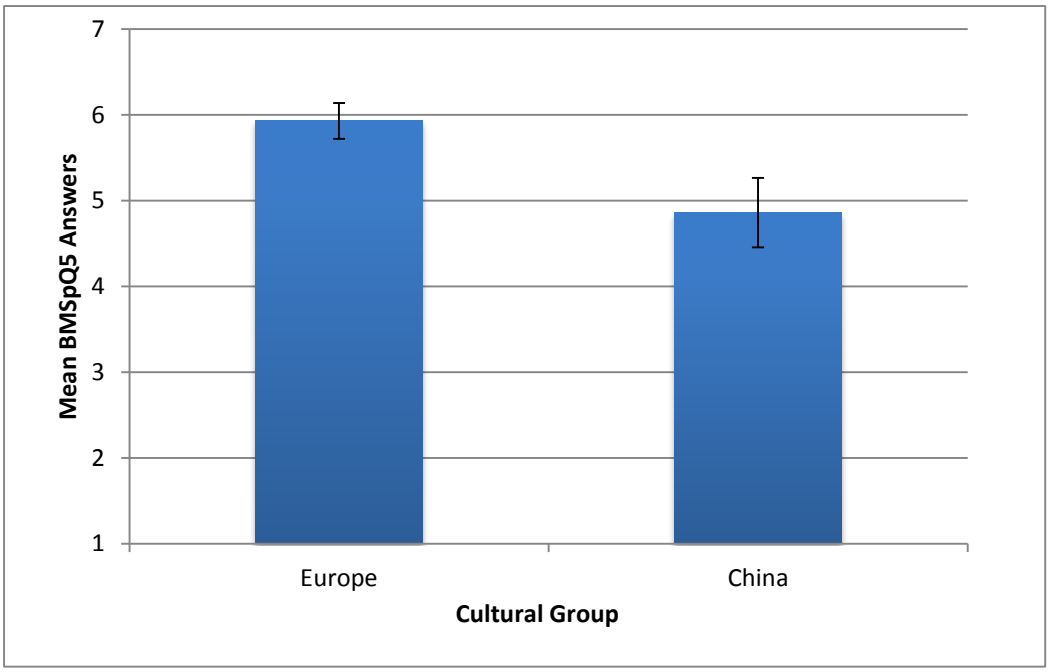


Figure 6.41 Mean Scores on BMSpQ5 for Participants from Europe and China

For WCSpQ1 (Did you prefer pages with text only or pages with numerous images?) low scores indicate preference on pages with numerous images and high scores indicate preference on pages with text only. The European participants have higher mean scores compared to the Chinese participants. The European participants preferred pages with text only more than the Chinese participants (see Figure 6.42). Chinese participants may prefer pages with numerous images since their native is not English.

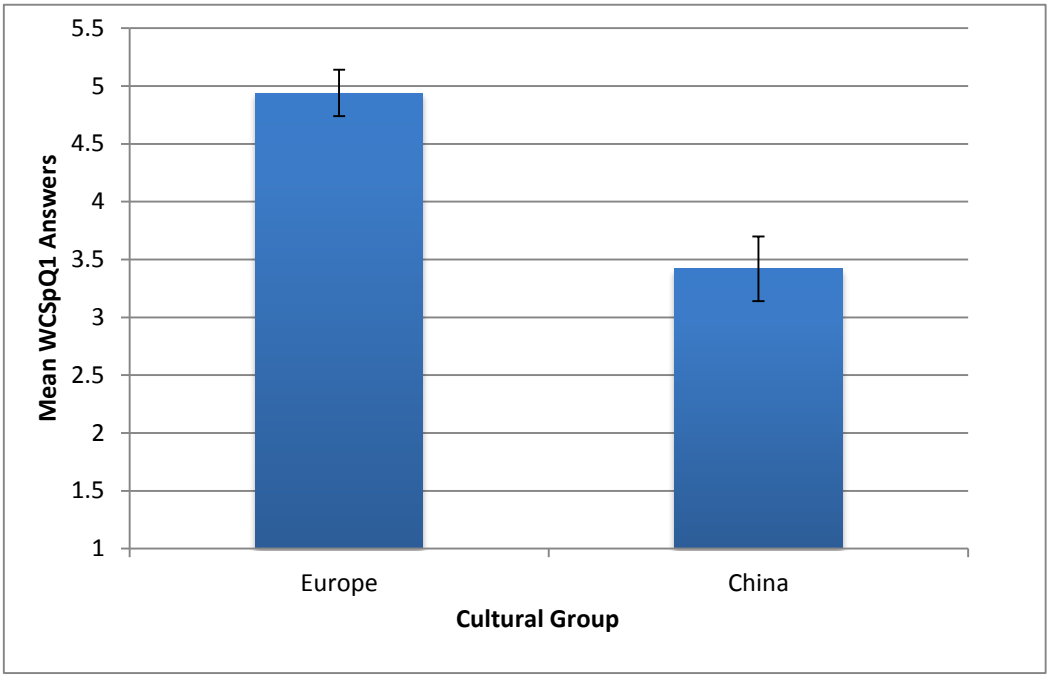


Figure 6.42 Mean Scores on WCSpQ1 for Participants from Europe and China

For WCSpQ2 (Did you like pages where you could see a number of options at once or pages where you see one item at a time?) low scores indicate preference on to see lot's of options on pages and high scores indicate preference on to see one item at a time on pages. The Chinese participants have higher mean scores compared to the European participants. The Chinese participants preferred to see one item at a time on pages more than the European participants (see Figure 6.43).

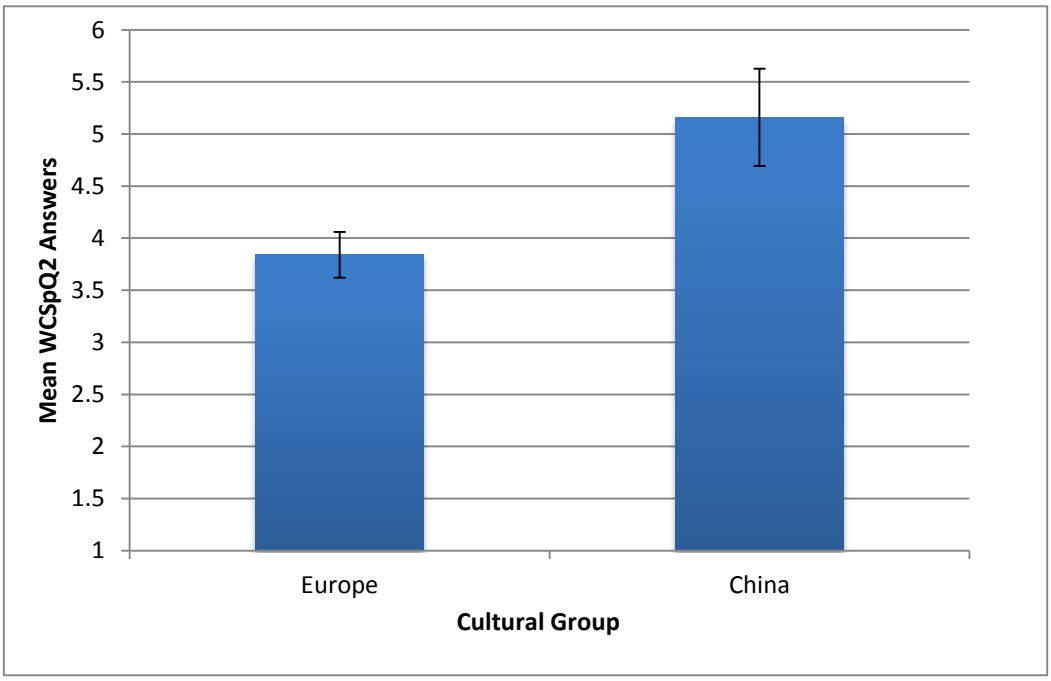


Figure 6.43 Mean Scores on WCSpQ2 for Participants from Europe and China

For WCSpQ4 (Did you prefer the pages where you needed to click through to get further information or pages where a lot of information was on one page and you needed to read through the page?) low scores indicate preference the pages where you needed to click through to get further information and high scores indicate preference on pages where a lot of information was on one page and you needed to read through the page. The European participants have higher mean scores compared to the Chinese participants. The European participants preferred pages where a lot of information was on one page and you needed to read through the page more than the Chinese participants (see Figure 6.44).

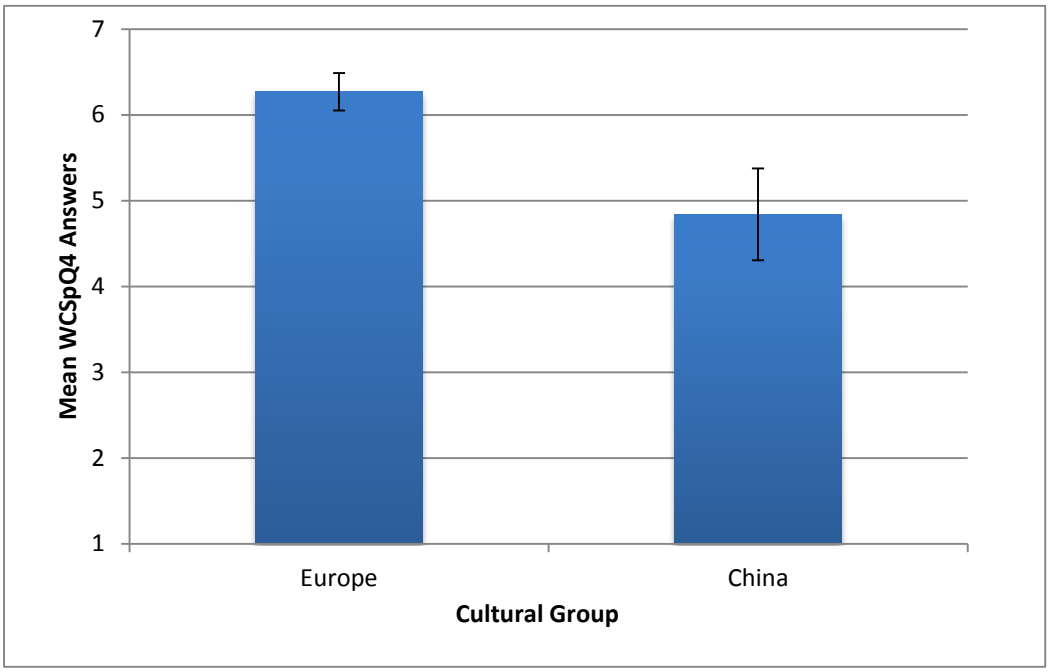


Figure 6.44 Mean Scores on WCSpQ4 for Participants from Europe and China

The next hypothesis investigated whether participants' preferences for specific features can be predicted from their cultures.

H_{29}: *Participants' preferences for specific features on websites can be predicted from their cultural background*

On participants' preference for navigating using the menu at the top of the page or through the images and links under the image on the BM website (BMSpQ1) (see Table 6.4 for the question), there was a significant overall linear regression ($r^2 = 0.05$, $F = 8.02$, $df = 1, 124$, $p < 0.01$), with cultural background being the significant predictor ($p < 0.01$). Further investigation of the data shows that the European participants preferred navigating using inpage menu more than the Chinese participants. This result has already been shown in the independent sample t-tests on BMSpQ1 presented above (see Figure 6.39).

On participants' preference for pages which had lots of text and small pictures or pages which had large pictures and a small amount of text on the BM website (BMSpQ3) (see Table 6.4 for the question), there was a significant overall linear regression ($r^2 = 0.08$, $F = 12.26$, $df = 1, 124$,

$p < 0.01$), with cultural background being the significant predictor ($p < 0.01$). Further investigation of the data shows that the European participants preferred pages with lots of text and small pictures more than the Chinese participants. This result has already been shown in the independent sample t-tests on BMSpQ3 presented above (see Figure 6.40).

On participants' preference for short pages where you had to click through frequently to get further information or pages where a lot of information was on one page and you needed to read through the page (BMSpQ5) (see Table 6.4 for the question), there was a significant overall linear regression ($r^2 = 0.03$, $F = 4.64$, $df = 1, 124$, $p < 0.05$), with cultural background being the significant predictor ($p < 0.05$). Further investigation of the data shows that the European participants preferred pages where a lot of information was on one page and you needed to read through the page more than the Chinese participants. This result has already been shown in the independent sample t-tests on BMSpQ5 presented above (see Figure 6.41).

On participants' preference for pages with text only or pages with numerous images (WCSpQ1) (see Table 6.4 for the question), there was a significant overall linear regression ($r^2 = 0.07$, $F = 1.95$, $df = 1, 123$, $p < 0.01$), with cultural background being the significant predictor ($p < 0.01$). Further investigation of the data shows that the European participants preferred pages with text only more than the Chinese participants. This result has already been shown in the independent sample t-tests on WCSpQ1 presented above (see Figure 6. 42).

On participants' preference for pages where you could see a number of options at once or pages where you see one item at a time (WCSpQ2) (see Table 6.4 for the question), there was a significant overall linear regression ($r^2 = 0.04$, $F = 5.62$, $df = 1, 123$, $p < 0.05$), with cultural background being the significant predictor ($p < 0.05$). Further investigation of the data shows that the Chinese participants preferred to see one item at a time on pages more than the European participants. This result has already been shown in the independent sample t-tests on WCSpQ2 presented above (see Figure 6. 43).

On participants' preference for pages where you needed to click through to get further information or pages where a lot of information was on one page and you needed to read through the page (WCSpQ4) (see Table 6.4 for the question), there was a significant overall linear regression ($r^2 = 0.04$, $F = 6.45$, $df = 1, 124$, $p < 0.05$), with cultural background being the significant predictor ($p < 0.05$). Further investigation of the data shows that the European participants preferred pages where a lot of information was on one page and you needed to read through the page more than the Chinese participants This result has already been shown in the independent sample t-tests on WCSpQ4 presented above (see Figure 6. 44).

Although, other specific features (BMSpQ2, BMSpQ4 and WCSpQ3) were tested, the $\boldsymbol{H_0}$ were retained for these variables.

6.5.5 Effects of Cultural Background on Performance

The next hypothesis investigated whether participants' task performances differ based on their cultural groups.

***H_{30}**: Participants' task performances will differ significantly depending on their cultural groups*

To test this hypothesis, independent sample t-tests were conducted to compare participants from the Europe and China on their task performances. The H_0 is rejected for participants for their task performances on the WC website (see Table 6.18).

Table 6.18 European and Chinese Participants' Task Performance Mean Scores and Tests of Significance

Wellcome Collection Museum					
Group	Mean	SD	t value	df	Significance
Europe	3.55	0.63	3.22	127	$p < 0.01$
Chinese	3.05	0.74			

For the WC website, The European participants have higher mean scores compared to the Chinese participants. The European participants showed better performance on WC tasks compared to the Chinese participants (see Figure 6.45).

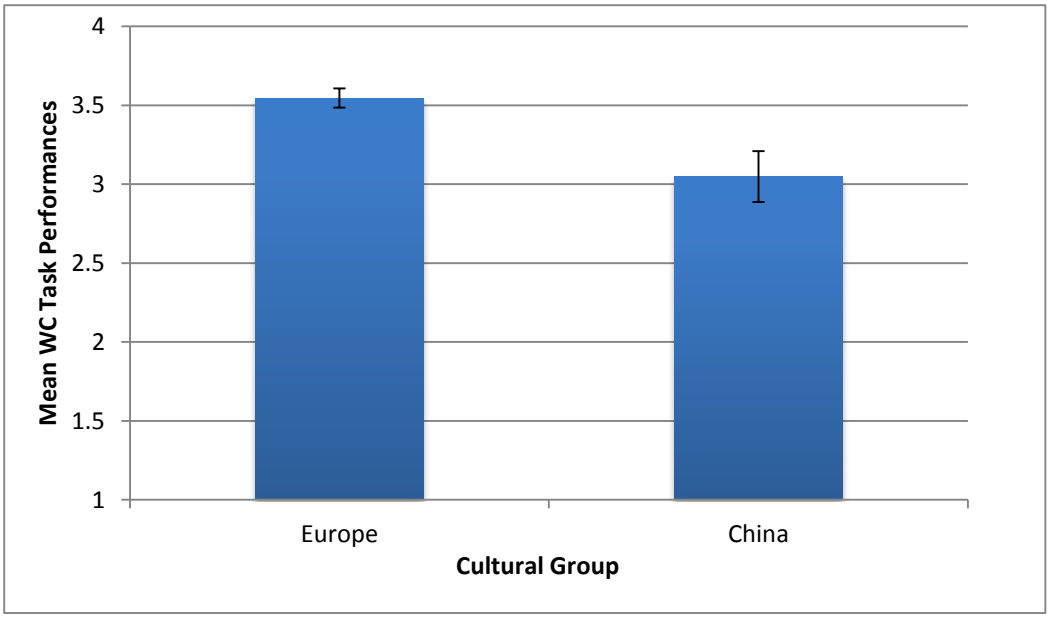


Figure 6.45 WC Task Performance Mean Scores for Participants from Europe and China

6.5.6 Effects of Cultural Background on Perceived Usability

The next hypothesis investigated whether participants ratings on website usability differ based on their cultural groups.

***H_{31}**: Participants' ratings of the usability of the website will differ significantly depending on their cultural groups*

To test this hypothesis, independent sample t-tests were conducted to compare participants from the Europe and China on their SUS scores. However, for these hypotheses H_0 retained. That means there are no significant differences between participants' usability ratings based on their cultural groups.

6.5.7 Other Important Results from the Museum Website Study

A final set of hypotheses was investigated. Although they were not directly related to the main research question of the impact of learning style and cultural background on the experience of museum websites, they were interesting hypotheses that were relevant in different ways to the research question and could be tested with the large dataset that had been collected.

6.5.7.1 Relation between EWRS Scores and SUS Scores

The next two hypotheses investigated whether participants' emotions about the websites correlate with their perception of the overall usability rating of the website.

H_{32}: *Participants' positive emotions about the websites will correlate positively with their perception of the overall usability rating of the website*

H_{33}: *Participants' negative emotions about the websites will correlate negatively with their overall usability rating of the website*

To test the H_{31}, EWRS positive scores were correlated with participant's SUS scores. For both the BM and the WC websites, the H_0 is rejected (for positive EWRS on BM: $r = 0.34$, $p < 0.01$; for positive EWRS on WC: $r = 0.21$, $p < 0.05$). The finding showed that there is a positive correlation between participants' positive EWRS and SUS score of the websites.

To test the H_{32}, EWRS negative scores were correlated with participant's SUS scores. For both the BM and the WC websites, the H_0 is rejected (for negative EWRS on BM: $r = -0.61$, $p < 0.01$; for negative EWRS on WC: $r = -0.61$, $p < 0.01$). The finding showed that there is a negative correlation between participants' negative EWRS and SUS score of the websites.

6.5.7.2 Relation between Learning Styles and Culture

There are several studies claiming that learning styles may differ from one culture to another (Agerup & Busser, 2004; Boondao et al., 2008; De Vita, 2001; Joy & Kolb, 2009; Katz, 1988; Kim & Bonk, 2002; Pratt, 1991; Ramburuth & McCormick, 2001; Teng, 2007). Therefore, next hypothesis investigated whether participants' learning styles differ depending on their cultural group:

H_{34}: *Participants' learning styles will differ significantly depending on their cultural group*

For the above hypothesis, independent sample t-tests were conducted to compare participants from the Europe and China on their learning styles. The H_0 is retained. There are no significant differences between participants' learning style preferences based on their cultural group.

6.5.7.3 Relation between Task Performance and EWRS Scores

H_{35}: *Participant's emotional reactions to the website will differ significantly depending on their task performances*

For the above hypothesis, a one-way ANOVA between participants analysis of variance was conducted. The hypothesis tested whether the participants with better task performance feel more positive emotions for the websites. However, for this hypotheses ***H_0*** retained. That means there are no significant differences between participants' emotions on websites based on their task performances.

6.6 Discussion and Conclusions

This study was designed to test the third research question that is *"How do learning styles and cultural background affect users' experience, performance and perceived usability of informal learning websites such as large museum websites?"*. In the light of findings of the card sort and the interview studies, this study was designed to examine the effects of learning styles and cultural background on users' experience, performance and perceived usability of two museum websites: the British Museum (BM) and the Wellcome Collection Museum (WC). Contrary to previous studies (see subsection 2.2.4) that examine the effects of learning style on websites by artificially manipulating hypertext/web material and developing different versions of websites that match users' learning styles, real museum websites were used in this study to ensure higher ecological validity. As also discussed in the literature review (see section 2.3), serving the needs of website visitors with diverse cultural backgrounds is gaining importance as a topic for both research and practice. However, there are only few websites that target the needs of users by customizing interfaces regarding their cultural backgrounds (Daniel et al., 2013). Therefore, participants were asked to perform several tasks on BM and WC websites and answered a range of questions to examine whether their learning styles and cultural background affect their emotional reaction to the websites, preferences for specific features on the websites, like/dislike on the websites, performance and perception of the usability of the website.

The following sections present the discussion and conclusions on results of learning styles (see subsections 6.6.1 to 6.6.3), cultural background (see subsections 6.6.4 to 6.6.6) and other important findings (see subsection 6.6.7) that are related to the museum website study. Then conclusions (see subsection 6.6.8) and guidelines (see subsection 6.6.9) based on the results of the museum website study will be discussed.

6.6.1 Effects of Learning Styles on User Experience

6.6.1.1 Effects of Learning Styles on EWRS Scores

Firstly, data were analyzed to investigate whether participants' emotional reactions to the websites differ significantly depending on their learning styles. It was found that there is a significant difference between the various ILS dimensions and participants' positive and negative emotional reactions to the websites as measured on the EWRS.

The results showed that there is a significant difference between the various groups of Seq-Glo participants in both their positive and negative emotional reactions to the BM website. For the positive emotions, the Highly/Very Strongly Seq participants have the least positive reaction and the Very Strongly Glo participants have the most positive reaction. The Highly/Very Strongly Seq participants are significantly less positive about the BM website than all the other groups, apart from the Moderately Glo participants. Apart from Moderately Glo participants, there is a general trend from less positive for Seq participants to more positive for Glo participants. For the negative emotions, the tendency is for Glo participants to be more negative about the BM website than the other groups apart from the Highly/Very Strongly Seq group (see subsection 6.5.1.1 for the details of H_1).

Sun and Chen (2010) illustrated that there are emotion variations between Vis and Ver users. Although no significant results were found for emotion variations on the Act-Ref and Vis-Ver dimensions in the current study, findings of H_1 gave clues on emotional variations in Seq-Glo and Sen-Int dimensions. Sun and Chen (2010) emphasized there are lots of studies that indicated the important role of emotions on development of users' learning experiences (Goleman, 2006; Izard, 1984; Kort, Reilly & Picard, 2001; LeDoux, 1994; Reilly & Kort, 2004). In addition, Izard (1984) showed that learning performance could be raised by positive emotions. Therefore, analyzing users' emotional variations amongst different learning styles is valuable because focusing on these variations has a potential to raise learning performances of users.

6.6.1.2 Effects of Learning Styles on ORQ Answers

The data were analyzed to show whether the aspects of the website that participants like/dislike can differ significantly depending on their learning styles as measured by the ORQ.

It was found that on the BM website, there is a significant difference on the Act-Ref dimension in the number of participants who liked the use of images, animations, and multimedia and who did not like the type of content, the design and organization of the pages/website and the search

facilities. Furthermore, on the WC website, there is a significant difference on the Act-Ref dimension in the number of participants who did not like the design of the pages/website.

Act participants mentioned images, animations and/or multimedia as positive aspects and type of content as a negative aspect of the BM website with a higher frequency, compared to Balanced Act-Ref participants and Ref participants. Results on higher preference of Act participants on images, animations and/or multimedia are consistent with findings from the study performed by Ocepek, Bosnik, Serbec and Rugelj (2013). Images, animations and/or multimedia are materials that increase interactivity of website. Act participants' decision on these materials as a positive aspect of the website can be explained by their preference to be dynamic and interactive during learning experience.

Ref participants mentioned the organization of the pages/website as a negative aspect of the BM website with a higher frequency compared to Balanced Act-Ref participants and Act participants. This result can be explained by the click through structure of the website. Generally, participants need to click on links for new information. Hence, Ref people who like to be inactive during learning process do not favor this.

Furthermore, Balanced Act-Ref participants mentioned the search facilities as a negative aspect of the BM website with a higher frequency compared to Act participants and Ref participants who even did not mention this category. In addition, Act participants and Balanced Act-Ref participants mentioned the design of the pages/website as a negative aspect of the WC website with a higher frequency, compared to Ref participants.

In addition, there is a significant difference on the Sen-Int dimension in the number of participants who mentioned that they like the organization of the pages/website they for the BM website. Balanced Sen-Int participants mentioned the organization of the pages/website as a positive aspect of the BM website with a higher frequency, compared to Sen participants and Int participants. Furthermore, there is a significant difference on the Sen-Int dimension in the number of participants who mentioned that they did not like miscellaneous things on the BM website. Int participants mentioned this category as a negative aspect of the website significantly more frequently than Sen and Balanced Sen-Int participants.

On the Vis-Ver dimension, it was found that there is a significant difference in the number of participants who liked the use of images, animations, multimedia and who did not like the navigation on the BM website. Vis participants mentioned images, animations and/or multimedia as a positive aspect of the BM website with a higher frequency compared to Balanced Vis-Ver participants and Ver participants. Results on the higher preference of Vis participants on images, animations and/or multimedia are consistent with results of several

studies (Ocepek et al., 2013; Sun & Chen, 2010). This result is not unexpected since Vis people like to learn through images, animations and multimedia. Vis participants and Ver participants mentioned navigation as a negative aspect of the BM website with a higher frequency, compared to Balanced Vis-Ver participants.

In addition, it was found that there is a significant difference in the number of Vis-Ver participants who did not like the navigation and search facilities. Ver participants mentioned the navigation and search facilities or lack of search facilities as a negative aspect of the WC website with a higher frequency, compared to Vis participants and Balanced Vis-Ver participants.

For the amount of content category, the study showed no significant difference on any of the four ILS dimensions (see subsection 6.5.1.2 for the details of H_2).

Consequently, the above results and the results that will be discussed in the following subsection give evidence that the aspects of the website that participants like/dislike and various types of materials on the websites that participants prefer differ significantly depending on their learning styles. These findings are consistent with studies from the literature that investigate how user preferences on website aspects (such as preference for particular media) differ depending on their learning styles (Alty, Al-Sharrah & Beacham, 2006; Ocepek et al., 2013; Sahasrabudhe & Kanungo, 2014; Sun & Chen, 2010). Aspects of websites and different types of materials if they are consistent with users' preferences could result in increased learning, while aspects, which are disliked, could break users' concentration or result in reduced learning. For that reason, focusing on users' learning styles has the potential to raise the learning performance of users.

6.6.1.3 Effects of Learning Styles on SFQ Answers

The data were analyzed to investigate differences between participants' preferences for different types of materials on the websites based on their learning style.

There are no significant differences between the Act-Ref, Sen-Int, Vis-Ver and Seq-Glo groups on their preference for navigating using the top menu or through the inpage menu (see from H_3 to H_6 in subsection 6.5.1.3 for the details).

It was predicted that Act participants would find large images attractive since to navigate through the images participants have to click on arrows and Act people like to be dynamic during their learning experiences. In contrast, it was predicted that Ref participants would find large images distracting since they do not like to be active during their learning experiences. Results showed that the Balanced Act-Ref participants found the large images significantly more attractive than the Strongly Act, Moderately Ref, Strongly Ref and Highly/Very Highly Ref participants. No significant differences were found between the Sen-Int, Vis-Ver and Seq-Glo

groups on their preferences about large images (see from H_7 to H_{10} in subsection 6.5.1.3 for the details).

In addition, it was predicted that Vis participants would prefer small amounts of text and Ver participants would prefer large amounts of text per page since Vis people are better with images whereas Ver ones are better with text during their learning experiences. However, no significant difference could be found between Vis-Ver participants on their preference for the amount of text per page (see subsection 6.5.1.3 for the details of H_{11}). Besides, no significant difference could be found between Vis-Ver participants on their preference for lots of images on pages to text only pages (see subsection 6.5.1.3 for the details of H_{12}).

It was also predicted that Sen participants would prefer lots of images on pages and Int participants would prefer text only pages since Sen people are better with concrete materials whereas Int ones are better with abstract text during their learning experience. Contrary to expectations, no significant differences could be found between the Sen-Int groups on their preference for lots of images on web pages versus text only web pages (see subsection 6.5.1.3 for the details of H_{13}). This may due to the influence of other factors such as text or image content. Even if the pages are composed of lots of images, if these images are abstract ones Sen people might not prefer these pages.

It was predicted that Act participants would prefer short pages, to see one item at a time and to click through for new information since they like to be dynamic during learning experiences. It was also predicted that Ref participants would prefer long pages, to have lots of options to be available on pages and to see all information on one page because they do not like to be active during learning experience. In addition, it was predicted that Seq participants would have similar preferences to Act participants since they like to learn in linear steps, not in large jumps. Furthermore, it was predicted that Glo participants would have similar preferences to Ref participants, as they like to see the big picture first. However, no significant differences were found between the Act-Ref and Seq-Glo participants about their preferences on page length (see subsection 6.5.1.3 for the details of H_{14} and H_{15}), their preferences on seeing one item at a time versus having lots of options to be available on pages (see subsection 6.5.1.3 for the details of H_{16} and H_{17}) and their preferences on the organization of the information on the website (see subsection 6.5.1.3 for the details of H_{18} and H_{19}).

No significant differences were found between Sen-Int participants on their preferences for the pages with concrete examples of concepts and facts and figures or for pages abstract text and discussion of topics (see subsection 6.5.1.3 for the details of H_{20} and H_{21}).

The data were then further analyzed with linear regression and it was found that it is possible to predict participants' preferences for some specific features on websites from their learning style

profile. The Sen-Int dimension can be used to predict participants' preference for pages that had rather abstract discussion of concepts, or pages that had concrete examples. In addition, the Seq-Glo dimension can be used to predict participants' preference for pages that had click through for information or pages that had all the information on one page. Although other specific features and the other two ILS dimensions were tested, no significant results were found for them (see subsection 6.5.1.3 for the details of H_{22}).

Website aspects or different types of materials if they are aligned with users' preference could result in increased learning, while those not preferred could break users' concentration or could result in decreased learning. For that reason, focusing on users' learning styles has a potential to raise learning performances of users.

6.6.2 Effects of Learning Styles on Performance

The data were analyzed to investigate whether participants spend longer times on pages that match their learning styles. However, the results showed that there is no correlation between the lengths of time of participants stay on pages and their learning styles (see subsection 6.5.1.2 for the details of H_{23}). This result supports the findings of Bajraktarevic, Hall and Fullick (2003) and Brown et al. (2007b). Bajraktarevic et al. (2003) investigated whether browsing time is shorter when participants use an OLS that matches their learning style. They concluded that there were no significant effects. However, this may have been due to the procedure of their study since they administered firstly matched and then unmatched sessions.

The data were also analyzed to investigate whether participants' task performance differs significantly depending on their learning styles. But, no significant differences between participants' task performance could be found based on their learning styles. This finding is consistent with previous research. Brown et al. (2006) also concluded that there is no evidence that one learning style is better than others for in terms of performance (see subsection 6.5.2 for the details of H_{24}).

6.6.3 Effects of Learning Styles on Perceived Usability

The data were analyzed to investigate whether participants' perceptions of the usability of the website differ significantly depending on their learning styles. The results showed that there is a difference between the various groups of Seq-Glo participants in their perception of the usability of the BM website. Further investigation showed that the Slightly Glo participants have the highest scores and the Moderately Glo participants have the lowest scores. The Moderately Glo participants have significantly lower scores about the of the usability BM website than all the other groups except for Strongly Glo group (see subsection 6.5.3 for the details of H_{25}).

These results are consistent with those of Graff (2014) who also found differences in perceived usability between users with different cognitive styles.

6.6.4 Effects of Cultural Background on User Experience

6.6.4.1 Effects of Cultural Background on EWRS Scores

The data were analyzed to investigate whether participants' emotional reactions to websites differ based on their cultural backgrounds. The results showed that there is a difference between the Europe and China groups for both positive and negative emotions on both the BM and WC websites. Further investigation showed that for both the BM and WC websites, the Chinese participants have higher mean EWRS positive and negative scores compared to European participants (see subsection 6.5.4.1 for the details of H_{26}).

There have been several studies that provided evidence on how emotional reactions to websites differ based on cultures (Davis, Wang & Lindridge, 2008; Eroglu, Machleit & Davis, 2001; Menon & Kahn, 2002). Therefore, the findings from the current study are consistent with previous research. Sun and Chen (2010) emphasized there are many studies that indicated the important role of emotions on development of users' learning experiences (Goleman, 2006; Izard, 1984; Kort, Reilly & Picard, 2001; LeDoux, 1994; Reilly & Kort, 2004). In addition, Izard (1984) showed that learning performance could be raised by positive emotions. Therefore, analyzing users' emotional variations amongst different cultural groups is valuable because focusing on these variations has a potential to raise learning performances of users.

6.6.4.2 Effects of Cultural Background on ORQ Answers

The data were analyzed to investigate whether the aspects of the website that participants like/dislike differ significantly depending on their cultural backgrounds.
It was found that on the WC website, there was a significant difference between participants from Europe and China groups who liked the use of images, animations, and multimedia. The Chinese participants mentioned the use of images, animations, and multimedia as a positive aspect of the website with a higher percentage compare to the European participants.

On the WC website, there was a significant difference between participants from Europe and China groups who liked type of content. The European participants mentioned the type of content as a positive aspect of the WC website with a higher frequency compared to the Chinese participants (see subsection 6.5.4.2 for the details of H_{27}).

These results provide evidence on how cultural background affects participants' preferences for different types of materials. These results are consistent with previous studies that investigated cultural effects on different website aspects and found significant differences between various

cultural groups (Barber & Badre, 1998; Callahan, 2005; Del Galdo, 1990; Duncker, Theng & Mohd-Nasir, 2000; Rajkumar, 2003; Russo & Boor, 1993; Schmid-Isler, 2000). Website aspects or different types of materials if they are consistent with users' preference could result in increased learning, while those not preferred could break users' concentration or could result in reduced learning. For that reason, focusing on users' cultural background has a potential to raise learning performances of users.

6.6.4.3 Effects of Cultural Background on SFQ Answers

The data were analyzed to investigate whether participants' preferences for different types of materials on the websites differ based on their cultural backgrounds. The results showed that the European participants preferred navigating using inpage menu, pages with lots of text and small pictures, long pages where a lot of information was on one page and you needed to read through the page, pages with text only, pages where you could see a number of options at once more than Chinese participants (see subsection 6.5.4.3 for the details of H_{28}).

In addition, the data were analyzed with linear regression and it was found that it is possible to predict participants' preferences for some specific features on websites from their cultural background group. Further examination revealed that the European participants preferred navigating using inpage menu more than Chinese participants. In addition, the European participants preferred pages with lots of text and small pictures more than the Chinese participants. Moreover, the European participants preferred pages where a lot of information was on one page and you needed to read through the page more than the Chinese participants. Further investigation of the data also illustrated that the European participants preferred pages with text only more than the Chinese participants. Furthermore, the Chinese participants preferred to see one item at a time on pages more than the European participants. Lastly, the European participants preferred pages where a lot of information was on one page and you needed to read through the page more than the Chinese participants (see subsection 6.5.4.3 for the details of H_{29}).

These results provide evidence on how cultural background affects participants' preferences for different types of materials. These results are consistent with previous studies that investigated cultural effects on different website aspects and found significant differences between various cultural groups (Barber & Badre, 1998; Callahan, 2005; Del Galdo, 1990; Duncker, Theng & Mohd-Nasir, 2000; Rajkumar, 2003; Russo & Boor, 1993; Schmid-Isler, 2000). Website aspects or different types of materials if they are aligned with users' preference could result in increased learning, while those not preferred could break users' concentration or could result in decreased learning. For that reason, focusing on users' cultural backgrounds has a potential to raise learning performances of users.

6.6.5 Effects of Cultural Background on Performance

The data were analyzed to investigate whether participants' task performance differed based on their cultural group. Results showed that there are significant differences between the cultural groups on their task performance for the WC website.

The data were analyzed to investigate whether participants' task performance differed based on their cultural group. Results showed that there are significant differences between the Europe and China groups on their task performance for the WC website. For the WC website, the European participants showed better performance on WC tasks compared to Chinese participants. The better performances of the Europe participants can perhaps be explained by their ability in English. This finding is consistent with Badre (2001) who found significant effects of culture on user performance (see subsection 6.5.5 for the details of H_{30}).

6.6.6 Effects of Cultural Background on Perceived Usability

The data were analysed to investigate whether participants' perception of the usability of the websites differ significantly depending on their cultural groups. However, the results showed no significant differences in perceived usability based on participants' cultural groups. This finding is contrary to Nantel and Glaser's (2008) study which concluded that perceived usability is higher when the website was originally conceived in the native language of the users (see subsection 6.5.6 for the details of H_{31}).

6.6.7 Other Important Results from the Museum Website Study

6.6.7.1 Relation between EWRS Scores and SUS Scores

The data were analysed to investigate whether participants' emotions about the websites correlate with their perception of the overall usability of the website. The results showed that there is a positive correlation between participants' positive emotions and usability ratings of the websites and there is a negative correlation between participants' negative emotions and usability ratings of the websites (see H_{32} and H_{33} in subsection 6.5.7.1 for the details).

6.6.7.2 Relation between Learning Styles and Culture

The data were analysed to investigate whether participants' learning styles differs significantly depending on their cultural group. However, no significant differences were found between participants' learning style preferences based on their cultural group (see H_{34} in subsection 6.5.7.2 for the details).

This finding is contrary to a number of studies, which have claimed learning styles differ from one culture to another (Agerup & Busser, 2004; Boondao, Hurst & Sheard, 2008; De Vita, 2001; Joy & Kolb, 2009; Katz, 1988; Kim & Bonk, 2002; Pratt, 1991; Ramburuth & McCormick, 2001; Teng, 2007). Based on Teng's (2007) study, US students are more active when compared with Taiwan students. US students are more likely to post, read and response online messages. As another example, Kim and Bonk (2002) showed that US students were more action-oriented and pragmatic in seeking results or giving solutions compared to Finnish students who were more reflective. Another study showed that Asian students are more collaborative compare to Australian students (Ramburuth & McCormick, 2001) whereas Joy and Kolb (2009) found that Asian students act more quiet and reflective in extraverted classes than other cultures.

However, none of the cultural groups compared in previous studies are the same as those compared in the current study.

6.6.7.3 Relation between Task Performance and EWRS Scores

The data were also analysed to investigate whether the participants who achieve better task performance feel more positive emotions for the websites. However, no significant differences were found between participants' emotions on the websites based on their task performance (see H_{35} in subsection 6.5.7.3 for the details).

6.6.8 Conclusions

The results of this study showed that participants' emotional reactions to museum websites, and likes and dislikes of the aspects of websites differ with their learning styles and cultural backgrounds. Participants' preferences for different types of materials on museum websites and their task performance on these websites differ with these individual and group characteristics. Finally, it has been shown that it is possible to use people's learning styles and cultural background to predict their preferences for some specific features on museum websites.

Therefore, analyzing users' emotional variations amongst different learning styles and cultural groups is valuable because focusing on these variations has the potential to raise learning experiences of users. Besides, developers will be attentive of suitable features to use on websites if they are aware of their visitors' learning styles and cultural background. Website aspects or different types of materials if they are inline with users' preference could result in increased learning, while not preferred ones could break users' concentration or could result in reduced learning. For these reasons, focusing on users' learning styles and cultural background has a potential to raise learning performances of users.

Contrary to the expectations, no evidence could be found for supporting that users' spend longer times on pages that match their learning styles. Furthermore, no significant differences

could be found between participants' task performances based on their learning styles. However, results showed that there are significant differences between the cultural groups on their task performances. Therefore, focusing on users' cultural background has a potential to raise learning performances of users.

It is also clear that users' ratings of the usability of the website differ significantly depending on their learning styles. Contrary to expectations, results demonstrated no significant differences between participants' usability ratings based on their cultural backgrounds. Hence, focusing on users' learning styles has a potential to raise websites' usability ratings.

To sum up, both learning styles and cultural background affect users' experience. While learning styles do not affect performance, cultural background affects it. Although learning styles affect users' perception of the usability, cultural background does not affect it.

Findings demonstrated other valuable findings. Firstly, positive emotions bring high usability rating of a website and negative emotions bring low usability rating for the website. Thus, focusing on users' emotional reactions has a potential to raise websites' usability ratings. Contrary to previous research, no significant differences could be found between participants' learning style preferences based on their cultural group. Besides, no significant differences could be found between participants' emotions on websites based on their task performances.

Furthermore, in this study a different but complementary approach was chosen, to design a study with greater ecological validity. Thus, the experience of people with different learning styles in realistic museum website environments were assessed and the effects of elements of the website that suit different learning styles were investigated with an ecologically valid study.

6.6.9 Guidelines for Creating Museum Websites based on the Results of the Museum Website Study

6.6.9.1 Guidelines for Creating Museum Websites to Suit Users with Different Learning Styles

1. Provide images, animations and multimedia materials as well as text to suit users with differing learning styles [results from H_2: The Act participants mentioned images, animations and/or multimedia as a positive aspect of the BM website highly compared to the other participants. Besides, the Vis participants mentioned images, animations and/or multimedia as a positive aspect of the BM website highly compared to the other participants.]

2. Make sure that the content provided is interesting and informative to the users [results from H_2: The Act participants mentioned type of content as a negative aspect of the BM website highly compared to the other participants.]
3. Organize pages and the whole website carefully to correspond as closely as possible to the needs of users [results from H_2: The Ref participants mentioned the organization of the pages/website as a negative aspect of the BM website highly compared to the other participants. Besides, the Balanced Sen-Int participants mentioned the organization of the pages/website as a positive aspect of the BM website highly compared to the other participants.]
4. Provide search facilities that meet the needs of users [results from H_2: The Balanced Act-Ref participants mentioned the search facilities as a negative aspect of the BM website highly compared to the other participants. Besides, the Vis participants mentioned the search facilities as a negative aspect of the WC website highly compared to the other participants.]
5. Design the individual pages and the whole website carefully to meet the needs of users [results from H_2: The Act participants, the Balanced Act-Ref and the Balanced Seq-Glo participants mentioned design of the pages/website as a negative aspect of the WC website highly compared to the other participants.]
6. Provide different navigational options to suit different kinds of users – some users like navigation through text links, some like navigation through images [results from H_2: The Ver participants mentioned the navigation as a negative aspect of the BM website compared to the other participants.]
7. Provide information both as a global overview on one page and as a sequence of items that can be moved through as a sequence of items [results from H_{22}: The Seq participants preferred to click through for information whereas the Glo participants preferred all information on one page.]

6.6.9.2 Guidelines for Creating Museum Websites to Suit Users with Different Cultural Groups

8. Provide images, animations and multimedia materials as well as text to suit users from different cultural backgrounds, particularly if you have Chinese users [results from both H_{27} and H_{28}: The Chinese participants mentioned the use of images, animations, and

multimedia as a positive aspect of the WC website. Besides, the Chinese participants preferred pages with numerous images compared to the European participants.]

9. Make sure that the content provided is interesting and informative to the users [results from H_{27}: The European participants mentioned type of content as a positive aspect of the website significantly more frequently than the Chinese participants.]
10. Provide different navigational options to suit different kinds of users. Provide navigation through inpage menu for the European users [results from H_{28}: The European participants preferred navigating using the inpage menu more than the Chinese participants.]
11. Provide options of text only pages and pages with text and images, as these appeal to users from different cultural groups [results from H_{28} and H_{29}: The European participants preferred pages with lots of text and small pictures and pages with text only more than the Chinese participants.]
12. Provide information both as a global overview on one page and as a sequence of items that can be moved through as a sequence of items, as these options appeal to different cultural groups [results from H_{28}: The European participants preferred a lot of information on one page where you had not to click through frequently to get further information more than the Chinese participants.]
13. Provide the option of long pages with lots of information and sequences of pages, which split the information up into small units [results from H_{29}: The European participants prefer long pages compared to the Chinese participants.]

Chapter 7: Overall Discussion and Conclusions

The first subsection of this final chapter reviews the research results found and highlights the main contributions of the programme of research (see section 7.1). Next, the limitations of the work are discussed (see section 7.2). Then, future work is discussed by identifying further research perspectives (see section 7.3). The thesis concludes with implications (see section 7.4) and guidelines (see section 7.5) that are discussed based on the research results obtained.

7.1 Synthesis of Main Results from this Programme of Research

The thesis presents a comprehensive literature review, related to learning styles, cultural differences and personalization of OLSs and websites in Chapter 2. In addition, a comprehensive literature review on Felder-Silverman LSM and Index of Learning Styles (ILS) is given in both Chapters 2 and 3. These reviews are valuable to researchers who study and work on these topics.

In Chapter 3, the Turkish Index of Learning Styles (T)ILS is introduced, this is a Turkish version of the ILS. With permission from the ILS's main author Professor R. M. Felder, the (T)ILS was developed by using professional translation techniques. More importantly, it was evaluated for its reliability and construct validity, and was found to have good reliability and validity. Therefore, now it is usable with Turkish learners. Turkish researchers who wish to undertake research with Turkish participants related to the Felder-Silverman LSM can use this questionnaire.

In Chapter 4, the first research question (*Are there any differences in users' categorizations and mental models of the IAs based on their learning styles and cultural background?*) has been addressed with a card sort study. The study showed interesting and meaningful differences between learning style dimensions and British, Chinese, Indian and Turkish participants in their categorizations and mental models of the information architectures (IAs) relating to both museum and news websites. This study also made a methodological contribution, showing that the card sort methodology can be used to investigate learning styles and cultural group differences. These results also will be important for website developers while they are developing websites with clear IAs.

In Chapter 5, the second research question (*What are museums trying to do with their websites and how are they trying to accommodate the wide range of user preferences (such as learning styles or cultural background) and are museums interested in using concepts such as learning style to make their online materials more engaging*

to users?) has been addressed by conducting interviews with museum personnel, particularly website developers. Detailed information is presented on what museums are trying to do with their websites, how are they trying to accommodate the wide range of user preferences and whether they are aware of strategies for personalizing their websites (such as learning styles and cultural differences). The interviews supported the conclusion that there is value in examining how learning styles and cultural differences affect users' experience of museum websites. The information from the interviews is not only intellectually interesting but also will be important for personnel responsible for museum websites since they may want to use these ideas while they are developing museum websites.

In Chapter 6, the third research question (*How do learning styles and cultural background affect users' experience, performance and perceived usability of informal learning websites such as large museum websites?*) has been addressed. The museum website study showed that learning styles affect users' experience, and perception of the usability but do not affect performance. The study also showed that cultural background affect users' experience and performance but do not affect and perception of the usability. In addition, the results showed a number of other valuable findings. Firstly, positive emotions correlate with high ratings of usability of a museum website and negative emotions correlate with low ratings of usability for a museum website. Contrary to previous research, no significant differences were found between participants' learning style preferences based on their cultural group. In addition, no significant differences were found between participants' emotions on websites based on their task performance.

Analyzing users' emotional variations amongst different learning styles and cultural groups is valuable because focusing on these variations has the potential to raise learning performance of users with museum websites. In addition, it is clear that by using learning styles and cultural groups it is possible to predict users' preferences for some specific features on websites. Thus, developers could be aware of suitable features to use during development of websites if they think about their visitors' learning styles and cultural groups. If aspects of websites or different types of materials are aligned with users' preferences, this could result in enhanced learning experiences for users; while website aspects or types of materials that are not aligned with users' preferences could break users' concentration or could result in decreased learning experiences. For that reason, focusing on users' learning styles has the potential to enhance learning experiences and focusing cultural background has the potential to enhance learning performance of users. Furthermore, focusing on users' learning styles and emotional reactions has the potential to raise the perception of the usability of websites. These results will be important for website developers who want to enhance users' experience with websites.

Finally, in this study a new methodological approach was chosen, to design a study with greater ecological validity than used in most of the previous research on personalization of online information such as museum websites for users with different learning styles or other preferences. Any real museum website is very unlikely to have a whole version that is optimized for each learning style. Thus, two real museum websites were used in the study. Hence, the experience of users with different learning styles in realistic museum website environments were assessed and the effects of elements of the website that suit different learning styles were investigated with an ecologically valid study.

News and museum websites can be categorized as informal learning environments. So that to understand how learning styles and cultural background affect users' experience on websites can help web developers to increase the quality of the user experience on these websites. It would seem important for web developers to present and offer materials on their websites attractive to each type of learning style and for a relevant range of cultural groups. In addition, these results will be valuable for museums to potentially increase their virtual and real visitors. From the perspective of users, they would have better experiences on museum websites that may lead to better perceptions of the usability of these websites.

7.2 Limitations of the studies

A limitation of this programme of research is the relatively restricted student samples who participated in the two main empirical studies. Participants of the studies presented in Chapters 3, 4 and 6 were students, mostly from the same universities in UK and Turkey, studying Information Systems or Computer Science. However, most of the related previous studies suffer from the same problem (Bajraktarevic et al., 2003; Popescu, 2008). But, it is clear that these participants are not totally typical of the population of museum visitors. Furthermore, investigating the effects of learning styles and culture on only news and museum websites could be seen as a limitation. However, museum websites are chosen because people who visit museum websites come from various different cultures and addressing the needs of culturally diverse audiences on such websites is both important and interesting as a research topic. In addition, news websites were chosen because many people visit these websites every day, including students, and people would seem to be familiar with their structure. Another limitation of the programme of research is the classroom settings in which the two main empirical studies were conducted (the card sort study and the museum website study which were conducted as part of students' practical work). Behaviour of the participants might be affected because they felt the study was part of the assessment of their course (it was not, and they were assured of this) and they knew that the researchers (who were sometimes their teachers, although not in all cases) were observing them. However, they are not aware of the purpose or expected outcome

of the research, so it is unlikely that they intentionally tried to confirm (or not) to the researcher's expectations.

7.3 Future Work

To overcome some of the limitations of the programme of research and generalize the outcomes from the research, further study needs to be done with a wider range of users and using different multimedia information resources. It would be interesting to conduct the experiments in more realistic settings, with users using multimedia information resources in their own home or work environments.

An exciting next step will be to provide further validation of the (T)ILS by using it with larger and more varied samples of Turkish people. In addition, future work could establish the discriminant validity of the scale, if the (T)ILS can be applied with students from a different major such as business students. Moreover, users' perception of their learning styles can be gathered to assess whether their measured learning style matches their perception of their styles. In additional, the (T)ILS can be used in educational institutions of Turkey to detect the learning styles of their students and to present materials that match their learning styles.

Another promising direction will be to contact museum personnel and share these findings with them to improve their museum websites. If museums are interested in using these concepts, assessment of user experience with actual museum websites that attempt to address the needs of users with different learning styles and cultural background[25].

7.4 Implications for museum website developers

Based on results of this programme of research, it is clear that website developers should be aware of the characteristics of their target audiences, such as learning styles and cultural groups.

For a balanced learning styles profile, web developers should allow Act-Ref users to both experience and think about the information provided. In addition, they should provide Sen-Int users with both hard facts and abstract concepts. They also should provide both visual and verbal cues on websites for Vis-Ver users. Lastly, they should provide information to Seq-Glo users in step by step but also by giving the big picture.

Besides, developers should be aware of using suitable features during website development based on preferences of different cultural groups. For example, images, animations and

[25] In response to a conference presentation about the museum website study, the Anne Frank Museum (http://www.annefrank.org/) has begun to use the learning style concept in evolving its website, so such research may well be possible in collaboration with that museum.

multimedia materials should be provided as well as text to suit users from different cultural backgrounds, particularly if you have Chinese users.

Furthermore, perceived usability of websites can be improved by analyzing users' emotional variations amongst different learning styles and cultural groups.

When developing websites, web developers should keep in mind that they are creating websites to users with different learning styles and cultural groups.

7.5 Re-visited Guidelines on Overall Results

7.5.1 Guidelines for Creating Museum Websites to Suit Users with Different Learning Styles

1. Provide images, animations and multimedia materials as well as text to suit users with differing learning styles
2. Make sure that the content provided is interesting and informative to the users
3. Organize pages and the whole website carefully to correspond as closely as possible to the needs of users
4. Provide search facilities that meet the needs of users
5. Design the individual pages and the whole website carefully to meet the needs of users
6. Provide different navigational options to suit different kinds of users – some users like navigation through text links, some like navigation through images
7. Provide information both as a global overview on one page and as a sequence of items that can be moved through as a sequence of items

7.5.2 Guidelines for Creating Museum Websites to Suit Users with Different Cultural Groups

8. Provide images, animations and multimedia materials as well as text to suit users from different cultural backgrounds, particularly if you have Chinese users
9. Make sure that the content provided is interesting and informative to the users from different cultural groups
10. Provide different navigational options to suit different kinds of users (e.g. Provide navigation through inpage menu for European users)
11. Provide options of text only pages and pages with text and images, as these appeal to users from different cultural groups

12. Provide information both as a global overview on one page and as a sequence of items that can be moved through as a sequence of items, as these options appeal to different cultural groups
13. Provide the option of long pages with lots of information and sequences of pages, which split the information up into small units

Appendix A

A.1 Felder-Solomon Index of Learning Styles (ILS)

Directions.
Enter your answers to every question on the ILS scoring sheet. Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently.

1. I understand something better after I
a) try it out.
b) think it through.

2. I would rather be considered as
a) realistic.
b) innovative.

3. When I think about what I did yesterday, I am most likely to get
a) a picture.
b) words.

4. I tend to
a) understand details of a subject but may be fuzzy about its overall structure.
b) understand the overall structure but may be fuzzy about details.

5. When I am learning something new, it helps me to
a) talk about it.
b) think about it.

6. If I were a teacher, I would rather teach a course
a) that deals with facts and real life situations.
b) that deals with ideas and theories.

7. I prefer to get new information in
a) pictures, diagrams, graphs, or maps.
b) written directions or verbal information.

8. Once I understand
a) all the parts, I understand the whole thing.
b) the whole thing, I see how the parts fit.

9. In a study group working on difficult material, I am more likely to
a) jump in and contribute ideas.
b) sit back and listen.

10. I find it easier
a) to learn facts.
b) to learn concepts.

11. In a book with lots of pictures and charts, I am likely to
a) look over the pictures and charts carefully.
b) focus on the written text.

12. When I solve math problems
a) I usually work my way to the solutions one step at a time.
b) I often just see the solutions but then have to struggle to figure out the steps to get to them.

13. In classes I have taken
a) I have usually gotten to know many of the students.
b) I have rarely gotten to know many of the students.

14. In reading nonfiction, I prefer
a) something that teaches me new facts or tells me how to do something.
b) something that gives me new ideas to think about.

15. I like teachers
a) who put a lot of diagrams on the board.
b) who spend a lot of time explaining.

16. When I am analyzing a story or a novel
a) I think of the incidents and try to put them together to figure out the themes.
b) I just know what the themes are when I finish reading and then I have to go back and find the incidents that demonstrate them.

17. When I start a homework problem, I am more likely to
a) start working on the solution immediately.
b) try to fully understand the problem first.

18. I prefer the idea of
a) certainty.
b) theory.

19. I remember best
a) what I see.
b) what I hear.

20. It is more important to me that an instructor
a) lays out the material in clear sequential steps.
b) gives me an overall picture and relates the material to other subjects.

21. I prefer to study
a) in a study group.
b) alone.

22. I am more likely to be considered as
a) careful about the details of my work.
b) creative about how to do my work.

23. When I get directions to a new place, I prefer
a) a map.
b) written instructions.

24. I learn
a) at a fairly regular pace. If I study hard, I will "get it".
b) in fits and starts. I will be totally confused and then suddenly it all "clicks".

25. I would rather first
a) try things out.
b) think about how I am going to do it.

26. When I am reading for enjoyment, I like writers to
a) clearly say what they mean.
b) say things in creative, interesting ways.

27. When I see a diagram or sketch in class, I am most likely to remember
a) the picture.
b) what the instructor said about it.

28. When considering a body of information, I am more likely to
a) focus on details and miss the big picture.
b) try to understand the big picture before getting into the details.

29. I more easily remember
a) something I have done.
b) something I have thought a lot about.

30. When I have to perform a task, I prefer to
a) master one-way of doing it.
b) come up with new ways of doing it.

31. When someone is showing me data, I prefer
a) charts or graphs.
b) text summarizing the results.

32. When writing a paper, I am more likely to
a) work on (think about or write) the beginning of the paper and progress forward.
b) work on (think about or write) different parts of the paper and then order them.

33. When I have to work on a group project, I first want to
a) have "group brainstorming" where everyone contributes ideas.
b) brainstorm individually and then come together as a group to compare ideas.

34. I consider it higher praise to call someone as
a) sensible.
b) imaginative.

35. When I meet people at a party, I am more likely to remember
a) what they looked like.
b) what they said about themselves.

36. When I am learning a new subject, I prefer to
a) stay focused on that subject, learning as much about it as I can.
b) try to make connections between that subject and related subjects.

37. I am more likely to be considered as
a) outgoing.
b) reserved.

38. I prefer courses that emphasize
a) concrete material (facts, data).
b) abstract material (concepts, theories).

39. For entertainment, I would rather
a) watch television.
b) read a book.

40. Some teachers start their lectures with an outline of what they will cover. Such outlines are
a) somewhat helpful to me.
b) very helpful to me.

41. The idea of doing homework in groups, with one grade for the entire group,
a) appeals to me.
b) does not appeal to me.

42. When I am doing long calculations
a) I tend to repeat all my steps and check my work carefully.
b) I find checking my work tiresome and have to force myself to do it.

43. I tend to picture places I have been
a) easily and fairly accurately.
b) with difficulty and without much detail.

44. When solving problems in a group, I would be more likely to
a) think of the steps in the solution process.
b) think of possible consequences or applications of the solution in a wide range of areas.

A.2 Öğrenme Stilleri Endeksi (ÖDS)/ Felder-Solomon Index of Learning Styles (ILS)

Yönlendirmeler.
Lütfen her soru için tek bir cevap veriniz. Eğer hem "a" hem "b" size uygun görünüyorsa, en sık uyguladığınızı işaretleyiniz.

1. Bir şeyi
a) denedikten
b) üzerinde düşündükten
sonra daha iyi anlarım.

2. Daha çok
a) gerçekçi
b) yenilikçi
biri olarak nitelendirilmeyi tercih ederim.

3. Dün ne yaptığım hakkında düşündüğüm zaman, daha çok
a) bir resim
b) kelimeler
elde ediyorum.

4. a) Konunun detaylarını iyi anlarım ancak genel yapı hakkında pek net olamamaya eğilimim vardır.
b) Konunun genelini çok iyi anlarım ama detaylara tam hakim olamamaya eğilimim vardır.

5. Yeni bir şey öğrenirken
a) o konu hakkında konuşmak
b) o konu hakkında düşünmek
bana yardımcı olur.

6. Eğer bir öğretmen olsaydım
a) olgular ve gerçek hayat durumlarını ele alan
b) fikirler ve teorileri ele alan
bir dersi öğretmeyi tercih ederdim.

7. Yeni bilgileri
a) resimler, şemalar, grafikler veya haritalar
b) yazılı yönlendirmeler veya sözlü bilgiler
olarak almayı tercih ederim.

8. a) Tüm parçaları anladığımda, bütünü anlarım.
b) Bütünü anladığımda, parçaların nasıl uyduğunu görürüm.

9. Çalışma grubunda, zor bir konu üzerine çalışırken, daha çok
a) hemen tartışmaya dâhil olur, görüşlerimle katkıda bulunurum.
b) arkama yaslanır ve dinlerim.

10. a) Olguları
b) Kavramları
öğrenmeyi daha kolay bulurum.

11. Birçok resim ve çizim ile dolu bir kitapta,
a) resimlere ve çizimlere dikkatlice göz gezdiririm
b) yazılı metine odaklanırım.

12. Matematik problemleri çözerken
a) genelde çözümlere adım adım giderim.
b) genellikle çözümleri hemen bulurum ama çözümleri ulaşmak için gerekli adımları anlamaya çalışmam gerekir.

13. Daha önce aldığım derslerde
a) genelde birçok öğrenciyi
b) nadiren sınıftaki öğrencileri
tanırım.

14. Kurgusal olmayan düzyazıda
a) bana yeni olgular öğreteni veya bir şeyi nasıl yapacağımı anlatanı
b) bana düşünmem için yeni fikirler vereni
tercih ederim.

15. a) Tahtaya birçok şema çizen
b) Zamanın çoğunu açıklama yaparak geçiren
öğretmenleri severim.

16. Bir hikâye veya roman analizi yaparken
a) olayları düşünür ve bir araya getirerek konuyu anlamaya çalışırım.
b) okumayı bitirdiğimde konunun ne olduğunu anlarım ve sonra geri dönüp bu konuyu oluşturan olayları bulurum.

17. Bir ev ödevi problemine başladığım zaman, daha çok
a) hemen sonuç üzerinde çalışmaya başlarım.
b) ilk önce problemin tamamını anlamaya çalışırım.

18. a) Kesin
b) Teorik
düşünceyi tercih ederim.

19. En iyi
a) gördüğümü
b) duyduğumu
hatırlarım.

20. Benim için eğitmenin
a) materyali açık ve sıralı adımlarla sunması
b) bütün resmi vermesi ve materyali diğer konularla ilişkilendirmesi
daha önemlidir.

21. a) Bir çalışma grubu içinde
b) Yalnız
çalışmayı tercih ederim.

22. Daha çok
a) çalışmamın detayları hakkında dikkatli
b) çalışmamı nasıl yaptığım hakkında yaratıcı
biri olarak nitelendirilirim.

23. Yeni bir yer için tarif aldığımda
a) bir harita
b) yazılı yönergeleri
tercih ederim.

24. a) Oldukça düzenli adımlarla öğrenirim. Eğer çok çalışırsam, onu elde ederim.
b) Rastgele çalışarak öğrenirim. Tamamen kafam karışır, daha sonra bir anda hepsi yerine oturur.

25. Ben önce birşeyi
a) denemeyi
b) nasıl yapacağım konusunda düşünmeyi
tercih ederim.

26. Eğlenmek için okuduğumda ne demek istediğini
a) açıkça söyleyen
b) yaratıcı, ilginç yollarla ifade eden
yazarları severim.

27. Derste şema ya da çizim gördüğümde, en çok
a) bir resim
b) eğitmenin onun hakkında söylediklerini
hatırlarım.

28. Bir grup bilgiyi değerlendirirken, daha çok
a) detaylara odaklanır ve büyük resmi kaçırırım.
b) detaylara girmeden önce büyük resmi anlamaya çalışırım.

29. a) Yaptığım bir şeyi
b) Üzerinde çok düşündüğüm bir şeyi
daha kolay hatırlarım.

30. Bir görev yerine getirmem gerektiğinde, genelde tercihim
a) o işi yapmanın en iyi yolunu tam öğrenmektir.
b) o işi yapmanın yeni yollarını bulmaktır.

31. Biri veri gösterdiği zaman
a) şema veya grafikleri
b) sonuçları özetleyen metni
tercih ederim.

32. Yazı yazarken, daha çok
a) yazının başı üzerinde çalışırım (düşünürüm veya yazarım) ve ileriye doğru geliştiririm.
b) yazının farklı parçaları üzerine çalışırım (düşünürüm veya yazarım) ve sonra onları sıraya koyarım.

33. Bir grup projesinde çalışmam gerektiğinde, ilk olarak
a) herkesin fikirleriyle katkıda bulunduğu bir beyin fırtınası isterim.
b) bireysel beyin fırtınasından sonra grup ile fikirleri karşılaştırmak için bir araya gelmeyi isterim.

34. Birine
a) mantıklı
b) hayal gücü kuvvetli
diye hitap etmenin daha yüksek bir övgü olduğunu düşünürüm.

35. Bir partide insanlarla tanıştığımda, onların daha çok
a) nasıl göründüklerini
b) kendileri hakkında ne söylediklerini
hatırlarım.

36. Yeni bir konu öğrenirken
a) konu üzerinde odaklanıp, konu hakkında öğrenebildiğim kadar çok şey öğrenmeyi tercih ederim.
b) o konu ve ilgili konular arasında bağlantı kurmaya çalışmayı tercih ederim.

37. Daha çok
a) dışa dönük
b) çekingen
biri olarak nitelendirilirim.

38. a) Somut materyal (olaylar, veri)
b) Soyut materyal (kavramlar, teoriler)
üzerinde duran dersleri tercih ederim.

39. Eğlence için
a) televizyon seyretmeyi
b) kitap okumayı
tercih ederim.

40. Bazı öğretmenler derslerine işleyecekleri konuların ana hatları ile başlarlar. Bu ana hatlar bana
a) biraz
b) çok
yardımcı olur.

41. Bütün gruba bir notun verileceği bir grupta ödev yapma fikri benim için
a) uygundur (çekicidir).
b) uygun değildir (çekici değildir).

42. Uzun hesaplamalar yaptığım zaman,
a) bütün adımlarımı tekrarlama ve işimi dikkatlice kontrol etme eğilimindeyimdir.
b) işimi kontrol etmek yorucu (sıkıcı) bulurum ve kontrol yapmak için kendimi zorlarım.

43. Daha önce bulunduğum yerleri
a) kolay ve oldukça doğru
b) zor ve az detayla
resmetmek eğilimindeyimdir.

44. Grup içinde problem çözerken, ben daha çok
a) çözüm sürecindeki adımları düşünürüm.
b) çözümlerin geniş çaptaki alanlarda olası sonuçlarını ve uygulamalarını düşünürüm.

Appendix B

B.1 Museum and News Websites used in Card Sort Study

Appendix Table B.1 Museum Websites used in Card Sort Study

British Museum	www.britishmuseum.org
Victoria and Albert Museum	www.vam.ac.uk
Natural History Museum	www.nhm.ac.uk
Science Museum	www.sciencemuseum.org.uk
National Museum of Rural Life	www.nms.ac.uk/our_museums/museum_of_rural_life.aspx
National Museum Cardiff	www.museumwales.ac.uk/en/cardiff/
National Museum Australia	http://www.nma.gov.au
Melbourne Museum	http://museumvictoria.com.au/melbournemuseum/
Powerhouse Museum	www.powerhousemuseum.com/
The Metropolitan Museum of Art	www.metmuseum.org/
The J. Paul Getty Museum	www.getty.edu/museum/
National Museum of the American Indian	www.nmai.si.edu/
SFMOMA	www.sfmoma.org/
The Art Institute of Chicago	www.artic.edu/aic/
The Nelson-Atkins Museum of Art	www.nelson-atkins.org/
Welcome to Royal Ontario Museum	www.rom.on.ca/index.php
Royal Tyrrel Museum	www.tyrrellmuseum.com/
Canadian Museum of Civilization	www.civilization.ca/cmc/home/cmc-home
Istanbul Archeological Museums	http://www.istanbularkeoloji.gov.tr/main_page
Pera Museum	http://en.peramuzesi.org.tr/
Topkapi Palace Museum	http://www.topkapisarayi.gov.tr/
Sakip Sabanci Museum	http://muze.sabanciuniv.edu/main/default.php?bytLanguageID=2
Rahmi M. Koc Museum	http://www.rmk-museum.org.tr/english/index.html

Appendix Table B.2 News Websites used in Card Sort Study

The Times	http://www.thetimes.co.uk
The Guardian	http://www.guardiannews.com/
The Independent	http://www.independent.co.uk/
The Globe and Mail	http://www.theglobeandmail.com/
The National Post	http://www.nationalpost.com
The Star	http://www.thestar.com/
Washington Post	http://www.washingtonpost.com/
Chicago Tribune	http://www.chicagotribune.com/
USA Today	http://www.usatoday.com/
Daily Mail	www.dailymail.co.uk

B.2 Priori Groups

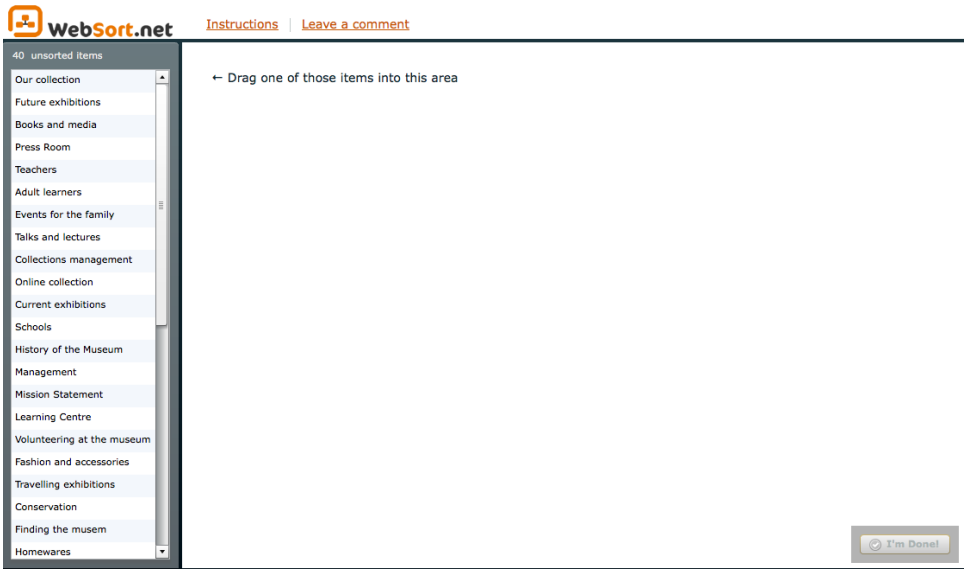
Appendix Table B.3 Museum Priori Groups

Exhibition	Education	Events	Museum
Current exhibitions	Schools	Events calendar	Jobs
Future exhibitions	Teachers	Events for the family	Contact us
Past exhibitions	Online resources	Talks and lectures	Press Room
Travelling exhibitions	Adult learners	Courses and demonstrations	Management
	Learning centre		History of the Museum
			Mission statement
			Volunteering at the museum
The Collection	Visit	Shop	
Our collections	Activities for families and children	Books and media	
Search the collection	Finding the museum	Prints and posters	
Conservation	Opening times	Jewellery	
Online collection	Eat and drink	Fashion and accessories	
Collections management	Access for disabled visitors	Home wares	
Highlights of the collection	Booking tickets	Stationery	
	Family visits	Shops	

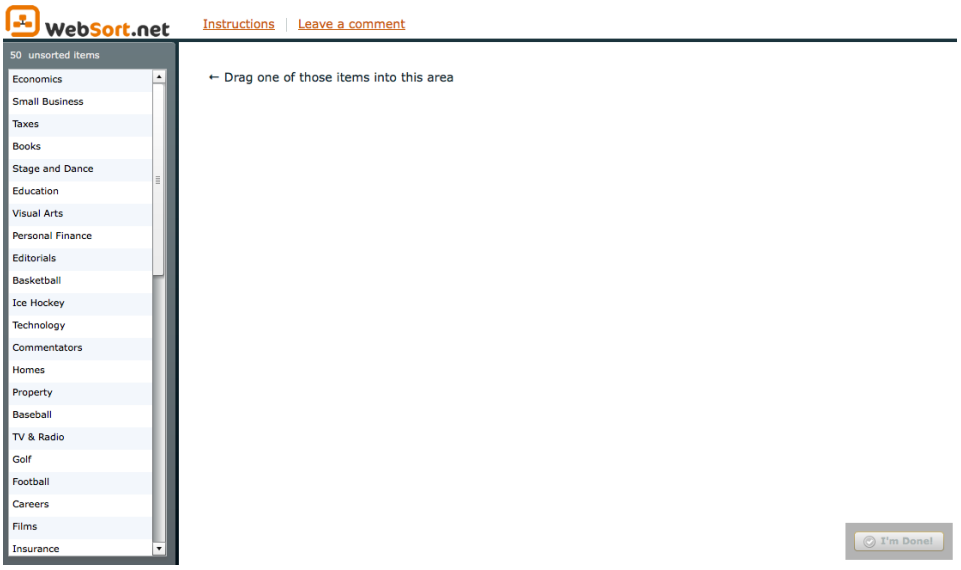
Appendix Table B.4 News Priori Groups

Art	News	Lifestyle	Sport
Films	National	Food and Drink	Football
Books	World	Fashion and Style	Golf
Music	Politics	Health	Tennis
Stage and Dance	Education	Family	Motor Sport
TV & Radio	Science	Homes	Ice Hockey
Comics	Local	Relationships	Baseball
Visual Arts	Technology	Puzzles and games	Basketball
Business	Opinion	Money	
Economics	Columnists	Savings	
Careers	Letters to the Editor	Property	
Small Business	Blogs	Taxes	
Industries	Cartoons	Investments	
Personal Finance	News Discussions	Pensions	
Markets	Editorials	Borrowing	
	Corrections	Insurance	
	Leading articles		
	Commentators		

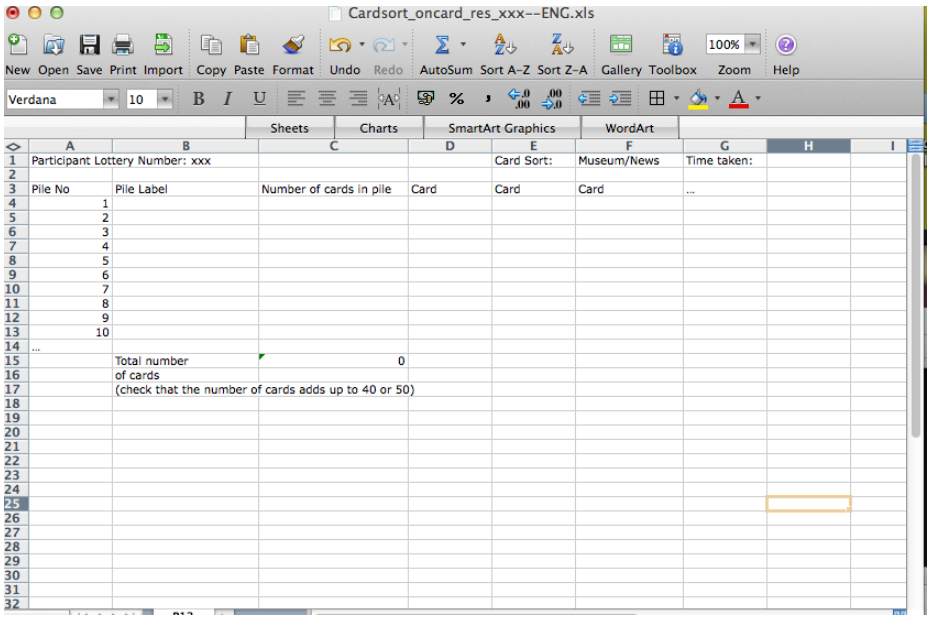
B.3 Screen Shots of Online and Oncard Studies



Appendix Figure B.1 Online Study for Museum Domain



Appendix Figure B.2 Online Study for News Domain



Appendix Figure B.3 Template Spreadsheet for Oncard Study

Appendix C

C.1 Profile of Interviewees

Appendix Table C.1 Profile of Interviewees

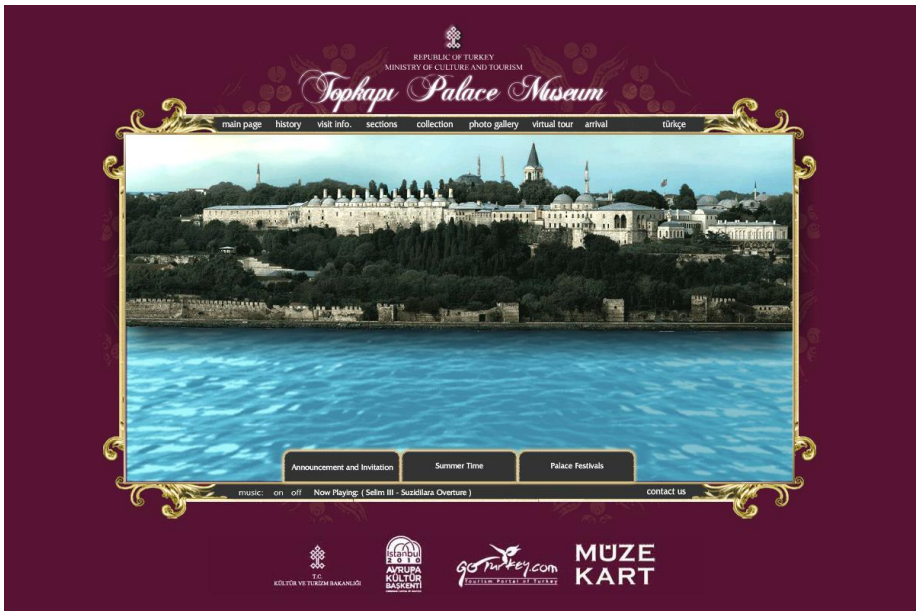
Museum	Position	Age	Sex	Years of experience
Sabanci Museum (Turkey)	Information Technology Responsible	30s	M	8
Koc Museum	Manager of Marketing and Public Relations Department	40s	F	17
Topkapi Museum	Culture and Tourism Specialist Assistant	30s	M	15
Istanbul Archaeological Museum	General Coordinator of Development Projects	30s	F	10
Pera Museum	Manager of Film, Video and Communication Programs	30s	F	8
British Museum (UK)	Head of Web Team	40s	M	15
Wellcome Trust (UK)	Web Editor	30s	M	10
Petrie Museum (UK)	Digital Resources Manager	30s	M	7
Thackray Museum (UK)	Visitor Services Manager	40s	F	10
Metropolitan Museum of Art (USA)	Education and Access Coordinator	30s	F	10

C.2 Interview Questions

Appendix Table C.2 Interview Questions

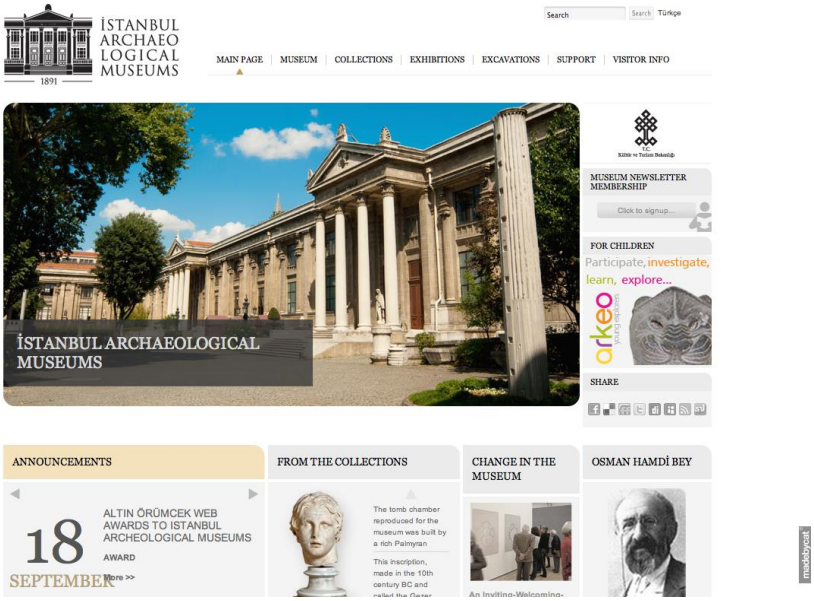
Purpose/Vision for the Website	
Q1	What is the purpose of your website? Is it to help visitors plan their visits? Does it have an educational purpose (if so, for what level of students and how)? Is it for researchers, academics in the particular field of expertise?
Q2	Do you have a vision/mission document for the website? Who is responsible for it?
Q3	Do you have targets for numbers of visitors to the website? Particular types of visitors? Visits to particular pages? Who sets the targets? What are they motivated by?
Organization of the Work	
Q4	Is your web design developed in-house or out-sourced?
Q5	If out-sourced, what kind of relationship do you have with the organization that does the website?
Q6	If out-sourced, what are the criteria for choosing the web development company (accessibility expertise? Domain expertise?)
Q7	Do you do research with visitors about what they want from the website? If so, how do you do that research?
Q8	Do you do user/visitor testing with the website as it is being develop? If so, how is this organized?
Personalization	
Q9	Do you try to provide different experiences on the website for different groups of people – children, families, students?
Q10	If so, how do you do that?
Learning Styles	
Q11	In the design of the website, how do you try to accommodate the needs of visitors with different learning styles?
Cultural Differences	
Q12	Do you know the proportion of visitors to your museum/your website are from overseas? From non-English speaking countries?
Q13	Do you provide information in different languages – print guides, audio guides, website?
Q14	When designing and developing your website, how do you try to accommodate the needs of visitors from different cultures?
Accessibility	
Q15	How do you consider the needs of visitors with disabilities to the website? People with visual disabilities? People with hearing disabilities?
Q16	Do you try to meet a particular WCAG standard on the website?

C.3 Museum Home Pages



Appendix Figure C.1 Topkapi Museum Homepage

Available from: http://www.topkapisarayi.gov.tr [Accessed 01st May 2013]

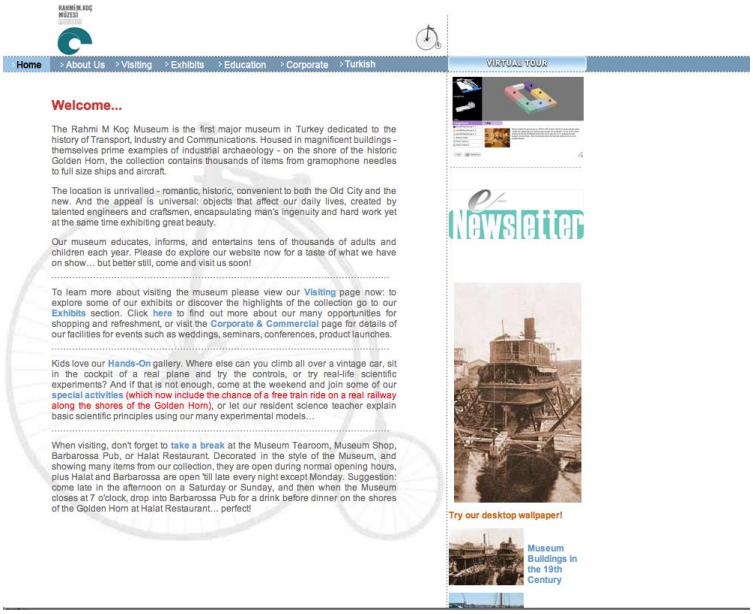


Appendix Figure C.2 Istanbul Archaeological Museum Homepage

Available from: http://www.istanbularkeoloji.gov.tr/main_page [Accessed 01st May 2013]

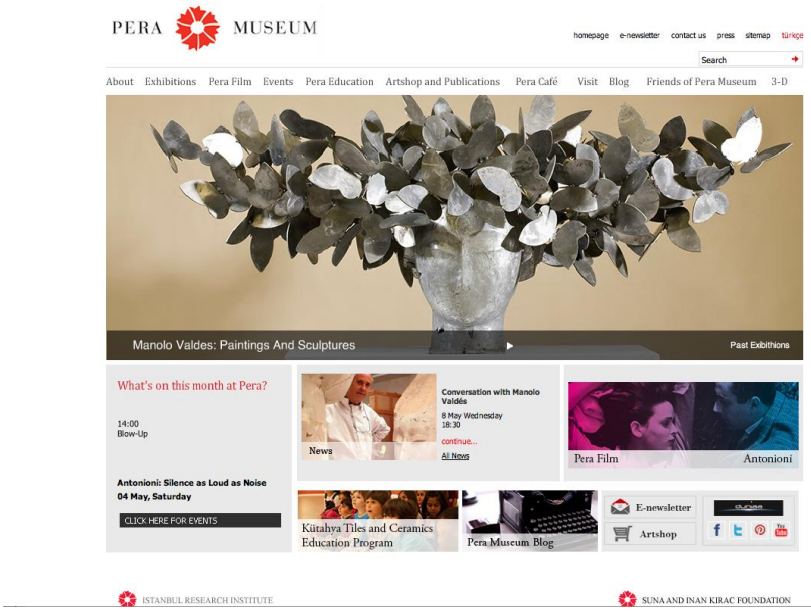
Appendix Figure C.3 Sakip Sabanci Museum Homepage

Available from: http://muze.sabanciuniv.edu/homepage [Accessed 01st May 2013]



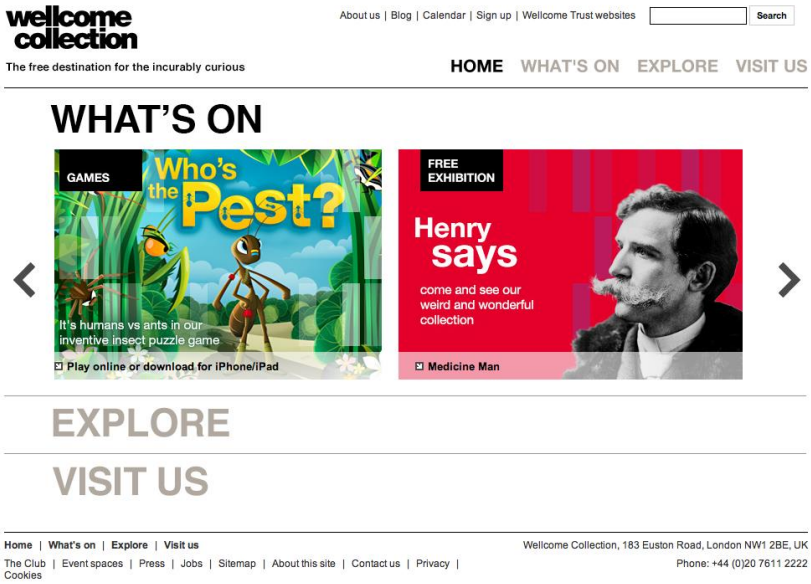
Appendix Figure C.4 Rahmi Koc Museum Homepage

Available from: http://www.rmk-museum.org.tr/english/ [Accessed 01st May 2013]



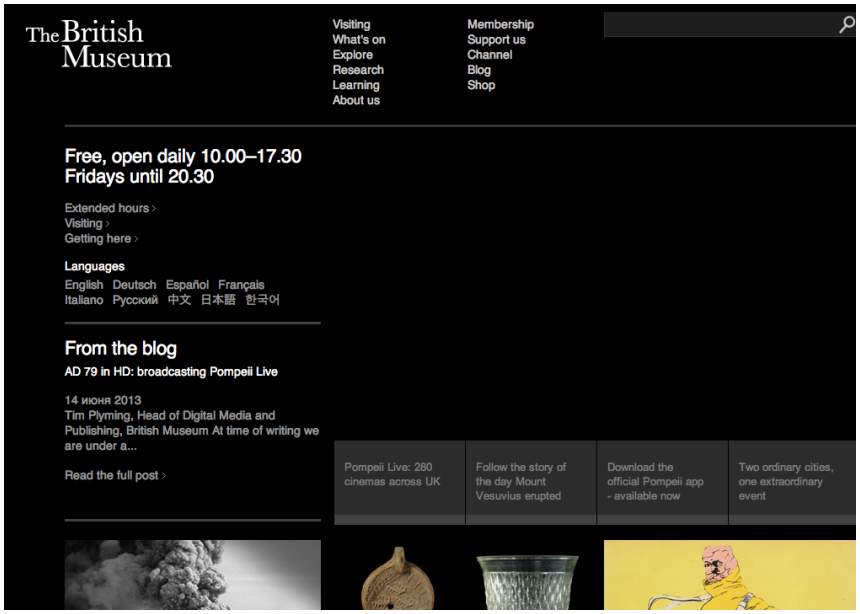
Appendix Figure C.5 Pera Museum Homepage

Available from: http://en.peramuzesi.org.tr [Accessed 01st May 2013]



Appendix Figure C.6 Wellcome Collection Museum Homepage

Available from: http://www.wellcomecollection.org/ [Accessed 21st June 2013]

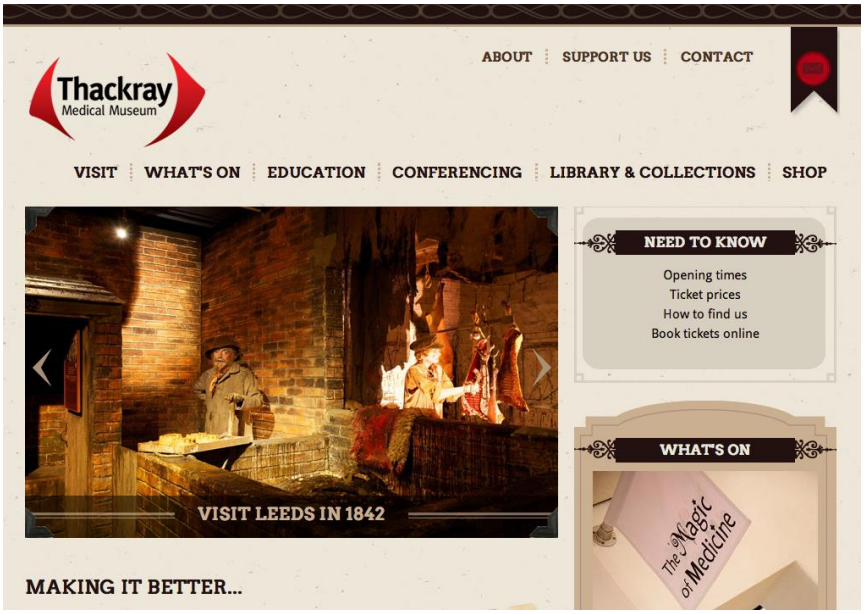


Appendix Figure C.7 The British Museum Homepage

Available from: http://www.britishmuseum.org [Accessed 21st June 2013]

Appendix Figure C.8 The Metropolitan Museum of Art Homepage

Available from: http://www.metmuseum.org [Accessed 21st June 2013]



Appendix Figure C.9 The Thackray Medical Museum Homepage

Available from: http://www.thackraymedicalmuseum.co.uk [Accessed 21st June 2013]

Appendix Figure C.10 The Petrie Museum of Egyptian Archaeology Homepage

Available from: http://www.ucl.ac.uk/museums/petrie [Accessed 21st June 2013]

Appendix D

D.1 Instructions for Participants

Aims

To understand individual differences in the way people learn and interact with information.

To investigate how people with different learning styles interact with web content (to be explained in detail after you have done the practical)

Procedure

You should work individually. Make sure you have a Lottery Number to identify all the different components of your results. If you have not installed the interaction logging script for this practical yet, do so now, following the instructions at: http://www-module.cs.york.ac.uk/hacs/Practicals/ScriptLoggingInstructions.pdf

Open Pre-Study Questionnaire at: https://docs.google.com/a/york.ac.uk/spreadsheet/viewform?formkey=dDhwMVVkdDNpOXhLZmhDMS1tdmpPeFE6MQ#gid=0 In ANOTHER window, open the following web address: http://www.engr.ncsu.edu/learningstyles/ilsweb.html

Complete the ILS of learning styles. The field labelled "Name" will not be stored. Please enter your Lottery number in the field labelled "Voucher ID". After you submit the ILS you will receive a set of results. Enter your Lottery Number and the four scores on the learning styles dimensions into the Pre-Study Questionnaire. Submit the Pre-Study Questionnaire!

Note: If you would like to know more about the different learning styles and strategies you might use that are appropriate for your learning style, have a look at: http://www4.ncsu.edu/unity/lockers/users/f/felder/public/ILSdir/styles.htm

You are going to complete two sets of tasks on museum websites. The two museum websites are: The British Museum and The Wellcome Collection. If you have EVEN one lottery number, do the British Museum tasks and questions first, *then* the Wellcome Collection. If you have an ODD lottery number, do the Wellcome Collection tasks first, *then* the British Museum.

For the British Museum tasks and a form with related questions, visit: https://docs.google.com/a/york.ac.uk/spreadsheet/viewform?formkey=dEpiWEllTkszaHlBOXlqQUxHZXR4dWc6MQ#gid=0 For the Wellcome Collection, tasks and a form with related questions, visit: https://docs.google.com/a/york.ac.uk/spreadsheet/viewform?formkey=dFlSQU1QczNxOXF0Y0J2UzdnQmFGM1E6MQ#gid=0

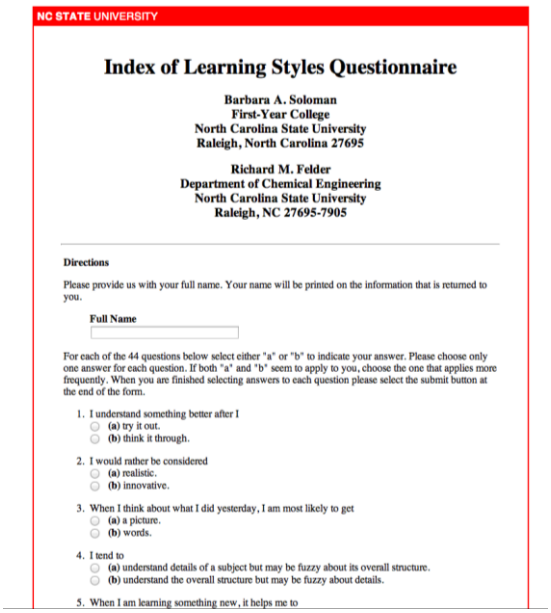
Submit the form for each website when you have completed the tasks and questions.

Finally, go to the Post-Study Questionnaire at: https://docs.google.com/a/york.ac.uk/spreadsheet/viewform?formkey=dGRfdVRRZjJKTEo0ejFZOXNOdjhoSkE6MQ#gid=0

This is a short demographic questionnaire. Complete that questionnaire and submit it.

You have finished!

D.2 Materials



NC STATE UNIVERSITY

Index of Learning Styles Questionnaire

Barbara A. Soloman
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Richard M. Felder
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Directions

Please provide us with your full name. Your name will be printed on the information that is returned to you.

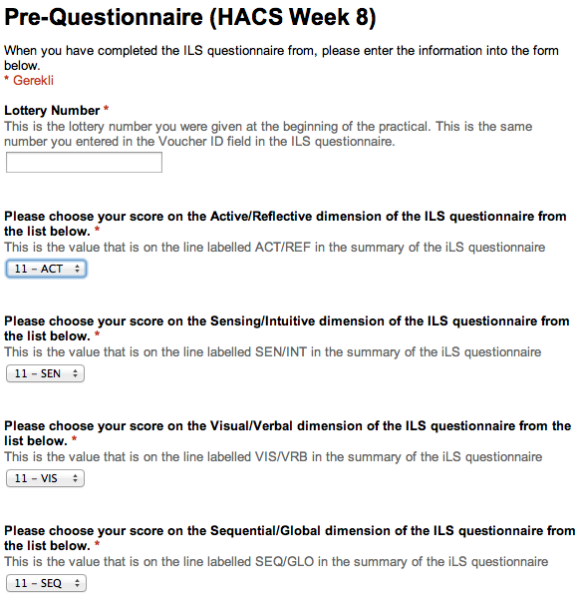
Full Name

For each of the 44 questions below select either "a" or "b" to indicate your answer. Please choose only one answer for each question. If both "a" and "b" seem to apply to you, choose the one that applies more frequently. When you are finished selecting answers to each question please select the submit button at the end of the form.

1. I understand something better after I
   - (a) try it out.
   - (b) think it through.
2. I would rather be considered
   - (a) realistic.
   - (b) innovative.
3. When I think about what I did yesterday, I am most likely to get
   - (a) a picture.
   - (b) words.
4. I tend to
   - (a) understand details of a subject but may be fuzzy about its overall structure.
   - (b) understand the overall structure but may be fuzzy about details.
5. When I am learning something new, it helps me to

Appendix Figure D.1 Online ILS Form

Available from: http://www.engr.ncsu.edu/learningstyles/ilsweb.html [Accessed 01st May 2013]



Pre-Questionnaire (HACS Week 8)

When you have completed the ILS questionnaire from, please enter the information into the form below.
* Gerekli

Lottery Number *
This is the lottery number you were given at the beginning of the practical. This is the same number you entered in the Voucher ID field in the ILS questionnaire.

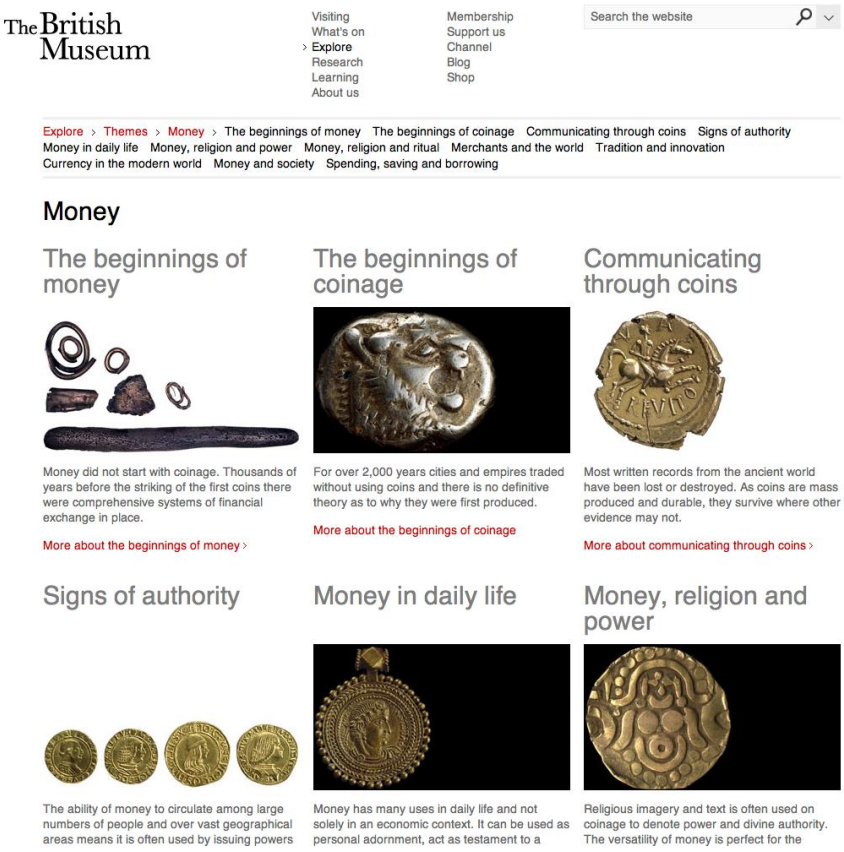
Please choose your score on the Active/Reflective dimension of the ILS questionnaire from the list below. *
This is the value that is on the line labelled ACT/REF in the summary of the iLS questionnaire
11 - ACT

Please choose your score on the Sensing/Intuitive dimension of the ILS questionnaire from the list below. *
This is the value that is on the line labelled SEN/INT in the summary of the iLS questionnaire
11 - SEN

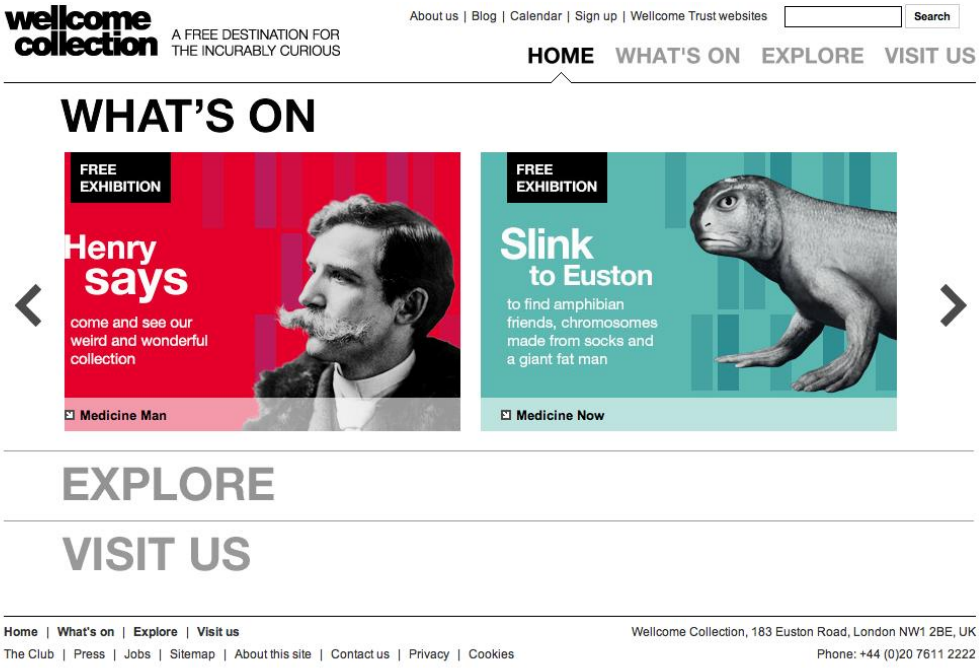
Please choose your score on the Visual/Verbal dimension of the ILS questionnaire from the list below. *
This is the value that is on the line labelled VIS/VRB in the summary of the iLS questionnaire
11 - VIS

Please choose your score on the Sequential/Global dimension of the ILS questionnaire from the list below. *
This is the value that is on the line labelled SEQ/GLO in the summary of the iLS questionnaire
11 - SEQ

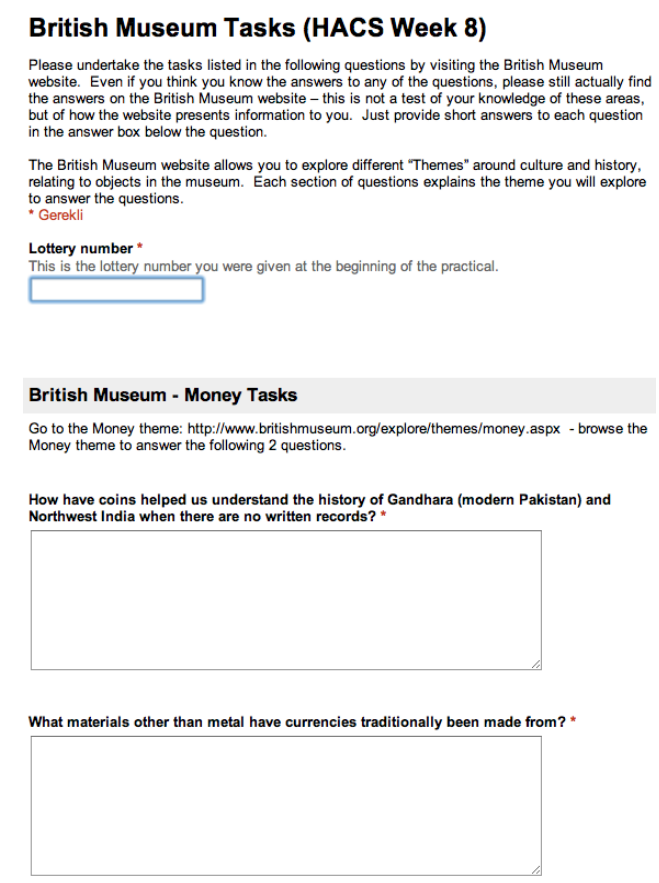
Appendix Figure D.2 Pre-questionnaire



Appendix Figure D.3 British Museum (BM) Homepage



Appendix Figure D.4 Wellcome Collection Museum (WC) Homepage



British Museum Tasks (HACS Week 8)

Please undertake the tasks listed in the following questions by visiting the British Museum website. Even if you think you know the answers to any of the questions, please still actually find the answers on the British Museum website – this is not a test of your knowledge of these areas, but of how the website presents information to you. Just provide short answers to each question in the answer box below the question.

The British Museum website allows you to explore different "Themes" around culture and history, relating to objects in the museum. Each section of questions explains the theme you will explore to answer the questions.

* Gerekli

Lottery number *

This is the lottery number you were given at the beginning of the practical.

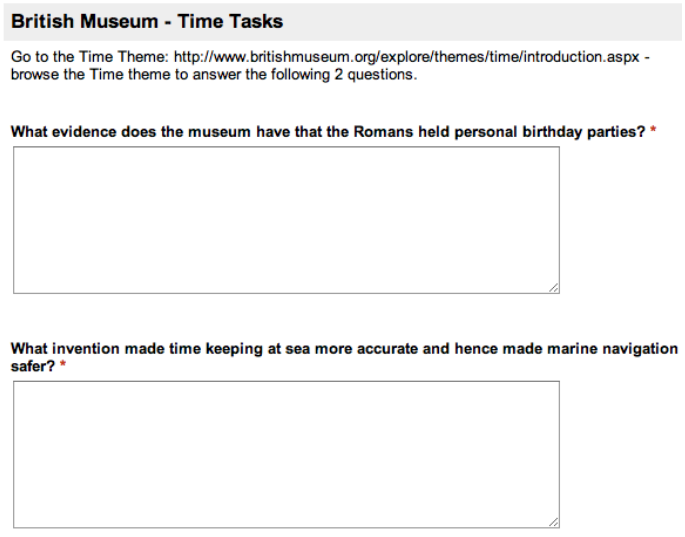
British Museum - Money Tasks

Go to the Money theme: http://www.britishmuseum.org/explore/themes/money.aspx - browse the Money theme to answer the following 2 questions.

How have coins helped us understand the history of Gandhara (modern Pakistan) and Northwest India when there are no written records? *

What materials other than metal have currencies traditionally been made from? *

Appendix Figure D.5 BM Tasks



British Museum - Time Tasks

Go to the Time Theme: http://www.britishmuseum.org/explore/themes/time/introduction.aspx - browse the Time theme to answer the following 2 questions.

What evidence does the museum have that the Romans held personal birthday parties? *

What invention made time keeping at sea more accurate and hence made marine navigation safer? *

Appendix Figure D.6 BM Tasks (Scrolled down)

Post-Task Questions

Please answer the following questions immediately after undertaking the tasks on the British Museum Website.

To what extent did the website make you feel each of the following? *

	1 (Not at all)	2	3	4	5 (Very)
Amused	○	○	○	○	○
Annoyed	○	○	○	○	○
Bored	○	○	○	○	○
Confident	○	○	○	○	○
Confused	○	○	○	○	○
Creative	○	○	○	○	○
Curious	○	○	○	○	○
Disappointed	○	○	○	○	○
Frustrated	○	○	○	○	○
Happy	○	○	○	○	○
Interested	○	○	○	○	○
Hopeful	○	○	○	○	○
Pleased	○	○	○	○	○
Relieved	○	○	○	○	○
Surprised	○	○	○	○	○
Unsure	○	○	○	○	○

Appendix Figure D.7 BM Emotional Word Rating Scale (EWRS)

Questions about the British Museum Website

For following questions, feel free to go back to the pages in the website (examples are provided) to remind yourself of the features being asked about.

On the "Money" introductory page did you prefer to navigate using the menu at the top of the page or through the images and links under those images? *
Money introductory page: http://www.britishmuseum.org/explore/themes/money.aspx

1 2 3 4 5 6 7 8 9

Menus ○ ○ ○ ○ ○ ○ ○ ○ ○ Images/Links

On pages such as "Communicating through coins" and "Tradition and innovation", did you find the large images distracting or attracting? *
Communicating through Coins:
http://www.britishmuseum.org/explore/themes/money/communicating_through_coins.aspx and
Tradition and Innovation:
http://www.britishmuseum.org/explore/themes/money/tradition_and_innovation.aspx

1 2 3 4 5 6 7 8 9

Very Distracting ○ ○ ○ ○ ○ ○ ○ ○ ○ Very Attracting

Did you prefer pages with lots of text and small pictures or the pages with large pictures and a small amount of text? *
Examples of a large amount of text:
http://www.britishmuseum.org/explore/themes/time/personal_time.aspx and a small amount of text:
http://www.britishmuseum.org/explore/themes/money/communicating_through_coins.aspx

1 2 3 4 5 6 7 8 9

Lots of text ○ ○ ○ ○ ○ ○ ○ ○ ○ Small amount of text

Did you prefer the pages which had rather abstract discussion of concepts or pages which had concrete examples? *
Examples of abstract concepts:
http://www.britishmuseum.org/explore/themes/time/measuring_and_keeping_time.aspx and
concrete examples: http://www.britishmuseum.org/explore/themes/time/mechanical_time.aspx

1 2 3 4 5 6 7 8 9

Abstract concepts ○ ○ ○ ○ ○ ○ ○ ○ ○ Concrete examples

Appendix Figure D.8 BM Specific Feature Questionnaire (SFQ)

Did you prefer short pages where you had to click through frequently to get further information or pages where a lot of information was on one page and you needed to read through the page? *

Examples of short pages: http://www.britishmuseum.org/explore/themes/money/tradition_and_innovation.aspx and long pages: http://www.britishmuseum.org/explore/themes/time/mechanical_time.aspx

	1	2	3	4	5	6	7	8	9	
Short pages	○	○	○	○	○	○	○	○	○	Long pages

What did you most like about the British Museum website? *

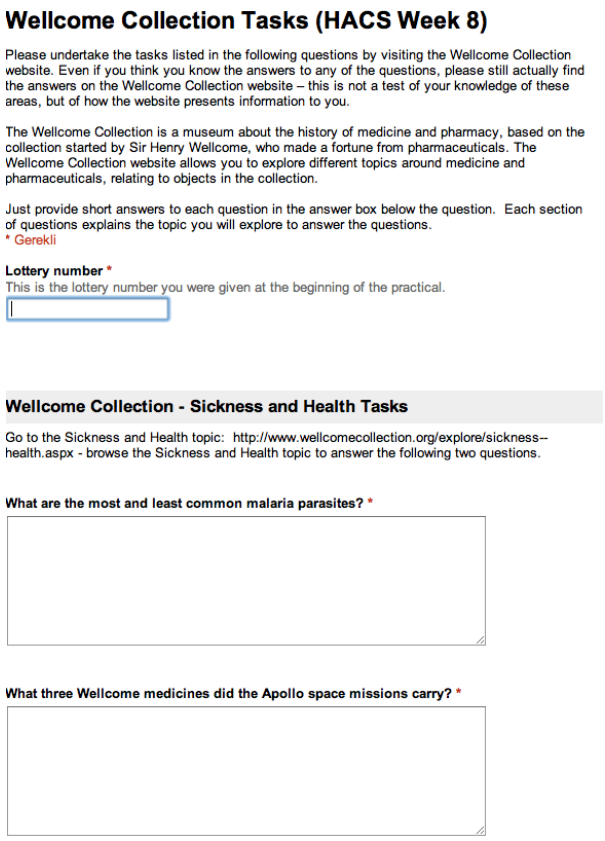
What did you like least about the British Museum website? *

Appendix Figure D.9 BM Specific Feature Questionnaire (SFQ) & Overall Reactions Questionnaire (ORQ)

Please indicate how much you agree or disagree with the following statements. *

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
I think that I would like to use this website frequently.	○	○	○	○	○
I found the website unnecessarily complex.	○	○	○	○	○
I thought the website was easy to use.	○	○	○	○	○
I think that I would need the support of a more technical person to be able to use this website well.	○	○	○	○	○
I found the various functions in this website were well integrated.	○	○	○	○	○
I thought there was too much inconsistency in this website.	○	○	○	○	○
I would imagine that most people would learn to use this website very quickly.	○	○	○	○	○
I found the website very awkward to use.	○	○	○	○	○
I felt very confident using the website.	○	○	○	○	○
I needed to learn a lot of things before I could get going with this website.	○	○	○	○	○

Appendix Figure D.10 BM System Usability Scale (SUS)



Wellcome Collection Tasks (HACS Week 8)

Please undertake the tasks listed in the following questions by visiting the Wellcome Collection website. Even if you think you know the answers to any of the questions, please still actually find the answers on the Wellcome Collection website – this is not a test of your knowledge of these areas, but of how the website presents information to you.

The Wellcome Collection is a museum about the history of medicine and pharmacy, based on the collection started by Sir Henry Wellcome, who made a fortune from pharmaceuticals. The Wellcome Collection website allows you to explore different topics around medicine and pharmaceuticals, relating to objects in the collection.

Just provide short answers to each question in the answer box below the question. Each section of questions explains the topic you will explore to answer the questions.
* Gerekli

Lottery number *
This is the lottery number you were given at the beginning of the practical.

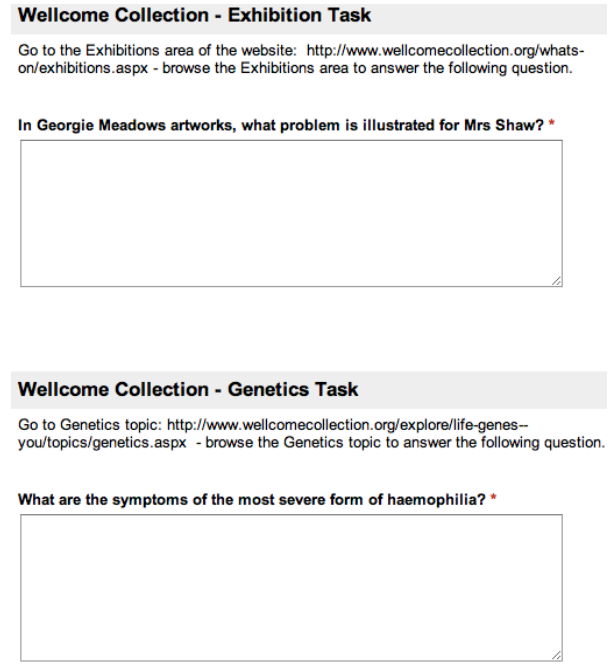
Wellcome Collection - Sickness and Health Tasks

Go to the Sickness and Health topic: http://www.wellcomecollection.org/explore/sickness--health.aspx - browse the Sickness and Health topic to answer the following two questions.

What are the most and least common malaria parasites? *

What three Wellcome medicines did the Apollo space missions carry? *

Appendix Figure D.11 WC Tasks



Wellcome Collection - Exhibition Task

Go to the Exhibitions area of the website: http://www.wellcomecollection.org/whats-on/exhibitions.aspx - browse the Exhibitions area to answer the following question.

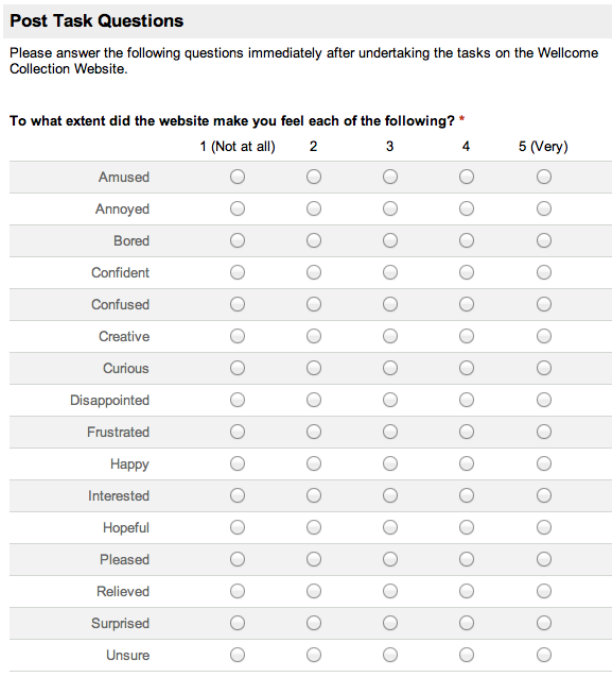
In Georgie Meadows artworks, what problem is illustrated for Mrs Shaw? *

Wellcome Collection - Genetics Task

Go to Genetics topic: http://www.wellcomecollection.org/explore/life-genes--you/topics/genetics.aspx - browse the Genetics topic to answer the following question.

What are the symptoms of the most severe form of haemophilia? *

Appendix Figure D.12 WC Tasks (Scrolled down)



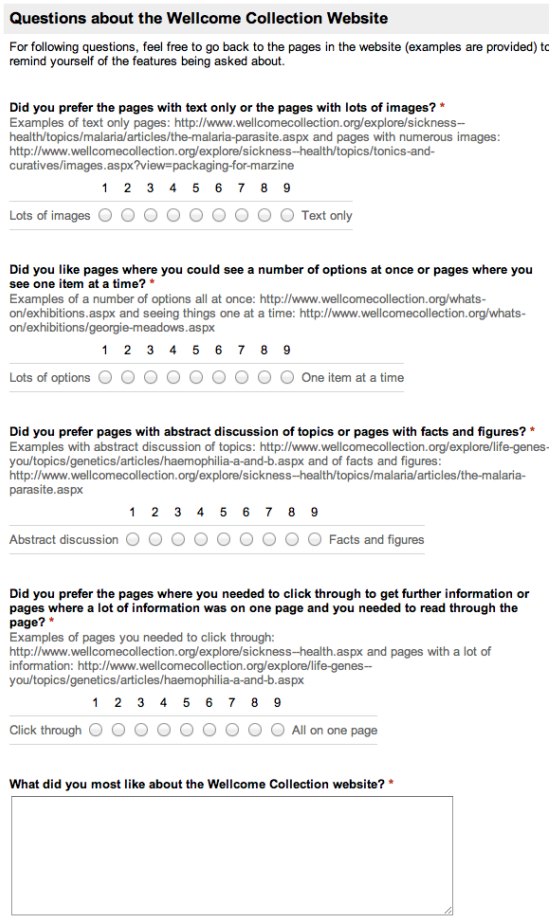
Post Task Questions

Please answer the following questions immediately after undertaking the tasks on the Wellcome Collection Website.

To what extent did the website make you feel each of the following? *

	1 (Not at all)	2	3	4	5 (Very)
Amused	○	○	○	○	○
Annoyed	○	○	○	○	○
Bored	○	○	○	○	○
Confident	○	○	○	○	○
Confused	○	○	○	○	○
Creative	○	○	○	○	○
Curious	○	○	○	○	○
Disappointed	○	○	○	○	○
Frustrated	○	○	○	○	○
Happy	○	○	○	○	○
Interested	○	○	○	○	○
Hopeful	○	○	○	○	○
Pleased	○	○	○	○	○
Relieved	○	○	○	○	○
Surprised	○	○	○	○	○
Unsure	○	○	○	○	○

Appendix Figure D.13 WC Emotional Word Rating Scale (EWRS)



Questions about the Wellcome Collection Website

For following questions, feel free to go back to the pages in the website (examples are provided) to remind yourself of the features being asked about.

Did you prefer the pages with text only or the pages with lots of images? *
Examples of text only pages: http://www.wellcomecollection.org/explore/sickness--health/topics/malaria/articles/the-malaria-parasite.aspx and pages with numerous images: http://www.wellcomecollection.org/explore/sickness--health/topics/tonics-and-curatives/images.aspx?view=packaging-for-marzine

1 2 3 4 5 6 7 8 9

Lots of images ○ ○ ○ ○ ○ ○ ○ ○ ○ Text only

Did you like pages where you could see a number of options at once or pages where you see one item at a time? *
Examples of a number of options all at once: http://www.wellcomecollection.org/whats-on/exhibitions.aspx and seeing things one at a time: http://www.wellcomecollection.org/whats-on/exhibitions/georgie-meadows.aspx

1 2 3 4 5 6 7 8 9

Lots of options ○ ○ ○ ○ ○ ○ ○ ○ ○ One item at a time

Did you prefer pages with abstract discussion of topics or pages with facts and figures? *
Examples with abstract discussion of topics: http://www.wellcomecollection.org/explore/life-genes-you/topics/genetics/articles/haemophilia-a-and-b.aspx and of facts and figures: http://www.wellcomecollection.org/explore/sickness--health/topics/malaria/articles/the-malaria-parasite.aspx

1 2 3 4 5 6 7 8 9

Abstract discussion ○ ○ ○ ○ ○ ○ ○ ○ ○ Facts and figures

Did you prefer the pages where you needed to click through to get further information or pages where a lot of information was on one page and you needed to read through the page? *
Examples of pages you needed to click through: http://www.wellcomecollection.org/explore/sickness--health.aspx and pages with a lot of information: http://www.wellcomecollection.org/explore/life-genes--you/topics/genetics/articles/haemophilia-a-and-b.aspx

1 2 3 4 5 6 7 8 9

Click through ○ ○ ○ ○ ○ ○ ○ ○ ○ All on one page

What did you most like about the Wellcome Collection website? *

Appendix Figure D.14 WC Specific Feature Questionnaire (SFQ) & Overall Reactions Questionnaire (ORQ)

What did you least like about the Wellcome Collection website? *

Please indicate how much you agree or disagree with the following statements. *

	1 (Strongly disagree)	2	3	4	5 (Strongly agree)
I think that I would like to use this website frequently.	○	○	○	○	○
I found the website unnecessarily complex.	○	○	○	○	○
I thought the website was easy to use.	○	○	○	○	○
I think that I would need the support of a more technical person to be able to use this website well.	○	○	○	○	○
I found the various functions in this website were well integrated.	○	○	○	○	○
I thought there was too much inconsistency in this website.	○	○	○	○	○
I would imagine that most people would learn to use this website very quickly.	○	○	○	○	○
I found the website very awkward to use.	○	○	○	○	○
I felt very confident using the website.	○	○	○	○	○
I needed to learn a lot of things before I could get going with this website.	○	○	○	○	○

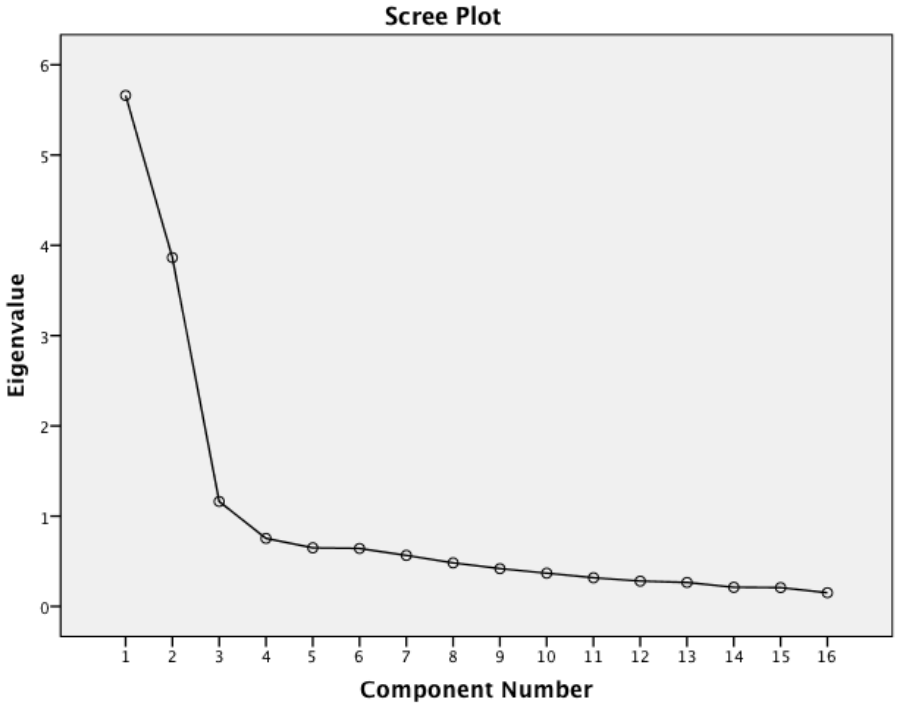
Appendix Figure D.15 WC Overall Reactions Questionnaire (ORQ)& System Usability Scale (SUS)

D.3 Principal Components Analysis (PCA) on EWRS Responses for BM Website

An initial principal components analysis (PCA), without rotation and an unlimited number of components, extracted three components, with the first two components accounting for nearly 60% of the variance in the data. This PCA is illustrated in Appendix Table D.1, below. The screen plot for this PCA, illustrated in Appendix Figure D.16, below, shows two components before the asymptote, so two factors were extracted.

Appendix Table D.1 Initial PCA for EWRS Responses for BM Website

Total Variance Explained						
Comp't	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.661	35.379	35.379	5.661	35.379	35.379
2	3.864	24.150	59.530	3.864	24.150	59.530
3	1.162	7.264	66.794	1.162	7.264	66.794
4	.754	4.710	71.503			
5	.649	4.056	75.559			
6	.642	4.015	79.574			
7	.565	3.533	83.107			
8	.482	3.012	86.119			
9	.419	2.617	88.736			
10	.368	2.300	91.036			
11	.318	1.984	93.021			
12	.280	1.752	94.773			
13	.265	1.657	96.430			
14	.212	1.323	97.754			
15	.208	1.303	99.056			
16	.151	.944	100.000			
Extraction Method: Principal Component Analysis.						



Appendix Figure D.16 Screen Plot for Initial PCA for EWRS Responses for BM Website

Appendix Table D.2 PCA for EWRS Responses for BM Website
(with Varimax Rotation and Two Component Extraction)

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.661	35.379	35.379	5.661	35.379	35.379	5.504	34.398	34.398
2	3.864	24.150	59.530	3.864	24.150	59.530	4.021	25.132	59.530
3	1.162	7.264	66.794						
4	.754	4.710	71.503						
5	.649	4.056	75.559						
6	.642	4.015	79.574						
7	.565	3.533	83.107						
8	.482	3.012	86.119						
9	.419	2.617	88.736						
10	.368	2.300	91.036						
11	.318	1.984	93.021						
12	.280	1.752	94.773						
13	.265	1.657	96.430						
14	.212	1.323	97.754						
15	.208	1.303	99.056						
16	.151	.944	100.000						
Extraction Method: Principal Component Analysis.									

A second PCA was then conducted, using varimax rotation and extracting two components only. This PCA is illustrated in Appendix Table D.2. The component loadings for each item are shown in Appendix Table D.3, below.

Appendix Table D.3 Component Loadings for a Two Components Solution for EWRS for BM Website

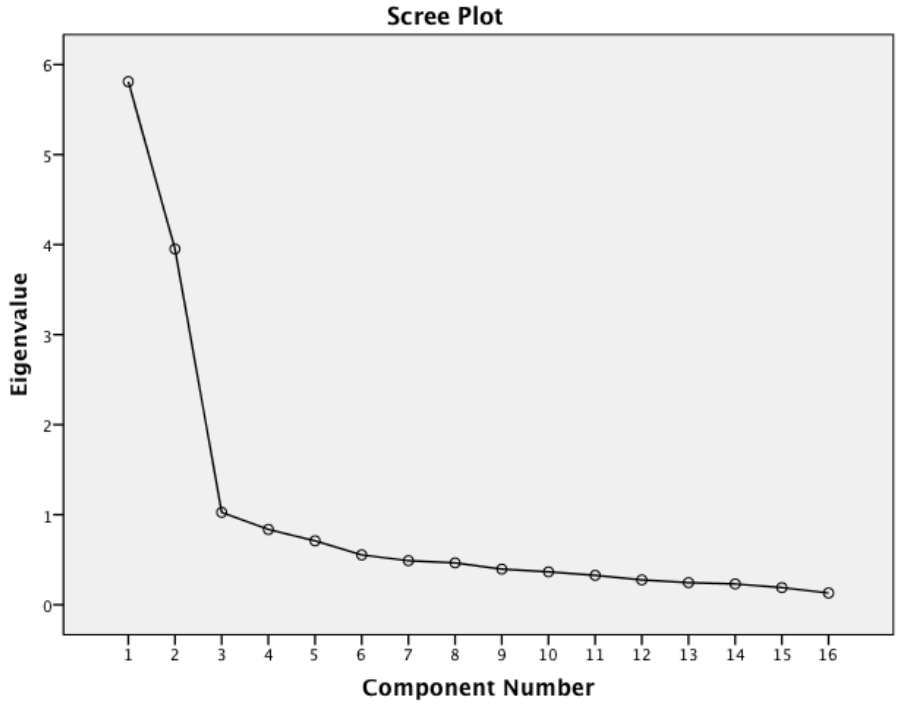
Rotated Component Matrix[a]		
	Component	
	1	2
BMEM1	.746	-.084
BMEM2	.014	.876
BMEM3	-.361	.532
BMEM4	.651	-.047
BMEM5	-.004	.767
BMEM6	.702	-.040
BMEM7	.615	-.287
BMEM8	-.023	.820
BMEM9	-.014	.876
BMEM10	.858	-.051
BMEM11	.622	-.379
BMEM12	.843	.095
BMEM13	.829	-.151
BMEM14	.795	.167
BMEM15	.607	.277
BMEM16	.036	.751
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

D.4 Principal Components Analysis (PCA) on EWRS Responses for WC Website

An initial principal components analysis (PCA), without rotation and an unlimited number of components, extracted three components, with the first two components accounting for nearly 60% of the variance in the data. This PCA is illustrated in Appendix Table D.4, below. The screen plot for this PCA, illustrated in Appendix Figure D.17, below, shows two components before the asymptote, so two factors were extracted.

Appendix Table D.4 Initial PCA for EWRS Responses for WC Website

Total Variance Explained						
Comp't	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.820	36.314	36.314	5.810	36.314	36.314
2	3.952	24.699	61.014	3.952	24.699	61.014
3	1.026	6.414	67.428	1.026	6.414	67.428
4	.836	5.225	72.654			
5	.710	4.438	77.092			
6	.553	3.456	80.548			
7	.489	3.055	83.604			
8	.465	2.905	86.509			
9	.395	2.472	88.981			
10	.365	2.283	91.264			
11	.326	2.039	93.303			
12	.275	1.721	95.024			
13	.245	1.534	96.558			
14	.230	1.440	97.998			
15	.130	.814	100.000			
16	.190	1.188	99.186			
Extraction Method: Principal Component Analysis.						



Appendix Figure D.17 Screen Plot for Initial PCA for EWRS Responses for WC Website

Appendix Table D.5 PCA for EWRS Responses for WC Website
(with Varimax Rotation and Two Components Extraction)

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.810	36.314	36.314	5.810	36.314	36.314	5.636	35.225	35.225
2	3.952	24.699	61.014	3.952	24.699	61.014	4.126	25.788	61.014
3	1.026	6.414	67.428						
4	.836	5.226	72.654						
5	.710	4.438	77.092						
6	.553	3.456	80.548						
7	.489	3.055	83.604						
8	.465	2.905	86.509						
9	.395	2.472	88.981						
10	.365	2.283	91.264						
11	.326	2.039	93.303						
12	.275	1.721	95.024						
13	.245	1.534	96.558						
14	.230	1.440	97.998						
15	.190	1.188	99.186						
16	.130	.814	100.000						
Extraction Method: Principal Component Analysis.									

A second PCA was then conducted, using varimax rotation and extracting two components only. This PCA is illustrated in Appendix Table D.5. The component loadings for each item are shown in Appendix Table D.6, below.

Appendix Table D.6 Component Loadings for a Two Components Solution for EWRS for WC Website

Rotated Component Matrix[a]		
	Component	
	1	2
WCEM1	.717	.181
WCEM2	-.325	.764
WCEM3	-.402	.567
WCEM4	.682	.094
WCEM5	-.159	.801
WCEM6	.698	.158
WCEM7	.688	-.047
WCEM8	-.260	.811
WCEM9	-.325	.798
WCEM10	.782	.194
WCEM11	.730	-.176
WCEM12	.811	.316
WCEM 13	.833	.215
WCEM14	.703	.418
WCEM15	.609	.331
WCEM16	-.208	.737
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

D.5 Data for the Museum Website Study

D.5.1 ILS Data

Lottery Number	Please choose your	Please choose your	Please choose your	Please choose your
999	11 - ACT	9 - SEN	7 - VRB	5 - GLO
14	11 - ACT	11 - SEN	11 - VIS	11 - SEQ
58	3 - REF	3 - INT	7 - VIS	5 - SEQ
29	3 - REF	9 - SEN	1 - VRB	9 - SEQ
31	3 - REF	3 - INT	3 - VRB	1 - GLO
53	9 - REF	9 - SEN	1 - VRB	11 - SEQ
50	5 - REF	9 - SEN	3 - VRB	5 - SEQ
48	7 - REF	3 - SEN	1 - VRB	3 - GLO
24	1 - REF	7 - SEN	11 - VIS	3 - SEQ
33	9 - REF	5 - SEN	3 - VRB	11 - SEQ
14	5 - ACT	5 - SEN	5 - VIS	5 - SEQ
26	9 - ACT	7 - SEN	11 - VIS	5 - SEQ
46	1 - ACT	3 - SEN	11 - VIS	3 - SEQ
34	7 - REF	7 - INT	11 - VRB	9 - GLO
56	5 - ACT	3 - INT	7 - VIS	3 - SEQ
51	7 - REF	1 - INT	7 - VIS	5 - SEQ
1	3 - ACT	1 - SEN	9 - VIS	3 - GLO
41	3 - REF	11 - INT	3 - VIS	7 - GLO
35	7 - REF	1 - INT	1 - VIS	3 - SEQ
15	7 - ACT	9 - INT	11 - VIS	1 - GLO
23	11 - REF	1 - INT	9 - VRB	9 - GLO
52	1 - ACT	1 - SEN	7 - VIS	7 - SEQ
54	9 - ACT	1 - SEN	7 - VIS	1 - SEQ
21	1 - REF	7 - SEN	7 - VIS	3 - SEQ
853697	1 - REF	3 - SEN	3 - VRB	3 - SEQ
59	3 - REF	3 - INT	1 - VRB	5 - SEQ
55	9 - REF	11 - INT	9 - VIS	11 - GLO
49	1 - REF	11 - SEN	3 - VIS	3 - GLO
42	5 - ACT	5 - SEN	7 - VIS	1 - GLO
30	3 - REF	3 - SEN	1 - VIS	5 - SEQ
22	5 - ACT	7 - SEN	9 - VIS	3 - SEQ
60	1 - REF	1 - INT	3 - VIS	1 - GLO
38	3 - REF	3 - SEN	7 - VRB	3 - SEQ
853697	1 - REF	7 - SEN	1 - VRB	7 - SEQ
57	9 - REF	3 - SEN	5 - VIS	5 - GLO
28	9 - ACT	5 - SEN	3 - VIS	9 - SEQ
20	7 - REF	9 - SEN	1 - VIS	7 - SEQ
45	9 - REF	3 - INT	7 - VIS	3 - SEQ
42	5 - ACT	5 - SEN	7 - VIS	5 - GLO
43	1 - REF	3 - SEN	11 - VIS	3 - GLO
25	3 - ACT	9 - SEN	5 - VIS	3 - SEQ
32	1 - REF	3 - SEN	3 - VIS	9 - SEQ
18	9 - ACT	1 - INT	9 - VRB	5 - SEQ
37	3 - REF	1 - SEN	5 - VIS	5 - SEQ
7	1 - REF	1 - INT	11 - VIS	1 - SEQ
39	5 - REF	9 - INT	1 - VRB	1 - GLO
AB853697	3 - ACT	5 - SEN	9 - VIS	1 - SEQ
40	1 - REF	5 - SEN	7 - VIS	5 - SEQ
13	11 - ACT	1 - SEN	7 - VIS	3 - GLO
AB 853697	3 - REF	7 - SEN	3 - VIS	1 - GLO
36	5 - REF	1 - INT	1 - VRB	3 - SEQ

Appendix Figure D.18 ILS Data

D.5.2 EWRS Data

Lottery number	To what extent did the website make you feel each of the following? [Amused]	To what extent did the website make you feel each of the following? [Annoyed]	To what extent did the website make you feel each of the following? [Bored]	To what extent did the website make you feel each of the following? [Confident]
997	1 (Not at all)	2	3	4
29	1 (Not at all)	3	4	3
33	1 (Not at all)	1 (Not at all)	2	1 (Not at all)
23	2	3	4	3
31	1 (Not at all)	3	2	1 (Not at all)
41	1 (Not at all)	1 (Not at all)	2	4
55	5 (Very)	2	1 (Not at all)	4
15	3	3	4	4
853697	1 (Not at all)	2	3	4
59	2	4	3	3
53	2	3	1 (Not at all)	4
1	3	3	4	3
51	1 (Not at all)	1 (Not at all)	3	2
35	1 (Not at all)	3	2	2
7	1 (Not at all)	1 (Not at all)	3	2
49	1 (Not at all)	2	4	1 (Not at all)
45	1 (Not at all)	1 (Not at all)	2	1 (Not at all)
21	1 (Not at all)	3	4	2
48	1 (Not at all)	4	4	3
853697	2	2	2	2
39	1 (Not at all)	2	3	1 (Not at all)
56	4	2	3	4
25	1 (Not at all)	4	4	2
50	4	2	2	4
14	1 (Not at all)	3	3	3
57	2	2	3	3
13	3	1 (Not at all)	2	3
28	1 (Not at all)	5 (Very)	5 (Very)	2
46	1 (Not at all)	3	5 (Very)	1 (Not at all)
26	1 (Not at all)	1 (Not at all)	4	1 (Not at all)
32	3	1 (Not at all)	5 (Very)	1 (Not at all)
47	4	2	3	3
24	1 (Not at all)	2	3	4
43	3	3	4	3
42	3	3	2	3
34	1 (Not at all)	5 (Very)	2	3
58	1 (Not at all)	1 (Not at all)	1 (Not at all)	1 (Not at all)
52	1 (Not at all)	1 (Not at all)	1 (Not at all)	4
18	1 (Not at all)	2	3	1 (Not at all)
40	1 (Not at all)	1 (Not at all)	5 (Very)	1 (Not at all)
54	1 (Not at all)	3	1 (Not at all)	1 (Not at all)
22	1 (Not at all)	3	1 (Not at all)	3

Appendix Figure D.19 EWRS Data

D.5.3 SFQ Data

Lottery number	Did you prefer the pages with text only or the pages with lots of images?	Did you like pages where you could see a number of options at once or pages where you see one item at a time?	Did you prefer pages with abstract discussion of topics or pages with facts and figures?	Did you prefer the pages where you needed to click through to get further information or pages where a lot of information was on one page and you needed to read through the page?
29	7	9	4	9
33	7	3	7	7
23	5	4	3	7
31	7	8	4	8
41	4	8	2	7
55	2	7	4	8
15	4	1	4	3
853697	7	2	8	7
59	6	2	2	8
53	7	2	8	5
1	7	7	7	7
51	3	6	3	8
35	4	3	7	7
7	2	3	7	9
49	7	1	8	7
45	1	1	3	8
21	3	4	8	9
48	8	7	6	7
853697	5	6	5	9
39	6	3	3	7
56	7	1	9	7
25	7	7	2	3
50	3	4	8	7
14	7	3	4	7
57	6	1	5	1
13	3	3	8	1
28	9	1	9	9
46	5	7	2	7
26	5	1	8	7
32	3	7	7	9
47	3	3	7	7
24	3	3	7	7
43	2	7	3	6
42	2	2	6	5
34	3	2	7	7
58	5	3	4	4
52	6	7	7	7
18	2	2	7	3
40	1	1	1	9
54	7	1	8	4
22	4	6	9	6
38	5	3	6	5

Appendix Figure D.20 SFQ Data

D.5.4 ORQ Data

Lottery number	What did you most like about the Wellcome Collection website?	What did you least like about the Wellcome Collection website?
29	It presented	It was very difficult to
33	The topics were	It was sometimes
23	nicely presented	too many pages to
31	Was well presented	Search didn't work,
41	Intuitive layout	Could fit more
55	The topics it covered,	At some times the
15	The main menu's	Certain information
853697	The navigation	The spelling of the
59	Interesting design,	Hard to find what
53	Very organised menu	The search function
1	Looks clean, minimal	Slightly
51	Not a lot. I'm not very	Having to click
35	The layout of the	The difficulty in
7	Fairly easy to	Some articles were
49	Side Menu	Layout of content
45	The layout of the	The quick notes
21	Bright colour scheme	Hard to navigate to
48	Overall navigation	Individual topics were
853697	Mix of topics	Occasionally slow to
39	Organization through	Slow interface when
56	Not a lot of waffle.	Lack of detail
25	Easy to find	Difficult to find the
50	The information	Some pages were
14	The way it was laid	Sometimes very little
57	I liked the structure	trying to find
13	That it has not only	that you don't know in
28	Nothing	Nothing
46	Well presented.	Boring.
26	The layout	Some things weren't
32	Homepage was	The topic.
47	Interesting artistic	white background,
24	I liked that the links	I found it difficult to
43	web page deign	Some article is too
42	Simple clear	Some information
34	The range of options	Waiting for
58	The individual icons	Often the articles
52	I liked the menu	I was difficult to scroll
18	The user interface at	The georgie
40	the lay-out	garish colour on left
54	Range of info	Lack of clarity.
22	It was factual.	I found the content
38	Lots of info on the	Topics can get

Appendix Figure D.21 ORQ Data

D.5.5 SUS Data

Lottery number	Please indicate how much you agree or disagree with the following statements. [I think that I would like to use this website frequently.]	Please indicate how much you agree or disagree with the following statements. [I found the website unnecessarily complex.]	Please indicate how much you agree or disagree with the following statements. [I thought the website was easy to use.]	Please indicate how much you agree or disagree with the following statements. [I think that I would need the support of a more technical person to be able to use this website well.]
29	1 (Strongly disagree)	5 (Strongly agree)	2	1 (Strongly disagree)
33	2	4	3	1 (Strongly disagree)
23	2	4	2	2
31	2	2	3	1 (Strongly disagree)
41	2	2	4	1 (Strongly disagree)
55	5 (Strongly agree)	3	3	1 (Strongly disagree)
15	2	2	4	1 (Strongly disagree)
853697	2	1 (Strongly disagree)	5 (Strongly agree)	1 (Strongly disagree)
59	1 (Strongly disagree)	4	2	1 (Strongly disagree)
53	4	2	3	1 (Strongly disagree)
1	2	5 (Strongly agree)	3	1 (Strongly disagree)
51	1 (Strongly disagree)	2	3	2
35	1 (Strongly disagree)	4	2	5 (Strongly agree)
7	2	3	3	1 (Strongly disagree)
49	1 (Strongly disagree)	4	2	1 (Strongly disagree)
45	3	3	5 (Strongly agree)	1 (Strongly disagree)
21	1 (Strongly disagree)	4	3	1 (Strongly disagree)
48	1 (Strongly disagree)	4	2	2
853697	2	2	4	2
39	2	2	3	1 (Strongly disagree)
56	4	1 (Strongly disagree)	4	1 (Strongly disagree)
25	2	4	2	2
50	2	1 (Strongly disagree)	4	1 (Strongly disagree)
14	3	2	3	1 (Strongly disagree)
57	1 (Strongly disagree)	2	3	1 (Strongly disagree)
13	3	3	4	1 (Strongly disagree)
28	1 (Strongly disagree)	1 (Strongly disagree)	1 (Strongly disagree)	3
46	1 (Strongly disagree)	2	3	1 (Strongly disagree)
26	3	2	4	1 (Strongly disagree)
32	1 (Strongly disagree)	5 (Strongly agree)	1 (Strongly disagree)	1 (Strongly disagree)
47	2	2	4	1 (Strongly disagree)
24	2	1 (Strongly disagree)	3	1 (Strongly disagree)
43	4	2	4	3
42	4	1 (Strongly disagree)	4	1 (Strongly disagree)
34	1 (Strongly disagree)	3	2	1 (Strongly disagree)
58	2	1 (Strongly disagree)	4	1 (Strongly disagree)
52	2	2	4	1 (Strongly disagree)
18	2	3	4	1 (Strongly disagree)
40	1 (Strongly disagree)	1 (Strongly disagree)	5 (Strongly agree)	1 (Strongly disagree)
54	1 (Strongly disagree)	2	2	1 (Strongly disagree)
22	1 (Strongly disagree)	2	5 (Strongly agree)	1 (Strongly disagree)
38	1 (Strongly disagree)	2	4	2

Appendix Figure D.22 SUS Data

D.5.6 Demographic Data

Lottery number	What is your age?	What is your sex?	What is your	Is English your	If English is not
999	36	Male	Canada	No	4
29	19	Male	England	Yes	
23	20	Male	UK	Yes	
51	19	Male	UK	Yes	
33	18	Male	United Kingdom	Yes	
31	19	Male	England	Yes	
41	20	Male	England	Yes	
48	18	Male	England / UK	Yes	5
853697	18	Male	UK	Yes	5
50	18	Male	England	Yes	
56	18	Male	England	Yes	
28	19	Male	England	Yes	
46	19	Male	Wales	Yes	
55	19	Male	Lithuania	No	5
853697	18	Male	United Kingdom	Yes	5
26	18	Male	England	Yes	
32	18	Male	UK	Yes	
15	18	Male	England	Yes	
59	18	Male	England	Yes	
53	18	Male	England	Yes	
1	18	Male	England	Yes	
24	18	Female	UK	Yes	
42	18	Male	England	Yes	
7	18	Male	United Kingdom	Yes	
AB853697	20	Female	Malaysia	No	3
35	18	Female	UK	Yes	
49	18	Male	England	Yes	
34	18	Male	England	Yes	
58	18	Male	New Zealand	Yes	
21	18	Female	England	Yes	
25	18	Male	England	Yes	
52	18	Female	United Kingdom	Yes	
13	18	Male	Lithuania	No	5
18	19	Male	England	Yes	
40	18	Male	England	Yes	
54	18	Male	United Kingdom	Yes	
22	18	Male	England	Yes	
38	19	Male	Bulgaria	No	5
57	18	Male	UK	Yes	
19	21	Male	England	Yes	
30	19	Male	United Kingdom of	Yes	
39	18	Male	England	Yes	
45	18	Male	United Kingdom	Yes	
60	18	Male	England	Yes	
43	20	Male	China	No	3
6	19	Male	England	Yes	
20	18	Male	England	Yes	
47	20	Male	Slovakia	No	5
44	17	Male	India	No	5
37	18	Male	England	Yes	
36	18	Male	England	Yes	
17	19	Female	Bulgaria	No	4

Appendix Figure D.23 Demographic Data

D.5.7 Tasks Data

Timestamp	Lottery number	What are the most	What three	In Georgie Meadows	What are the	
11/27/2012 12:45:34	997	Sick 1	Sick 2	Exhibition 1	Genetics 1	1
11/27/2012 14:42:12	29	The most common	Apollo Spaceships	Mrs Shaw is hungry	In the most severe	1
11/27/2012 14:45:01	33	Most - P. vivax	Marzine, Actifed,	She is hungry but	significant delay in	1
11/27/2012 14:46:18	23	The most common	'Marzine', 'Actifed'	Mrs Shaw is hungry	Sickle cell anaemia	
11/27/2012 14:46:57	31	The most common	Marzine	Aging and dementia	there is a significant	1
11/27/2012 14:49:05	41	The most common	'Marzine', 'Actifed',	Mrs Shaw is hungry	bleeding,	1
11/27/2012 14:49:24	55	Most common: P.	Marzine, Actifed,	Mrs Shaw is hungry	Significant delay in	5
11/27/2012 14:50:15	15	Most - P. vivax	Marzine	Mrs Shaw is hungry	A significant delay in	
11/27/2012 14:51:29	853697	Most Common: P.	'Marzine', 'Actifed',	The primacy of visual	Significant delay in	1
11/27/2012 14:51:31	59	The most common	Marzine,Actifed,Neos	dementia	there is a significant	
11/27/2012 14:53:31	53	P. vivax is the most	Marzine, Actifed and	She is hungry but the	Bleeding,	
11/27/2012 14:53:48	1	P. vivax is the most	Marzine, Actifed and	She is hungry but	A significant delay in	
11/27/2012 14:54:20	51	Most common =	Marzine, Actifed,	Her brain no longer	In both types of	1
11/27/2012 14:54:20	35	Most common: P.	Marzine	Mrs Shaw is hungry	Spontaneous	1
11/27/2012 14:54:28	7	The most common	Marzine, Actifed and	Mrs Shaw is hungry	In the most severe	1
11/27/2012 14:54:29	49	The most common	- Marzine	Mrs Shaw is hungry	There is a significant	1
11/27/2012 14:56:43	45	The most common	Marzine	The part of her brain	In the most severe	1
11/27/2012 14:57:01	21	Most common - P.	Marzine, Actifed and	She is hungry but her	Bleeding,	1
11/27/2012 14:59:19	48	Most common: P.	Marzine	Mrs Shaw is hungry	A	1
11/27/2012 14:59:27	853697	P. Vivax Infection and	Marzine, Actifed and	Hungry but forgot	Abnormal blood flow	
11/27/2012 15:00:44	39	The most common	Apollo Spaceships	Mrs Shaw is hungry	In the most severe	1
11/27/2012 15:00:53	56	P. vivax is the most	Marzine, Actifed and	Mrs Shaw is hungry	Abnormal blood flow	
11/27/2012 15:01:00	25	The most common is	Marzine, Actifed and	She has a	abnormal blood flow	1
11/27/2012 15:01:01	50	Most common: P.	Marzine for motion	"Mrs Shaw is hungry	Delay in the blood	
11/27/2012 15:02:18	14	The most common	Apollo Spaceships	a woman is hungry	joint deformity	1
11/27/2012 15:02:21	57	P. vivax is the most	Marzine ,Actified and	she is hungry but her	delay in blood clotting	
11/27/2012 15:03:04	13	Most common P.	Marzine	Mrs Shaw is hungry	there is a significant	
11/27/2012 15:03:29	28	P vivax is the most	marzine, actified,	she cannot	Cannot find answer.	1
11/27/2012 15:04:03	46	P. Vivax is the most	Marzine, Actifed,	She is hungry but she	Protracting bleeding,	1
11/27/2012 15:04:18	26	The most common	Marzine, Actifed and	She is hungry but the	A significant delay in	1
11/27/2012 15:04:34	32	The malaria parasite	In the late 19th	Not obvious.	Symptoms	
11/27/2012 15:06:05	47	The most common	Marzine, Actifed and	Mrs Shaw is hungry	Significant delay in	
11/27/2012 15:06:08	24	The most common	The apollo space	The problem that she	In the severest	1
11/27/2012 15:06:25	43	mosquitoes	Marzine	Meadows' works are	In the most severe	
11/27/2012 15:07:36	42	Least - P. ovale	Marzine, Actifed and	She is hungry but her	Significant delay in	
11/27/2012 15:10:00	34	Most common:	Marzine	She has lost the	Prolonged bleeding	1
11/27/2012 15:11:05	58	Most common: P.	Marzine	Mrs. Shaw is hungry,	Bleeding,	1
11/27/2012 15:12:12	52	The most common	They carried Marzine,	Mrs Shaw is hungry,	In the severe cases,	1
11/27/2012 15:13:04	18	The most common	Marzine, Actifed and	The part of her brain	There is a delay in	1
11/27/2012 15:14:12	40	The most common	Marzine, Actifed,	Mrs Shaw is hungry	In the most severe	1
11/27/2012 15:15:11	54	The most common	Marzine - against	(unsure)	(Couldn't find answer)	1
11/27/2012 15:15:16	22	Plasmodium parasite	Marzine, Actifed &	Mrs Shaw is hungry	Significant delay in	1
11/27/2012 15:16:21	38	The most common	Apollo Spaceships	Either a woman finds	In the most severe	1
11/27/2012 15:17:22	30	P. = Plasmodium: P.	Marzine(Travel	She is hungry but the	A significant delay in	
11/27/2012 15:17:43	19	The most common is	'Marzine', 'Actifed',	Dementia.	In the most severe of	1
11/27/2012 15:21:33	60	The most common	'Marzine' as a	Personal experiences	An abnormal blood	
11/27/2012 15:27:21	37	The most common is	Marzine, Actifed and	Aging and dementia	Delayed blood	1
11/27/2012 15:31:24	6	The most common	Apollo Spaceships	Meadows' concern	Haemophilia A and B	1
11/27/2012 15:32:44	20	The most common	They carried	She needs to eat, but	Significant delay in	
11/27/2012 15:36:45	17	P. vivax is the most	'Marzine', 'Actifed',	Meadows creates	bleeding,	1
11/27/2012 15:37:41	44	Most common - P.	Actifed' relieved	She figures that	in the most severe	1
11/27/2012 15:46:35	36	most common:	Marzine; Actifed;	Dementia	pass	1
11/28/2012 12:05:13	213	The most common	Marzine	Mrs Shaw is hungry	The severe forms of	

Appendix Figure D.24 Tasks Data

D.6 Summary Result Tables for the Museum Website Study

Table D.7 Results on effects of Learning Styles on User Experience variables

Measure	Dimension	Statistics	Interpretation
Emotional Wording Scale (EWRS) Scores			
British Museum			
Positive Scores	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	F = 2.79, df = 7, 134 p < 0.01	See Figure 6.31 Apart from Moderately Glo participants, there is a general trend from less positive Seq participants to more positive Glo participants
Negative Scores	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	F = 2.13, df = 7, 134 p < 0.05	See Figure 6.32 Apart from Highly/Very Strongly Seq participants, Glo participants are more negative about the website than the other participants
Wellcome Collection			
Positive Scores	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Negative Scores	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Overall Reactions Questionnaire (ORQ)			
British Museum			
Use of images, animations, multimedia	Act-Ref	Chi-square = 6.43, df = 2, p < 0.05	Act participants mentioned this category as a positive aspect of the website significantly more frequently than Balanced Act-Ref and Ref participants
	Sen-Int	n.s.	
	Vis-Ver	Chi-square = 11.0, df = 2, p < 0.05	Vis participants mentioned this category as a positive aspect of the website significantly more frequently than Balanced Vis-Ver and Ver participants
	Seq-Glo	n.s.	
Content – type of content (e.g. interesting, factual, ranged, useless, or informative content)	Act-Ref	Chi-square = 8.07, df = 2, p < 0.05	Act participants mentioned this category as a negative aspect of the website significantly more frequently than Balanced Act-Ref and Ref participants
	Sen-Int	n.s.	
	Vis-Ver	n.s.	

	Seq-Glo	n.s.	
Content – amount of content (too little, too much)	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Design of the pages/website	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Organization of the pages/website	Act-Ref	Chi-square = 6.76, df = 2, p < 0.05	Ref participants mentioned this category as a negative aspect of the website significantly more frequently than Act and Balanced Act-Ref participants
	Sen-Int	Chi-square = 7.64, df = 2, p < 0.05	Balanced Sen-Int participants mentioned this category as a positive aspect of the website significantly more frequently than Sen and Int participants
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Navigation (includes on menus)	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	Chi-square = 8.32, df = 2, p < 0.05	Ver participants mentioned this category as a negative aspect of the website significantly more frequently than Vis and Balanced Vis-Ver participants
	Seq-Glo	n.s.	
Search facilities (or lack of)	Act-Ref	Chi-square = 14.4, df = 2, p < 0.05	Balanced Act-Ref participants mentioned this category as a negative aspect of the website significantly more frequently than Act and Ref participants
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Miscellaneous (speed, language option, not suited to tasks) – not enough examples for coding or not relevant (not suited to tasks)	Act-Ref	n.s.	
	Sen-Int	Chi-square = 7.33, df = 2, p < 0.05	Int participants mentioned this category as a negative aspect of the website significantly more frequently than Sen and Balanced Sen-Int participants
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Comments on balance between text and images	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Wellcome Collection Museum			
Use of images, animations, multimedia	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	

	Seq-Glo	n.s.	
Content – type of content (e.g. interesting, factual, ranged, useless, or informative content)	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Content – amount of content (too little, too much)	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Design of the pages/website	Act-Ref	Chi-square = 11.4, df = 2, $p < 0.05$	Balanced Act-Ref and Act participants mentioned this category as a negative aspect of the website significantly more frequently than Ref participants
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Organization of the pages/website	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Navigation (includes on menus)	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Search facilities (or lack of)	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	Chi-square = 7.38, df = 2, $p < 0.05$	Ver participants mentioned this category as a negative aspect of the website significantly more frequently than Vis and Balanced Vis-Ver participants
	Seq-Glo	n.s.	
Miscellaneous (speed, language option, not suited to tasks) – not enough examples for coding or not relevant (not suited to tasks)	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Comments on balance between text and images	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Specific Features Questionnaire (SFQ)			
British Museum			
BMSpQ1	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
BMSpQ2	Act-Ref	$F = 2.26$, df = 8, 133, $p < 0.05$	See Figure 6.33 Balanced Act-Ref participants significantly found the large images more attractive than all groups apart from Highly/Very Strongly Act, Moderately Act and Very Strongly Ref
	Sen-Int	n.s.	

	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
BMSpQ3	Vis-Ver	n.s.	
BMSpQ4	Sen-Int	Linear regression $r^2 = 0.86$, $F = 3.20$, $df = 4, 137$, $p < 0.05$	Participants' preference for pages which had abstract of concepts or pages which had concrete examples on the websites, this dimension being the only predictor
BMSpQ5	Act-Ref	n.s.	
	Seq-Glo	n.s.	
Wellcome Collection Museum			
WCSpQ1	Vis-Ver	n.s.	
	Sen-Int	n.s.	
WCSpQ2	Act-Ref	n.s.	
	Seq-Glo	n.s.	
WCSpQ3	Sen-Int	n.s.	
WCSpQ4	Act-Ref	n.s.	
	Seq-Glo	n.s.	
		Linear Regression $r^2 = 0.29$, $F = 2.05$, $df = 4, 136$, $p < 0.01$	Participants' preference for pages which had click through for information or pages which had all the information on one page on the websites, this dimension being the only significant predictor

Table D.8 Results of effects of Learning Styles on User Performance variables

Measure	**Dimension**	**Statistics**	**Interpretation**
Number of visited pages suited to a specific learning style	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Percentage of time spent on pages to a specific learning style	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	
Task performance	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s.	

Table D.9 Results on effects of Learning Styles on Perceived Usability

System Usability Scale (SUS)			
British Museum			
Measure	Dimension	Statistics	Interpretation
SUS score	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	$F = 2.31$, $df = 7, 134$, $p < 0.05$	See Figure 6.34 The Moderately Glo participants have significantly lower scores than all the other groups apart from Highly/Very Strongly Seq, Slightly Seq and Strongly Glo groups
Wellcome Collection			
SUS score	Act-Ref	n.s.	
	Sen-Int	n.s.	
	Vis-Ver	n.s.	
	Seq-Glo	n.s	

Table D.10 Results on effects of Cultural Background on User Experience variables

Measure	**Group**	**Statistics**			**Interpretation**
Emotional Wording Scale (EWRS) Scores					
British Museum		Mean	SD	t value, df, Significance	
Positive Scores	Europe	2.28	0.76	-2.24, 124, $p <$ 0.05	See Figure 6.35 The Chinese participants' mean EWRS positive scores were higher
	China	2.68	0.65		
Negative Scores	Europe	2.28	0.88	-2.36, 124, $p <$ 0.05	See Figure 6.37 The Chinese participants' mean EWRS negative scores were higher
	China	2.76	0.63		
Wellcome Collection Museum					
Positive Scores	Europe	2.16	0.78	-2.47, 123, $p <$ 0.05	See Figure 6.36 The Chinese participants' mean EWRS positive scores were higher
	China	2.63	0.69		
Negative Scores	Europe	2.53	0.98	-2.17, 124, $p <$ 0.05	See Figure 6.38 The Chinese participants' mean EWRS negative scores were higher
	China	3.06	0.94		
Overall Reactions Questionnaire (ORQ)					
British Museum					
Use of images, animations, multimedia	Europe	n.s			
	China				
Content – type of content (e.g. interesting, factual, ranged, useless, or informative content)	Europe	n.s			
	China				
Content – amount of content (too little, too much)	Europe	n.s			
	China				

Design of the pages/website	Europe China	n.s			
Organization of the pages/website	Europe China	n.s			
Navigation (includes on menus)	Europe China	n.s			
Search facilities (or lack of)	Europe China	n.s			
Miscellaneous (speed, language option, not suited to tasks) – not enough examples for coding or not relevant (not suited to tasks)	Europe China	n.s			
Comments on balance between text and images	Europe China	n.s			
Wellcome Collection Museum					
Use of images, animations, multimedia	Europe China	Chi-square = 9.16, df = 1, $p < 0.01$			The Chinese participants mentioned this category as a positive aspect of the website significantly more frequently than the European participants
Content – type of content (e.g. interesting, factual, ranged, useless, or informative content)	Europe China	Chi-square = 4.87, df = 1, $p < 0.05$			The European participants mentioned this category as a positive aspect of the website significantly more frequently than the Chinese participants
Content – amount of content (too little, too much)	Europe China	n.s			
Design of the pages/website	Europe China	n.s			
Organization of the pages/website	Europe China	n.s			
Navigation (includes on menus)	Europe China	n.s			
Search facilities (or lack of)	Europe China	n.s			
Miscellaneous (speed, language option, not suited to tasks) – not enough examples for coding or not relevant (not suited to tasks)	Europe China	n.s			
Comments on balance between text and images	Europe China	n.s			
Specific Features Questionnaire (SFQ)					
British Museum		Mean	SD	t value, df, Significance	
BMSpQ1	Europe	7.51	2.22	2.83, 124, $p < 0.01$	See Figure 6.39 The European participants preferred navigating using inpage menu more than the Chinese participants
	China	6.00	2.30		

		Linear Regression $r^2 = 0.05$, F = 8.02, df = 1, 124, p < 0.01			Participants' preference for navigating using the menu at the top of the page or through the images and links under the image, cultural background being the only significant predictor
BMSpQ2	Europe			n.s	
	China				
BMSpQ3	Europe	4.75	1.92	-3.50, 124, p < 0.01	See Figure 6.40 The European participants preferred pages with lots of text and small pictures more than the Chinese participants
	China	6.33	1.71		
		Linear Regression $r^2 = 0.08$, F = 12.26, df = 1, 124, p < 0.01			Participants' preference for pages which had lots of text and small pictures or pages which had large pictures and a small amount of text, cultural background being the only significant predictor
BMSpQ4	Europe			n.s	
	China				
BMSpQ5	Europe	6.93	2.13	2.73, 124, p < 0.05	See Figure 6.41 The European participants preferred long pages where a lot of information was on one page and you needed to read through the page more than the Chinese participants
	China	4.84	1.85		
		Linear Regression $r^2 = 0.03$, F = 4.64, df = 1, 124, p < 0.05			Participants' preference for short pages where you had to click through frequently to get further information or pages where a lot of information was on one page and you needed to read through the page, cultural background being the only significant predictor
Wellcome Collection Museum					
WCSpQ1	Europe	4.94	2.06	3.13, 123, p < 0.01	See Figure 6.42 The European participants preferred pages with text only more than the Chinese participants
	China	3.42	1.22		
		Linear Regression $r^2 = 0.07$, F = 1.95, df = 1, 123, p < 0.01			Participants' preference for pages with text only or pages with numerous images, cultural background being the only significant

					predictor
WCSpQ2	Europe	3.84	2.26	-2.37, 123, $p < 0.05$	See Figure 6.43 The Chinese participants preferred to see one item at a time on pages more than the European participants
	China	5.16	2.04		
		Linear Regression $r^2 = 0.04$, $F = 5.62$, df = 1, 123, $p < 0.05$			Participants' preference for pages where you could see a number of options at once or pages where you see one item at a time, cultural background being the only significant predictor
WCSpQ3	Europe			n.s	
	China				
WCSpQ4	Europe	6.27	2.25	2.54, 123, $p < 0.05$	See Figure 6.44 The European participants preferred pages where a lot of information was on one page and you needed to read through the page more than the Chinese participants
	China	4.84	2.34		
		Linear Regression $r^2 = 0.04$, $F = 6.45$, df = 1, 124, $p < 0.05$			Participants' preference for pages where you needed to click through to get further information or pages where a lot of information was on one page and you needed to read through the page, cultural background being the only significant predictor

Table D.11Results on effects of Cultural Background on User Performance variables

Measure	**Group**	**Statistics**			**Interpretation**
British Museum		Mean	SD	t value, df, Significance	
Task performance	Europe			n.s	
	China				
Wellcome Collection Museum					
Task performance	Europe	3.55	0.63	3.22, 127, $p < 0.01$	See Figure 6.45 The European participants have higher task performance mean scores compared to the Chinese participants for the website
	China	3.05	0.74		

Table D.12 Results on effects of Cultural Background on Perceived Usability

System Usability Scale (SUS)			
British Museum			
Measure	Group	Statistics	Interpretation
SUS score	Europe	n.s	
	China	n.s	
Wellcome Collection Museum			
SUS score	Europe	n.s	
	China	n.s	

Table D.13 Results on Other Important Findings

British Museum		
Measures	Statistics	Interpretation
Positive EWRS Score SUS Score	$r = 0.34$, $p < 0.01$	There is a positive correlation between participants' positive EWRS and SUS score of the website
Negative EWRS Score SUS Score	$r = -0.61$, $p < 0.01$	There is a negative correlation between participants' negative EWRS and SUS score of the website
Learning Styles Culture Groups	n.s	
Task Performance EWRS Score	n.s	
Wellcome Collection Museum		
Positive EWRS Score SUS Score	$r = 0.21$, $p < 0.05$	There is a positive correlation between participants' positive EWRS and SUS score of the website
Negative EWRS Score SUS Score	$r = -0.61$, $p < 0.01$	There is a negative correlation between participants' negative EWRS and SUS score of the website
Learning Styles Culture Groups	n.s	

Task Performance EWRS Score	n.s	

Glossary

Adaptive educational hypermedia (AEH): Adaptive educational hypermedia (AEH) is a term that is used when adaptive hypermedia is applied in education.

Adaptive hypermedia (or adaptive systems): Adaptive hypermedia can be defined as "…all hypertext and hypermedia systems, which reflect some features of the user in the user model and apply this model to adapt various visible aspects of the system to the user" (Brusilovsky, 1996, p.88).

Back-translation technique: A back-translation technique is a translation of an instrument that has been already translated into a target language back into the source language (Maxwell, 1996).

Bayesian networks: A Bayesian network is a graphical probabilistic model where there are some random variables and conditional dependencies.

Card sort technique: This technique is a simple, quick, cheap, and reliable method and can be used for numerous grouping tasks. In this technique, participants are typically given a set of cards with terms already written on them and they are asked to put them in logical groupings, and to find a category name for each grouping.

Case-based reasoning (CBR): CBR is the process of solving new problems based on the solutions of similar past problems.

Cognitive styles: Cognitive styles can be defined as "individuals possess a personal way of thinking" (Rayner, 2001, p.2172).

Collaborative learning: Collaborative learning can be defined as "educational method where a group of learners collaborate to learn and improve themselves" (Economides, 2008, p. 243).

Computer-based learning (CBL): Computer-based learning (CBL) the process of using computer as a key component for learning.

Construct validity: Construct validity refers to a degree to which a test measures what it claims to be measuring.

Content analysis: Content analysis is a technique for making inferences by methodically and objectively identifying particular characteristics of texts (Holsti, 1968, p. 608).

Cronbach alpha: Cronbach alpha can be defined as a measurement of internal consistency.

Culture: The way of how people think, behave, feel and act (Hofstede, 1983).

Demand characteristic: Demand characteristic can manipulate how a participant behaves can pose a threat to the outcome of a research.

Discriminant validity: Discriminant validity tests whether measurements that are supposed to be unrelated are, in fact, unrelated.

Edit distance: Edit distance is the minimum number of operations needed to adapt one card sort into another. For adaption, the basic operation is to move one card from a group to another (Deibel, Anderson & Anderson, 2005).

E-learning (or elearning or technology-enhanced learning (TEL)): E-learning can be defined as as "…all forms of electronic supported learning and teaching, which are procedural in character and aim to effect the construction of knowledge with reference to individual experience, practice and knowledge of the learner. Information and communication systems, whether networked or not, serve with specific media to implement the learning process." (Tavangarian et al., 2004, p.274).

Factor analysis: The use of one of several methods for reducing a set of variables to a lesser number of new variables.

Formal learning: According to the Organisation for Economic Co-operation and Development (OECD)[26] formal learning is "… always organised and structured, has learning objectives and is always intentional".

Hypermedia: An extension to hypertext providing multimedia.

Hypertext: A digital text in which the reader may navigate related information through embedded hyperlinks.

Informal learning: According to the Organisation for Economic Co-operation and Development (OECD)[27] informal learning is "…is never organised, has no set objective in terms of academic performances and is never intentional from the learner's standpoint".

Internal consistency: Internal consistency determines how well the test to measure the general construct produce similar scores (Cronbach & Shavelson, 2004).

Learning styles: Learning styles can be defined as "…how people acquire and understand new knowledge and skill" (ETaLD, 2005, p.5).

Multimedia: The use of different media like graphs, audio, animation and so on.

Multiple forward translation technique: A multiple forward translation technique is the translation of an instrument from the source language into the target language independently by a number of translators (Maxwell, 1996).

Online learning systems (OLSs) (or web-based learning (WBL)): Online learning systems (OLSs) can be defined as presenting information to learners via the web.

Personalization: Personalization is the process of tailoring interface characteristics such as visualization, content, functionality, etc. to users' goals, interests, preferences, knowledge, and so on.

Predictive validity: Predictive validity is a measure for demonstrating the ability of a measure to predict the results.

Principal components analysis: Principal component analysis is a statistical analysis for transforming a number of correlated variables into a smaller number of uncorrelated variables.

Test-retest correlation/reliability: Test-retest correlation/reliability checks the correlation between scores gathered at two different times from the same set of respondents to see whether the tests yield same or compatible results.

[26] http://www.oecd.org/edu/skills-beyond-school/recognitionofnon-formalandinformallearning-home.htm, Accessed 7th Aug 2014

[27] http://www.oecd.org/edu/skills-beyond-school/recognitionofnon-formalandinformallearning-home.htm, Accessed 7th Aug 2014

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