THE EFFECTS OF INDIVIDUAL DIFFERENCES AND INSTRUCTIONAL AIDS ON LEARNERS' DISORIENTATION, LEARNING PERFORMANCE AND ATTITUDES IN A HYPERMEDIA LEARNING SYSTEM

A thesis submitted for the degree of Doctor of Philosophy

by

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September 2011

Abstract

Hypermedia Learning Systems (HLS) are being used increasingly widely in Higher Education, offering non-linear navigation through complex learning materials and, it is argued, leading to improve cognitive flexibility. For some learners, though, nonlinear navigation in HLS leads to higher levels of disorientation, which can have an impact on their learning performance and attitudes towards the learning system. There has been significant research into the factors that can influence individual learners' experiences. For example, a number of studies have confirmed that individual differences such as cognitive style, domain knowledge and computer experience affect individuals' levels of disorientation and learning performance, and influence their attitudes towards HLS. It has also been suggested that instructional aids (in the form of certain visual elements and audio elements) can reduce levels of disorientation and, in turn, increase learning performance in, and positive attitudes towards, HLS for some learners. However, existing studies have tended to look at only a subset of these three individual differences in relation to an individual and/or consider only a small number of visual instructional aids. No study up to this point has considered the impact of cognitive style, domain knowledge and computer experience on disorientation, learning performance and attitudes in a HLS that incorporates a full range of visual instructional aids. In terms of the research related to audio instructional aids, no studies have looked into the effects of audio aids and these three individual differences in relation to disorientation, learning performance and attitudes in HLS. This thesis addresses these two shortcomings through two experiments. The aim of experiment 1 was to examine the effects of and between these three individual differences with respect to disorientation, learning performance and attitudes in two versions of a HLS: one that incorporated the set of visual instructional aids and one that did not. Experiment 2 aimed to do the same, but with respect to a HLS that provided audio instructional aids. The experiments used quantitative and qualitative approaches to gather data to address a set of research questions and research hypotheses. The participants were 384 university students from across London. The Cognitive Style Analysis (CSA) test was administered to determine participants' field dependence, and participants' demographic information, levels of computer experience and levels of prior knowledge were gathered using questionnaires. Learning performance was measured through achievement tests and a practical task. Levels of disorientation were measured using questionnaires, and attitudes were assessed using questionnaires and interviews. Participants were also observed when they were interacting with the HLS to perform learning tasks. A number of interesting results were revealed. Significant effects were found between the three individual differences with respect to disorientation, learning performance and attitudes in the HLS that provided no instructional aids. No significant effects were found between the three individual differences with respect to disorientation or learning performance in the other two versions of the HLS – those providing visual and audio instructional aids. Significant effects were found between the three individual differences with respect to the use of the visual and audio instructional aids to perform learning in the HLS. No significant effects were found between the three individual differences with respect to attitudes in the HLS that provided visual instructional aids. Significant effects were found between the three individual differences with respect to attitudes in the version that provided audio instructional aids. Analysis of the results led to the framing of a set of HLS design guidelines which are presented in this thesis. Finally, an agenda for future research leading on from the study's findings is presented.

Dedication

This PhD thesis is dedicated with deepest love and everlasting respect to my devoted late father, Mr Soorooj Dev Ruttun, the most honourable person in my life. My father worked very hard so that I could achieve high levels of education. Sadly, he passed away, but I am sure, wherever he is, that he will be happy seeing me complete my PhD.

Acknowledgement

I am indebted and owe great thanks to my supervisors, Professor Robert Macredie and Professor Sherry Chen for their excellent supervision, enthusiastic guidance, endless patience and immense encouragement throughout my research. The PhD journey was not easy and it would have been impossible for me to see the light at the end of the tunnel without their support. They have taught me not only how to undertake research effectively but also how to be patient, how to cope and not to give up when it is difficult to achieve something in life.

I would like to thank both my internal and external examiners for agreeing to read and assess my thesis.

Special appreciation goes to the staff in the Department of Information Systems and Computing (DISC) at Brunel University, especially Ms Ela Heaney, Mrs Julie Whitaker, and Mr Gareth Hirst for their time, understanding, guidance and kind support while completing my PhD.

A special note of gratitude is extended to those taking their time to participate in the experimental studies reported in this thesis.

I would like to express my deepest gratitude to my mum and my sister for their constant encouragement, support, love, sacrifice and understanding throughout my PhD journey.

I truly appreciate the continued and constant support, encouragement and thoughtful advice from my elder brother cousin, Madu, throughout this project.

My special thanks are given to Mr Salil Roy and my uncle, Mr Raj Mahabeer, for their financial support, without which this achievement would not have been possible.

Finally, I am very grateful to my friends and family for their time, understanding, advice and never-ending support of my endeavours and dreams.

Declaration

Aspects of the research reported in this thesis have been presented in the form of the following publications:

Ruttun, R., Khalid, S. (2008). Learners' Preferences on visual elements in Web-based instruction: An individual Approach. *7th European Conference on e-learning, Cyprus*, pp.376-385.

Ruttun, R. (2009). Evaluating the effects of integrated visual elements in hypermedia learning: a domain expertise approach. *Journal of e-working*, 3, pp.33-51.

Ruttun, R. (2009). Effects of visual elements and cognitive styles on students' learning in hypermedia environment. *World Academy of Science, Engineering and Technology*, (49), pp.963-971.

Ruttun, R. and Macredie, R.D. (in press). Effects of individual differences and visual instructional aids on disorientation, learning performance and attitudes in a Hypermedia Learning System. Journal of *Computers in Human Behaviour*.

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Abbreviations and Symbols

HLS – Hypermedia Learning System

WWW – World Wide Web

CSA – Cognitive Style Analysis

FD – Field Dependent

FI – Field Independent

FM – Field Mixed

XHTML – Extensible Hypertext Mark-up Language

HTML – Hypertext Mark-up Language

DK – Domain Knowledge

CE – Computer Experience

IV – Independent Variable

DV – Dependent Variable

FAQ – Frequently Asked Question

GEFT – Group Embedded Figures Test

SPSS – Statistical Package for Social Sciences

ANOVA – Analysis of Variance

Chapter One: Introduction

1.1 Background of the Study

The use of HLS is growing considerably in higher education (Yen and Li, 2003; Liu et al., 2007; Waniek and Schafer, 2009). Once connected to the internet, learners can access the HLS from anywhere and at anytime to support their learning. One of the features of HLS is that the learning material is presented in a non-linear structure (Khalifa and Lam, 2002), allowing learners to determine their own learning path (Amadieu et al., 2008) and the sequence in which they will view the learning content, which has been argued to offer potential improvements in terms of learning and cognitive flexibility (Triantafillou et al., 2003).

However, the flexibility offered by HLS may cause problems for some users. It has been suggested that not all users can develop their own learning paths effectively to achieve their learning goals in HLS (Lazonder et al., 2000; Hua and Pei, 2009) and the literature has indicated that users may experience disorientation when navigating through HLS (Chen, 2002b; Amadieu et al., 2009b).

A relationship between disorientation and learning performance has been observed in studies in this area, showing that learners who encounter higher levels of disorientation perform less well in learning tasks (Mitchell et al., 2005a). Encountering disorientation and performing less well in learning tasks may, when taken together, have an impact on learners' attitudes towards HLS. It is argued that when learners experience disorientation in HLS, which in turn hinders their learning performance, their chances of them displaying negative attitudes towards the non-linear learning environment offered by HLS increases (Dringus, 2000). Consequently, they may show less interest in learning using HLS.

While some learners appreciate being given freedom of navigation, others have difficulty navigating in HLS to find the information that they require in order to achieve their learning goals. This difference may be associated with the characteristics that learners possess (Chen and Paul, 2003; Graf et al., 2010), meaning that the individual differences that those characteristics represent become important for HLS design. Studies have found that individual differences, such as cognitive style (Chen and Macredie, 2004; Chen and Liu, 2011), domain knowledge (Caliser and Gurel, 2003; Mitchell et al., 2005; Amadieu et al., 2010) and computer experience (Tabatabai and Shore, 2005; Khosrowjerdi and Iranshani, 2011) may play in the effectiveness of learning using HLS. It is argued this is because this set of individual differences tend to influence learners' navigation (Roy et al., 2003; Lee at al., 2005; White et al., 2009), disorientation (Chen and Macredie, 2004; Fan, 2005; Mishra and Yadav, 2006) learning performance in (Umar and Maswan, 2007), and attitudes towards (Chen and Macredie, 2004; Fan, 2005; Mitchell et al., 2005c), HLS.

It has been suggested that reducing the levels of disorientation experienced by learners with different characteristics, may have two benefits. First, learners may improve their learning performance. Second, they may show more interest in learning using HLS, and more positive attitudes towards these non-linear environments (Chen et al., 2004; Su and Klein, 2006). To reduce disorientation, the use of visual instructional aids in the form of conceptual structural support/navigation mechanisms (for example, maps) has been suggested (Chen and Macredie, 2004; Lee et al., 2005; Amadieu et al., 2010). A number of studies have examined the effects of maps and individual differences on learners' levels of disorientation and learning performance in, and attitudes towards, HLS (Parkinson et al., 2004; Fan, 2005; Amadieu et al., 2009b). The results from these studies mostly show that when maps are provided in HLS, learners' levels of disorientation are decreased and learning performance and positive attitudes are increased.

In addition to maps, studies have suggested that visual orientation cues – in the form of breadcrumbs, graphic visualisations, history-based mechanisms, highlighting context, page labels, pagination, different link colours and link annotation – can also reduce disorientation and enhance efficiency in learning performance and learning satisfaction in HLS (Chen, 2002a; Alomyan, 2004; Fan, 2005).

Although there has tended to be a focus on visual instructional aids to support learners in HLS, there are a number of studies that have looked at audio instructional aids and the support that they might offer. The relationship between audio instructional aids and learner disorientation, learning performance and attitudes in HLS has been considered by researchers in recent years (Morley et al., 1998; Walker et al., 2006; Barreto et al, 2007). The findings from these studies tend to show that when audio is used to provide instructional aids in HLS, learners' levels of disorientation are reduced which, in turn, leads them to learn more effectively and, consequently, to show more positive attitudes towards HLS.

Although there is a corpus of studies that have focused on the impact of instructional aids (in the form of visual and audio elements) in HLS in relation to individual differences, there are still gaps that remain and which are used to frame the research questions for this dissertation.

1.2 Research Question

As noted in section 1.1, a number of studies have looked at the effects of one or all of these individual differences (that is, cognitive style, domain knowledge and computer experience) on learner disorientation, learning performance and attitudes in relation to a HLS that provides maps. However, these studies tend to consider either one or two of these individual differences together, rather than all three. There is no evidence that the effects of and between all three of these individual differences with respect to learner disorientation, learning performance and attitudes in a HLS that provides maps have been studied.

Section 1.1 also introduced research that has suggested that visual orientation cues (in the form of breadcrumbs, graphic visualisation, history based mechanism, highlighting context, page labels, pagination, different link colours and link annotation) can reduce disorientation for learners with different characteristics (such as cognitive style, domain knowledge, computer experience). However, there are no studies where all of these visual orientation cues have been provided in a single HLS and their effects studied. Therefore, the effects of and between cognitive style, domain knowledge and computer experience with respect to learner disorientation, learning performance and attitudes in this such as HLS have not been examined. Addressing these two gaps in relation to maps, visual orientation cues and HLS leads this study to frame three research questions (as presented in Table 1.1).

Table 1.1: Research questions related to HLS, visual instructional aids, individual differences, and learners' learning

Research Question 1(a): What are the effects of and between individual differences (cognitive style, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?
Research Question 1(b): What are the effects of and between individual differences (cognitive style, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?
Research Question 1(c): What are the effects of and between individual differences (cognitive style, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?

In addition to the instructional aids (in the form of visual elements), section 1.1 also introduced studies that have suggested that when audio is provided in HLS, learners' disorientation is reduced, and learning performance and learning satisfaction are increased. However, little consideration seems to have been given to individual differences in these studies. This research gap in terms of HLS leads this study to frame three further research questions (as presented in Table 1.2).

Table 1.2: Research questions related to HLS, audio instructional aids, individual differences and learners' learning

Research Question 2(a): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?
Research Question 2(b): What are the effects of and between individual differences (cognitive style, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?
Research Question 2(c): What are the effects of and between individual differences (cognitive style, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?

Answering these six research questions is the main objective of this research effort.

The next section briefly discusses the appropriate research methodology used within this study.

1.3 Research Methodology

Since this study aims to examine the effects of and between individual differences and HLS features (in the form of visual and audio instructional aids) with respect to learners' disorientation, learning performance and attitudes, an experimental research study (Walliman, 2001; Johnson et al., 2007) was conducted, which involved two experiments. The experiments gathered quantitative and qualitative data using a variety of instruments which will be presented and justified in Chapter 4.

The data gathered in this study was analysed using the Statistical Package for Social Science (SPSS 15). A multiple three-way Analysis of Variance (ANOVA) employed to examine the relationships between the individual differences, disorientation, learning performance and attitudes in relation to the HLS. The level of statistical significance in this study was set at $p < 0.05$. The appropriate analysis employed in this study is presented and justified in detail in Chapter 4.

1.4 Dissertation Outline

The remainder of this thesis is structured as follows.

Chapter Two provides an introduction to the growth, features and limitations of HLS in Higher Education. Individual differences such as cognitive style (FD/FI), domain knowledge, computer experience and gender – which are considered to have an impact on learners' disorientation, learning performance and attitudes in HLS – are then reviewed. The chapter examines previous studies where instructional aids (in the form of maps and the set of visual orientation cues considered in this thesis) have been used or suggested as being useful to support individual differences in reducing learners' disorientation which, in turn, can increase learning performance in, and positive attitudes towards HLS. The chapter then considers audio instructional aids (in the form of audio elements) in HLS and research related to audio and individual differences (cognitive style (FD/FI), domain knowledge, computer experience and gender), disorientation, learning performance and attitudes in HLS.

Chapter Three builds on the analysis in Chapter 2 to identify gaps that exist from in relevant studies and frame a set of research questions that are addressed in the remainder of the thesis. The chapter then uses the research questions to formulate hypotheses that will be tested through the practical work reported in the thesis.

Chapter Four discusses the appropriate research methods to support this research effort. An experimental research method is argued to be most suitable, though it is argued that the use of a descriptive approach (in the form of observation, interviews and surveys) is useful in tandem with the experiments so as to gain an improved understanding of users': attitudes towards the HLS; levels of disorientation in the HLS; and interaction behaviour with the HLS. The experimental structure and methods used in this study, including the sample, data collection instruments and procedures, are then considered and the chosen data analysis techniques are justified.

Chapter Five reports the findings in relation to experiment 1, which addresses research questions 1(a-c). The chapter presents a description of the characteristics of the participants, including their field dependence, levels of expertise in using computers, and levels of prior knowledge of the learning content used in the HLS. The chapter then presents and considers the findings from the analysis of the different data sources associated with the use of the two versions of the HLS (without instructional aids and with visual instructional aids). The chapter then draws out and presents the high-level findings in relation to experiment 1.

Chapter Six reports the findings in relation to experiment 2, which addresses research questions 2(a-c). The chapter follows the same pattern as Chapter 5, but in relation to the HLS that provided the audio (rather than visual) instructional aids.

Building on the previous two chapters, Chapter Seven presents detailed findings in relation to the two experiments and seeks to present answers to the research questions. From this, the chapter identifies issues from which guidelines are developed to inform the design of HLS.

Chapter Eight briefly re-states the purpose of this research effort and reviews the thesis, before summarising the findings in relation to each research question and hypothesis. The chapter then presents the original contributions made this research effort, before reflecting on limitations of the research and making recommendations for areas of future research.

Chapter Two: Literature Review

2.1 Introduction

This study looks at the growth of Hypermedia Learning Systems (HLS) in Higher Education. In addition, this study examines how individual differences (Field Dependent and Field Independent cognitive style, domain knowledge, computer experience and gender) influence learners' navigation/disorientation, learning performance and attitudes in HLS. Moreover, this study seeks to explore, with regards to individual differences, the effects of visual instructional aids – maps and a set of visual orientation cues – on learners' navigation/disorientation, learning performance and attitudes in HLS.

In addition to studies of visual instructional aids, perhaps surprisingly, there also seems to be a number of studies looking at the use of audio instructional aids in HLS. Consequently, it may be useful to consider the potential of audio in HLS. For this reason, this dissertation investigates previous studies where the effects of audio elements and individual differences on learners' navigation/disorientation, learning performance and attitudes in HLS have been observed.

Examining these areas may support designers in gaining a detailed understanding of interactions between instructional aids and individual differences in relation to navigation/disorientation, learning performance and attitudes in HLS. To support this overall aim of the dissertation, this chapter will review existing research in relevant area of HLS.

This chapter is structured as follows. Section 2.2 starts with an introduction about HLS and its features in education, before Section 2.3 discusses the limitations of HLS. Section 2.4 examines the influences of individual differences on learners' learning in HLS. In Section 2.5, with regards to the same set of individual differences that are noted in Section 2.4, the effects of visual elements in form of navigation aids and orientation cues on learners' navigation/disorientation, learning performance and attitudes are examined. In Section 2.6, the potential of audio instructional aids in relation to navigation/disorientation, learning performance and attitudes in HLS are examined. Finally, Section 2.7 presents a summary of this chapter.

2.2 Hypermedia Learning Systems (HLS) and Features

As the World Wide Web (WWW) becomes ever more widely used as an educational platform (Yen and Li, 2003; Alomyan and Au, 2004; Mitchell at al., 2005a; Liaw et al., 2007; Liu et al., 2007; Waniek and Schafer, 2009), HLS are gaining increased attention from researchers (Chen, 2005; Chen et al., 2006; Lajoie and Azavedo, 2006; Amadieu et al., 2009a; Amadieu et al., 2010). While hypertext is a text-only electronic environment, HLS also incorporates other media: for example, graphics, images, audio and video within the content (Jacobson and Archodidou, 2000; Masiello et al. 2005; Scheiter and Gerjets, 2007; Yu-Hung Chien, 2010). One of the major reasons for moving from traditional classroom-based learning to offering instruction through the use of HLS is that the latter can present learning material in a non-linear structure (Chen and Macredie, 2002; Khalifa and Lam, 2002; Calcaterra et al., 2005). Such non-linearity affords learners greater flexibility in navigating the learning content and allows them to choose their own paths through it to meet their learning goals (Farell and Moore, 2000; Barua, 2001; Chen, 2002a; Amadieu et al., 2008).

Additionally, non-linearity allows learners to access and sequence information in accordance with their individual needs (Lawless and Brown, 1997; Kim, 2000; Goldshalk et al., 2004; Amadieu et al., 2008; Gerjets et al., 2009). These findings support Sweany et al. (1996) and Jacobson and Archodidou (2000), who argue that, in non-linear learning systems, it is the learners who decide what, which way and for how long they are going to view each topic. Furthermore, allowing learners to have control over their learning may also make them motivated to learn, improving their learning performance and cognitive flexibility (Mendes and Hall, 1999; Triantafillou et al., 2003).

2.3 HLS and Limitations

As discussed earlier, HLS affords learners to choose their own learning paths and to access and sequence information in accordance with their individual needs. However, the flexibility offered by HLS may cause problems for some users. It has been argued that not all learners can 'develop' their own navigation paths effectively to satisfy their learning goals when using HLS (Lazonder et al., 2000; Last et al., 2001; Shapiro and Niederhauser, 2004; Hua and Pei, 2009). Therefore, navigating in HLS can cause disorientation for some learners (Last et al., 2001; Chen, 2002b; Mitchell et al., 2005a; Gwisdka and Spence, 2007; Amadieu et al., 2009b).

The concept of disorientation when applied to HLS can be broadly viewed as the user having uncertainty about where they are and to reach another location in the information space (Conklin, 1987; Head et al., 2000). Typically, the disoriented user is unable to gain an overview of the learning material and encounters problems in deciding if information that they require is available, where to look for the information and how to get there (Kim and Hirtle, 1995). In the same way, Smith (1996) reported that when learners experienced *"cognitive problems of finding their way in the information space"* (p.365), the *"lost in hyperspace phenomenon"* appeared. Caliser et al. (2007) described disorientation in HLS under two categories; Conceptual and Structural. Conceptual disorientation occurs when learners have difficulties in relating different concepts presented in the HLS. Structural disorientation occurs when learners fail to know their current location, fail to reach their desired location and do not know where to go next in the HLS. Cress and Knabel (2003) argue that learners experience disorientation in HLS because they have difficulties imposing a structure on the learning content, or mapping a mental representation of the document structure (i.e., the physical arrangement of the document).

Studies have revealed that a common consequence of the different types of disorientation in HLS is of degradation in users' learning performance (Chen, 2002a; Mitchell et al., 2005a). Researchers suggest that some learners who use HLS take more time and perform less well in learning tasks than those who use linear versions, and this is because these learners fail to set their own leaning paths through the HLS to meet their learning goals (McDonald and Stevenson, 1996).

Separately and in combination, disorientation and poorer performance in learning tasks may have an impact on learners' attitudes towards HLS. Dringus (2000), for example, argues that when learners experience disorientation in HLS, and are hindered in their learning performance, there is an increased chance of showing negative attitudes towards the non-linear learning environment. Consequently, such learners may feel less motivation to learn using HLS. Similarly, the findings of Mitchell et al.'s (2005) study suggest that the participants who enjoyed the Web were more comfortable learning in the non-linear environment that was offered in the HLS. In contrast, those who did not enjoy the Web had more difficulties learning in the non-linear environment. This view reflects the findings from Atef and Shuib's (2009) and Duda and Garett's (2008) studies, which suggest that positive attitudes may lead learners to have more motivation to learn whereas negative attitudes can cause learners to give up learning.

The research findings suggest that not all learners are comfortable using, satisfied with or learn effectively from HLS, implying that the value of HLS can be influenced by the characteristics of the learner (Graf and Kinshuk, 2010). This means that the individual differences that these characteristics represent are critical for effective HLS' design. For this reason, in the next section this study will examine how individual differences influence navigation/disorientation, learning performance and attitudes in HLS.

2.4 Individual Differences and HLS

Individual differences refer to the way that individuals differ in their behaviour, thinking and feeling (Jonassen and Grabowski, 1993). Individual differences such as cognitive style (Chen and Macredie, 2002; Chen, 2005; Calcaterra et al., 2005; Chen, L-H, 2010; Chen and Liu, 2011), domain knowledge (Caliser and Gurel, 2003; Mitchell et al., 2005b; Amadieu et al., 2008; Amadieu et al., 2010), computer experience (Alomyan, 2004; Mitchell et al., 2005b; Cagiltay et al., 2006; Waniek and Schafer, 2009) and gender (Roy and Chi, 2003; Mustafa, 2005; Liu and Huang, 2008; Chen and Macredie, 2010) are the most commonly studied in research related to learning and HLS use. As these individual differences have been of great interest in the context of research into, it is vital to look at each of them and their effects on learning so that we can better understand the likely impact of those attributes on the use and design of HLS. In this way, HLS may be developed according to users' specific needs, which may help to reduce their disorientation problem, to increase their learning performance and to increase their learning satisfaction.

The remainder of section 2.4 will consider individual differences such as cognitive style, domain knowledge, computer experience and gender and their interaction with the features of HLS to perform their learning.

2.4.1 Cognitive Style and HLS

The ways in which an individual thinks, memorises, perceives, organises, processes, and presents information is often referred to as cognitive style (Riding and Rayner, 1998). Among the different dimensions of cognitive style that have been studied to date, Field Dependence and (FD) and Field Independence (FI) are often argued to be of interest, especially with respect to research that is related to HLS (Kim, 2000; Kim, 2001; Ford & Chen, 2000; Chen & Macredie, 2004), because previous studies have revealed that learners with these cognitive style (FD/FI) show different learning preferences and require different navigational support in HLS (Chen and Macredie, 2002; Chen and Macredie, 2004; Chen and Liu, 2011)

Field Dependence and Field Independence originated in Witkin's (1977) work and describe an individual's tendency to perceive and isolate elements embedded in complex fields or contexts (Calcaterra et al., 2005). Witkin's (1977) Group Embedded Figure Test (GEFT) and Riding's (1991) Cognitive Style Analysis (CSA) are two common instruments used to identify a learner's cognitive style, which will be discussed in detail in Chapter 4. Characteristics of FD and FI learners are summarised in Table 2.1 and are now discussed.

FI learners tend to rely on internal references, adopt an active approach to learning and process information using an analytical approach (Witkin et al., 1977; Jonassen and Grabowski, 1993; Oughton and Reed, 1999; Chou, 2001). As a result, the parts embedded within the complex context are easily perceived and separated by FI learners. Furthermore, FI learners are more likely to reorganise information to provide a context for prior knowledge. Also, FI learners can impose their own structure when it is not inherent in the presented information and are able to extract relevant cues from a complex context (Witkin et al., 1977). Other characteristics that best describe FI learners are that they demonstrate greater proportional reasoning skills, are less influenced by social reinforcement and prefer working alone (Jonassen and Grabowski, 1993).

Conversely, FD learners tend to rely on external references, adopt a passive approach to learning and accept information exactly the way it is presented to them (Witkin et al., 1977; Jonassen and Grabowski, 1993). In this way, they tend to be more global in their perceptions, meaning that they are less analytical, less attentive to detail and see the perceptual context as a whole (Oughton and Reed, 1999; Chou, 2001). As a result, the parts embedded within the complex context are not easily perceived and separated by them.

Furthermore, FD learners have difficulty restructuring new information and forging links with prior knowledge and have difficulty extracting relevant cues within a complex context (Witkin et al., 1977). Unlike FI learners, FD learners prefer to learn in situations where structure is provided as they cannot impose it themselves. Other characteristics that best describe FD learners are that they demonstrate fewer proportional reasoning skills, their personalities show a greater social orientation and they prefer working in groups (Jonassen and Grabowski, 1993).

Table 2.1: Differences between FD learners and FI learners (Adapted from Witkin, Moore, Goodenough, and Cox, 1977; Jonassen and Grabowski, 1993; Chen and Macredie, 2002)

FD learners	FI learners
Experience surroundings in a relatively global fashion	Experience surroundings analytically
Are not good at problems that require taking elements out of their whole context	Are good at problems that require taking elements out of their whole context
Have difficulty restructuring new information and forging links with prior knowledge	Able to reorganise information to provide a context for prior knowledge
Adopt passive approach to learning	Adopt active approach to learning
Have difficulty providing structure to ambiguous information	Provide structure when it is not inherent in the presented information
Have difficulty attending to, removing, and using non-salient cues	Can disembed relevant items within the field or context
Demonstrate fewer proportional reasoning skills	Demonstrate greater proportional reasoning skills
Externally directed	Internally directed
Accept ideas as presented	Accept ideas strengthened through analysis
Their personalities show a greater social orientation	Are influenced less by social reinforcement
Prefer working in groups	Prefer working alone

Based on the characteristics noted in Table 2.1, it is expected that FD learners and FI learners will show different preferences and will take different approaches when learning. These concerns further alert researchers about whether cognitive styles (FD/FI) will have an effect on learners' learning in HLS. Therefore, the impact of cognitive style (FD/FI) on learning in HLS is examined in relation to the following four themes to which researchers have paid attention: (i) navigation – linear and non-linear pathways; (ii) disorientation, (iii) learning performance; and (iv) attitudes.

With regards to navigation, a number of studies have looked at the relationship between cognitive style (FD/FI) and preferences for the use of linear and non-linear pathways through HLS (Dufresne and Turcotte, 1997; Reed and Oughton, 1997; Kim, 2001; Chen and Macredie, 2004; Lee et al., 2005; Fan, 2005; Chen, L-H, 2010). The studies used a range of sample sizes, from 31 to 220 participants. The participants in these studies were college, Undergraduate or Masters students, enrolling on different courses. In these studies, the navigation strategies and searching performance of learners with FD and FI cognitive styles were examined. The studies used Witkin's (1977) Group Embedded Figure Test (GEFT) or Riding's (1991) Cognitive Style Analysis (CSA) instruments to identify a learner as FD or FI cognitive style. Also, a questionnaire, where needed, was used to determine the level of online search experience. Typically, the students interacted with the HLS to learn topics related to their course before completing a set of learning tasks.

In six of the studies noted (Dufresne and Turcotte, 1997; Reed and Oughton, 1997; Kim, 2001; Chen and Macredie, 2004; Lee et al., 2005; Fan, 2005), the results tended to indicate that FI learners took more non-linear steps whereas FD learners took more linear steps in their interaction with the HLS to meet their learning goals. Additionally, FD learners spent more time completing their learning tasks in the non-linear version than in the linear version. Another finding was that FI learners outperformed FD learners in the non-linear version. However, FD learners performed better in the linear version than those in the non-linear version.

However, in Chen L-H's study (2010), the results showed no significant effects between cognitive style and navigation behaviours, with both FD and FI users navigating through the HLS using linear pathways. Chen (2010) argued that this was because both FD and FI users wanted to understand the learning materials.

Researchers have also shown interest in the effects of the non-linear learning environment offered by HLS on the degree of disorientation of learners with FD and FI cognitive styles, and a number of experimental studies (Dufresne and Turcotte, 1997; Palmquist and Kim, 2000; Wang et al., 2000; Kim, 2001; Chen and Macredie, 2004; Fan, 2005) have looked into this area. These studies used sample sizes between 24 and 61 participants, with participants being either Undergraduate or Master's students, depending on the specific study. To identify each student's cognitive style, the studies applied the CSA or the GEFT instrument. In most of these studies, the students interacted with the HLS to perform prescribed learning tasks.

The results of these studies mostly showed that FI learners enjoyed the freedom of navigation and experienced less disorientation in the non-linear learning environment offered by HLS. In contrast, FD learners were more likely to encounter navigation difficulties, and, in turn, experienced more disorientation in the non-linear learning environment offered by HLS.

As well as looking at disorientation and linear and non-linear pathways, research has also focussed on cognitive style and learning performance. A number of experimental studies (Ford and Chen, 2000; Parkinson and Redmond, 2002; Redmond et al., 2003; Ghinea and Chen, 2003; Graff, 2003; Parkinson et al., 2004; Fan, 2005; Lee, 2006; Altun and Cakan, 2006; Umar and Maswan, 2007) have been conducted to observe whether cognitive style (FD/FI) has an impact on learning performance in HLS. These studies used sample sizes between 47 and 422 participants, with participants being high school students, Undergraduate students, or teachers, depending on the specific study. The GEFT, CSA or the Hidden Figure Test instruments were used to identify students' cognitive styles. In all of the studies noted, a HLS was used to deliver learning materials to the participants. The time performance, search performance and the accuracy of answers given were used in the studies to evaluate participants' learning performance.

In six of the studies noted (Ford and Chen, 2000; Parkinson and Redmond, 2002; Ghinea and Chen, 2003; Graff, 2003; Fan, 2005; Umar and Maswan, 2007), the results showed that FI learners performed better in terms of time performance, search performance and learning tasks performance than did FD learners in HLS. These findings are supported by a number of studies (Witkin et al., 1977; Yoon, 1993; Dufresne and Turcotte, 1997; Chen and Macredie, 2004; Oh and Lim, 2005; Chen, L-H, 2010) that have suggested that FD learners performed better when they were given a linear learning system as they could easily follow the sequence of the learning materials to achieve their learning goals.

However, in four of the studies noted (Redmond et al., 2003; Parkinson et al., 2004; Lee, 2006; Altun and Cakan, 2006), no significant effects were found, with both FD and FI learners performing equally well in the learning tasks. Parkinson et al. (2004) argued that FD learners can still learn effectively in different learning environments, such as HLS, if appropriate instructional aids are provided to them.

Finally, a number of studies have examined the effects of cognitive style in relation to attitudes towards a HLS (Alomyan and Au, 2004; Chen and Macredie, 2004; Fan, 2005; Oh and Lim, 2005; Altun and Cakan, 2006). The results reported in Fan (2005) and Chen and Macredie (2004) confirm that cognitive style (FD/FI) influences learners' attitudes towards HLS, with FI learners showing more positive attitudes towards HLS than FD learners. This finding is further supported by other research (Reed and Oughton, 1997; Chen and Macredie, 2002) that has suggested that FD learners have a strong preference for well-structured learning systems and do not like flexible pathways when seeking to meet their learning goals. In contrast, FI learners have a strong preference for unstructured learning systems and flexible pathways to meet their learning goals (Reed and Oughton, 1997; Chen and Macredie, 2002). One reason for this difference in attitude towards HLS could be owing to the differences in their characteristics, as discussed in Table 2.1, which allow FI learners to be confident and motivated to learn in HLS than FD learners.

However, in the other studies (Alomyan and Au, 2004; Oh and Lim, 2005; Altun and Cakan, 2006), the results showed that cognitive style (FD/FI) did not relate to attitudes towards HLS, with both FD and FI users having a positive attitude towards the HLS. It could be that factors other than cognitive style, including domain knowledge, computer experience and age, may have influenced the findings in these cases.

The findings from the studies reported in the preceding sections suggest that, compared to FD learners, FI learners: prefer being given high levels of freedom of navigation; experience less disorientation in the HLS; perform well in learning tasks; and have a positive attitude towards HLS. One reason for these findings is that FI learners are able to follow a restructuring approach more easily because they are internally directed and tend to adopt an active approach to their learning. Additionally, they can extract relevant items from within a complex context, such as a HLS, because they are more analytical (Witkin and Goodenough, 1977; Chou, 2001; Chen, 2002a; Chen and Liu, 2008). In contrast, FD learners have difficulty imposing structure on ambiguous information and restructuring new information, such as that within a HLS, because they rely on external references and adopt a passive approach to learning (Witkin and Goodenough, 1977; Chou, 2001; Chen, 2002a; Chen and Liu, 2008). They also have difficulties extracting relevant items within a complex context, such as a HLS, because they are less analytical (Chen et al., 2004; Chen and Liu, 2008; Chen L-H, 2010).

Since HLS allow learners to have control over their learning, which may improve learning performance and cognitive flexibility (Mendes and Hall, 1999; Triantafillou et al., 2003), there has been a rapid growth of this type of learning system in Higher Education (Chen and Macredie, 2002; Chen, 2002a; Alomyan, 2004). As a result, FD learners are increasingly likely to be given a HLS to perform their learning. To help FD learners to choose appropriate learning paths through the HLS, which, in turn, can reduce their levels of disorientation, improve their learning performance and increase their learning satisfaction in HLS, it has been suggested that FD learners are assisted through the provision of instructional guidance, for example visual navigational aids in the form of maps (Ford and Chen, 2000; Chen and Macredie, 2002; Chen, 2002a; Fan, 2005) and visual orientation cues (for example, breadcrumbs, link annotation, graphic visualisations and others) (Chen, 2002a; Chen and Macredie, 2002). This reflects Redmond et al's (2003) position that FD learners can learn effectively as FI learners in HLS if they are provided with instructional aids. Therefore, in section 2.5, this study will look at previous work related to visual instructional aids, navigation/disorientation, and learning performance and attitudes to learners with different cognitive style in HLS. This may help designers and developers to gain a better understanding of the link between HLS features and the needs of learners with different individual differences, and how this may support learning and motivation in HLS, and foster positive attitudes towards HLS use (Chen and Macredie, 2010).

Having considered cognitive style, existing research on domain knowledge in HLS will now be discussed.

2.4.2 Domain Knowledge and HLS

Domain knowledge refers to the existing knowledge and experience related to the learning content that is presented in the HLS (Lazonder, 2000; Alomyan, 2004). Empirical research suggests that domain knowledge is an important factor that affects learning in HLS (Last et al., 2001; Caliser and Gurel, 2003; Alomyan, 2004; Mitchell et al., 2005; Chen et al., 2006; Amadieu et al., 2008). Therefore, this study will consider previous research in the area of domain knowledge in HLS where researchers have provided a focus on navigation and disorientation.

With respect to navigation, a number of studies have particularly looked at how learners with different levels of domain knowledge navigate through the learning content in HLS to meet their learning goals (McDonald and Stevenson, 1998a; Holsher and Strube, 2000; Fan, 2005; White et al., 2009; Waniek and Schafer, 2008). The results from these studies suggest that, compared to learners with low levels of domain knowledge, learners with high levels of domain knowledge used more efficient navigation strategies, longer queries and technical query terms to achieve their learning goals in the HLS. Additionally, users with high levels of domain knowledge preferred to learn in a learning system that provides flexible paths, such as HLS, where they could take more non-linear steps through the learning content to reach their learning goals. In contrast, learners with low levels of domain knowledge preferred to learn in a learning system that provided structured paths, as in this way they could easily find the information that they needed in relation to their learning goals.

Having looked into navigation, the effects of domain knowledge on learners' degree of disorientation in HLS is now examined. A number of experimental studies have been conducted to see whether a relationship between levels of domain knowledge and the degree of disorientation in HLS exists (McDonald and Stevenson, 1998a; Chen, 2005; Fan, 2005; Last et al., 2001; Mishra and Yadav, 2006; Amadieu et al., 2009c). The studies used sample sizes between 10 and 65 participants, with participants being either Undergraduate or Master's students, depending on the specific study. In of all the studies, half of the learners had high knowledge whereas the other half had low knowledge about the subject matter that was presented in the HLS. In all of the studies noted, the participants interacted with a HLS to learn a prescribed subject before completing a set of learning tasks. The searching performance was used in these studies to evaluate the effects of domain knowledge on learners' degree of disorientation in HLS.

The results of these studies revealed that domain knowledge influences the degree of disorientation in HLS. Learners with high levels of domain knowledge seemed to be comfortable with non-linear learning, experiencing less disorientation in the HLS. The opposite was found for learners with low levels of domain knowledge: they had difficulties navigating through the HLS to perform their learning and, in turn, experienced high levels of disorientation.

The findings related to domain knowledge, navigation/disorientation and learning performance (as discussed in the preceding sections) suggest that, in general, compared to learners with low levels of domain knowledge, those with high levels of domain knowledge are more comfortable learning in the non-linear learning environment that is provided in the HLS. One of the reasons for this difference is that learners with high levels of domain knowledge are already familiar with the subject content, which enables them to impose a meaningful conceptual structure on it (McDonald and Stevenson, 1998a; Last et al., 2001; Chen et al., 2006). Conversely, learners with low levels of domain knowledge are unfamiliar with the subject content, which makes it difficult for them to impose a meaningful conceptual structure on the content (McDonald and Stevenson, 1998a; Last et al., 2001; Chen et al., 2006).

As there continues to be rapid growth in the use of HLS, designers need to consider how to support learners with low levels of domain knowledge to successfully find their way through the learning content in the HLS to reach the information that they need. It is suggested that those users with low levels of domain knowledge can be assisted through the provision of instructional guidance, for example visual orientation cues and visual navigational aids in the form of maps (Alomyan, 2004; Chen et al., 2006; Chen and Macredie, 2010). Such instructional aids can help these learners to relate to different concepts presented in the HLS, to facilitate navigation or to reduce their orientation problems, which, in turn, can improve learning performance and learning satisfaction. In section 2.5, this study will examine the existing research on visual instructional aids and domain knowledge in HLS.

This chapter will now consider the effects of computer experience on learners' learning in HLS.

2.4.3 Computer Experience and HLS

Computer or system experience refers to knowledge or familiarity with computers, hypermedia and the Web (Lazonder, 2000). Similar to domain knowledge, researchers have suggested that computer experience is an important factor that affects learning in HLS (Alomyan, 2004; Chen, 2005; Mitchell et al., 2005b; Thatcher, 2008; Amadieu et al., 2008). Waniek and Schafer (2009, p.224) suggest that *"system experience is a relevant factor for navigation and orientation in hypermedia, and that, in general, system experience refers to the experience of a user to navigate in a hypermedia environment, and to understand the concept of non-linear electronically linked text documents."*

Research has argued that learners not only need to impose a structure of the learning content that is presented in the HLS, but also to a map a mental representation of the document structure so as to facilitate their navigation and orientation while learning in the HLS (Westerink et al., 2000; Muelle-Kalthoff and Moeller., 2003). The remainder of this section relates to previous works where the effects of computer experience on learners' navigation behaviour and navigation/searching performance in HLS have been examined.

The existing research related to navigation behaviour suggest that learners with high levels of computer experience prefer the non-linear pathways that are normally offered in HLS, which enable them to set their own learning paths to reach their learning goals. In contrast, learners with low levels of computer experience prefer linear pathways where they can easily follow the sequence of the learning content to achieve their learning goals (Reed and Oughton, 1998; Reed et al., 2000; Mitchell et al., 2005b; Cagiltay et al., 2006). This finding reflects previous works (Holscher and Strube, 2000; Kim, 2001), who examined the effects of computer experience on navigation strategy in HLS. Their results showed that learners with high levels of computer experience tended to use the hyperlinks and other tools such as Go, History and Bookmark which allowed them to promote non-linear pathways rather than linear pathways in HLS. In contrast, learners with low levels of computer experience tended to follow more linear pathways, for example linear embedded links, and the back, forward and home buttons, to reach the information that they needed in the HLS.

Having considered navigation behaviour, previous studies related to the effects of computer experience on learners' navigation/searching performance will now be examined. A number of experimental studies have been conducted to examine the effects of computer experience on learners' navigation/searching performance in HLS (Lazonder et al., 2000; Chen, 2005; Tabatabai and Shore, 2005; Aula and Nordhaussen, 2006; Chevalier and Kicka, 2006; Shih et al., 2006; Thatcher, 2008; Waniek and Schafer, 2009; Khosrowjerdi and Iranshani, 2011). The studies used sample sizes between 22 and 135 participants, with participants from various educational and occupational backgrounds.

In all of the studies noted, participants had a range of experience with computers, the Internet and HLS. The participants in these studies were recruited to interact with a HLS to perform a range of web searching tasks. In these studies, navigation/search performance was measured in terms of composing correct queries, the number of learning tasks completed and time efficacy. The results of these studies suggest that, when compared with lower levels of computer experience, learners with high levels of computer experience: navigated effectively; took fewer steps to reach the information that they needed in relation to their learning goals; browsed more pages and were able to reach more detailed levels of the subject content; enhanced their time efficacy; and, overall, performed well in learning tasks in the HLS.

The findings from the studies reviewed have suggested that users with high levels of computer experience have an advantage over those with low levels of computer experience when learning in HLS. It is argued that this is because well-developed understandings of different computer applications (Mustafa, 2005; Thatcher, 2008) enable those with high levels of computer experience to develop mental representations of the information that is presented in the computer system, and because they are more comfortable with non-linear learning (Calcaterra et al, 2005; Mitchell et al., 2005b). In contrast, a lack of skills related to the use of computers and their applications (Mustafa, 2005; Thatcher, 2008) makes it difficult for those with low levels of computer experience to successfully map a mental representation of the information that is presented in the HLS and to successfully navigate through the HLS to find the information that they need (Calcaterra et al, 2005; Mitchell et al., 2005b).

As discussed earlier, with a rapid growth of HLS in higher education, learners are increasingly likely to have access to a HLS to support their learning. To help users with low levels of computer experience to choose appropriate paths through the HLS to achieve their learning goals, it has been suggested that they are assisted through the provision of visual instructional aids – maps and visual orientation cues. In section 2.5, this study will examine some of these instructional aids that are provided in HLS to help users with low levels of computer experience to facilitate their navigation and to reduce their orientation problems, which in turn may improve their learning performance.

Having considered cognitive style, domain knowledge and computer experience, another individual difference in which researchers have shown an interest in relation to HLS is gender, which will be discussed in the following section.

2.4.4 Gender and HLS

Many studies have been conducted in relation to gender differences and Information Technology (Gunn et al., 2003; Ono and Zavodny, 2003). Research further shows evidence that gender differences have significant effects in relation to learning in HLS, with males and females showing different navigation patterns and preferences (Large et al., 2002; Roy & Chi, 2003; Mustafa, 2005; Chen and Macredie, 2010). These concerns further alert designers about the different user interfaces and different navigation support that is required by users of different gender in HLS (Large et al., 2002; Roy et al., 2003a). Therefore, this study will examine previous research on gender differences in HLS, where attention has been paid to the following three themes: navigation/information-seeking; learning performance; and attitudes.

In terms of navigation/information-seeking, a large body of empirical research has focussed on gender differences in HLS (Reed and Oughton, 1997; Ford et al., 2001; Large et al, 2002; Roy and Chi, 2003; Roy et al., 2003a; Hupfer and Detlor, 2006; Lorigo et al., 2006; Liu and Huang, 2008). These studies used sample sizes, between 14 and 422 participants, with participants being either primary school, Undergraduate, Masters or graduate students. The studies recruited the participants to interact with a HLS to search for prescribed information. In the studies noted, navigation behaviour and search performance were used to examine the students' navigation/information-seeking approach.

The results of six of the studies noted (Reed and Oughton, 1997; Ford et al., 2001; Large et al, 2002; Roy and Chi, 2003; Roy et al., 2003a; Liu and Huang, 2008) suggested that gender differences had an effect on students' navigation/information-seeking approaches in HLS. Male students preferred to take more non-linear steps while female students preferred to take more linear steps while navigating through a HLS to look for the information that they required. Additionally, male students formulated more queries and were quicker in meeting their learning goals than female students. Another finding was that, unlike male students, female students: tended to be more nervous and less confident with web-based instructions; experienced more disorientation problems; and depended a lot on navigational aids to perform their learning tasks in HLS. One reason for these findings may be that, compared to male learners, female learners may tend to possess lower levels of computer experience and have less confidence navigating in HLS (Mustafa, 2005).

However, in the other two studies (Hupfer and Detlor, 2006; Lorigo et al., 2006), contrary findings were revealed. For instance, the results from Hupfer and Detlor (2006) suggest that there was no relationship between gender differences and search frequency. Additionally, Lorigo et al.'s (2006) study suggests that, compared to male students, female students took more non-linear than linear pathways while searching through the learning system.

With identified gender differences in learners' navigation/information-seeking approaches, there has been interest in the study of gender differences in relation to learning performance. A number of experimental studies have been conducted to look at the relationship between gender differences and learning performance in HLS (Young and McSporran, 2001; Roy et al. 2003b; Roy and Chi, 2003; Liu, 2004; Price, 2006; Protopsaltis and Bouki, 2008; Yukselturk and Bulut, 2009). The studies used sample sizes of between 14 and 268 participants, with participants being 6th grade, 8th grade or Undergraduate students. In these studies, half of the participants were male and the other half were female. Questionnaires were used in these studies to gather data related to participants' demographic information, and their experience of using computers, the Web and HLS. The studies recruited the participants to interact with a HLS to learn a prescribed learning content before completing a set of learning tasks. In these studies the accuracy of the participants' response to practical tasks, pre and post-test and time performance were used to evaluate their learning performance.

The results of these studies showed mixed results. In two of the studies noted (Young and McSporran, 2001; Price, 2006), the results showed that female students performed better than male students. Female students also completed a greater number of learning tasks than male students. One reason suggested in Young and McSporran's (2001) study for this finding is that male learners tend to be over-confident in their abilities and lack basic skills of time management while performing online learning tasks when compared to female learners. Conversely, in two of the studies (Roy and Chi, 2003; Roy et al., 2003b), it was the male learners who performed better than the female learners. It is argued that this may be because the male learners possessed more experience in using computers, the Web and HLS than did the female learners (Mustafa, 2005).

However, in the remaining studies noted (Liu, 2004; Protopsaltis and Bouki, 2008; Yukselturk and Bulut, 2009), the results revealed no gender differences in the level of learning performance, with both male and female students performing equally well. A reason for this finding may be that both male and female learners possessed the same levels of experience of using computers, the Web and HLS (Prostopsaltis and Bouki, 2008). Kelly (2000) argues that a well-designed HLS can eliminate the disparity in the learning performance between male and female learners, so it is important to look at existing research where instructional aids have been provided to help female learners learning effectively in HLS. This is an issue that will be considered in section 2.5.

Finally, in terms of attitude towards HLS, a number of studies (Jackson et al. 2001; Schumacher and Morahan-Martin, 2001; Liaw, 2002; Koohang, 2004; Broos, 2005; Chen, 2005; Fan, 2005) have looked into gender differences. The studies used sample sizes between 40 and 1058 participants. The studies recruited high school, Undergraduate or Masters students. The studies used a questionnaire to gather data on participants': demographic information, including gender: experience of using computers and Web; and attitudes towards the prescribed HLS. The participants interacted with a HLS to learn a prescribed topic before completing a set of learning tasks.

The results of the seven studies (Jackson et al., 2001; Schumacher and Morahan-Martin, 2001; Liaw, 2002; Koohang, 2004; Broos, 2005; Chen, 2005; Fan, 2005) showed significant effects between gender differences and attitudes. For instance, female participants reported having higher levels of discomfort, being less confident learning in HLS (as supported by Gunn and McSporran, 2003; Mustafa, 2005), and, overall, showing more negative attitudes towards non-linear learning. In contrast, male participants said that they were competent and confident using computers and web-based technologies (as supported by Gunn and McSporran, 2003; Mustafa, 2005) and, overall, favoured the HLS. It is suggested that providing instructional guidance, for example visual instructional aids, can help female learners to have more confidence when learning in HLS (Fan and Macredie, 2006). Therefore, it is essential to look at existing studies where the effects of visual instructional aids and gender differences on learners' attitudes towards HLS have been examined. This area will be reviewed in section 2.5.

The picture about the influences of gender on attitude is not, though, straight forward. In contrast to the seven studies reviewed earlier, other studies have revealed different findings. For instance, Kim et al. (2007) examined gender differences and attitudes in relation to online travel information search. 1334 participants took part in the study and they were required to fill in questionnaires to gather data on their demographic information and attitudes towards online instructions. Their results showed that females had more positive attitudes towards online searching than males. Other studies have shown that there is no relationship between gender differences and attitudes towards HLS (see, for example, Koohang and Durante (2003) and Liu (2004)). These studies used sample sizes between 155 and 1334 participants. Koohang and Durante's (2003) study used questionnaires whereas Liu's (2004) study used questionnaires and interviews to gather data on student's demographic information and attitudes towards HLS. The results of the studies showed no significant gender differences in attitudes towards HLS, with both males and females enjoying learning in the learning system, and showing a positive attitude towards the HLS. Koohang and Durante (2003) suggested that a well-designed HLS can help learners to satisfy their learning goals effectively which, in turn, may eliminate the gender differences in learners' attitudes towards HLS. It could be that common instructional guidance such as visual navigation aids and orientation cues were provided in these studies, though no explicit detail to this end is given. Therefore, it is important to look at previous research on instructional aids and gender in HLS. Examining this area may help designers and developers to have a better understanding about the particular types of instructional aids that are preferred by female learners, which may reduce disorientation and, in turn, improve learning performance and increase positive attitudes in HLS.

The findings reported in Section 2.4 have shown that individual differences (Cognitive style – FD/FI, computer experience, domain knowledge and gender differences) have been given a significant consideration by researchers in the field of HLS. This is because these attributes influence learners' navigation/disorientation, learning performance and attitudes in HLS. The findings have also shown that, in relation to these individual differences, visual instructional aids (in the form of maps and orientational cues) have been suggested to reduce levels of disorientation, which may increase learning performance and satisfaction in HLS. Therefore, it is argued to be useful to examine research on these instructional aids and in relation to the same set of individual differences considered in this study. This will be the focus of the next section.

2.5 Individual Differences and Instructional Guidance in HLS

The studies that were reviewed in section 2.4 mostly suggest that individual differences (cognitive style, domain knowledge, computer experience and gender) influence learners' navigation/disorientation, learning performance and attitudes in HLS. It was also suggested that reducing levels of disorientation experienced by learners with different characteristics may improve their learning performance and, in turn, may lead to learners showing greater interest in learning using HLS (Chen and Macredie, 2002; Chen and Macredie, 2004; Chen et al., 2006). Furthermore, it was suggested that, to reduce learners' disorientation in HLS, the use of instructional guidance, namely visual navigational aids and visual orientational, cues need to be provided. For this reason, this thesis will examine research related to navigational aids and then look at visual orientation cues, both in relation to the same set of individual differences considered in section 2.4.

2.5.1 Individual Differences and Visual Navigational Aids in HLS

To reduce the disorientation problem in HLS, the use of visual navigational aids, for example maps, has been most commonly suggested (McDonald and Stevenson, 1998a; Chen, 2002a; Chen and Macredie, 2002; Alomyan, 2004; Lee et al., 2005; Su and Klein, 2006; Chen et al., 2006; Chen et al., 2008; Amadieu et al., 2009a; Amadieu et al., 2010). Maps are visual graphical representations of the structure of a HLS. Such graphical representations show the learning components and their relationship in the HLS (Cornwell, 2000). Generally, maps can benefit HLS learners in three ways. Firstly, they enable learners to gain an understanding of the relationships between elements of information that are presented in the HLS (Minetou et al, 2008). Secondly, they show a document structure (i.e., the physical arrangement of the HLS document) (Minetou et al., 2008). Thirdly, they facilitate navigation by providing a contextual overview of the structure of the information that is presented in the HLS (Chen et al., 2006). With a growth in HLS use in education, maps can be useful to accommodate learners with different characteristics. For this reason, the rest of this section will look at research on maps in HLS with respect to the same set of individual differences discussed in section 2.4.

First, studies related to cognitive style (FD/FI), maps and HLS will be discussed. As discussed in section 2.4.1, the literature suggests that the degree of field dependence influences learners' learning in HLS. FI learners experience fewer navigation/disorientation problems and perform well in learning tasks; in contrast, FD learners experience more navigation/disorientation problems and in turn perform less well in learning tasks. Studies suggest that visual navigational aids in the form of external conceptual support, for example maps, might supplement FD learners' passive approach to learning and assist them in comprehending and recalling information (Chen and Macredie, 2002; Chen and Macredie, 2004). As a result, their navigation efficacy can increase, their disorientation problems can decrease and their learning performance may improve.

A number of studies have looked at the effects of both maps and cognitive style (FD/FI) on learners' learning in HLS (Umar, 1999; Ford and Chen, 2000; Redmond et al., 2003; Alomyan and Au, 2004; Chen and Macredie, 2004; Parkinson et al., 2004; Fan, 2005; Lin and Chen, 2008). The studies used a range of sample sizes, between 61 and 101 participants, with participants being undergraduate or postgraduate students depending on the studies. In these studies, the GEFT or the CSA instrument was used to determine an individual's cognitive style, where half of the students were FDs, and the remaining half were FIs. A HLS with at least two treatments – maps and index – was developed in the studies. In these studies, the navigation behaviour, searching performance or degree of disorientation of students with FD and FI cognitive styles were examined. Typically, the students interacted with the prescribed HLS to learn a given topic before completing a set of learning tasks. The navigation performance, searching performance and accuracy of answers given were used in the studies to evaluate the students' learning performance and degree of disorientation.

In seven of studies noted (Ford and Chen, 2000; Redmond et al., 2003; Alomyan and Au, 2004; Chen and Macredie, 2004; Parkinson et al., 2004; Fan, 2005; Lin and Chen, 2008), the results mostly showed that when maps were given FD learners' levels of disorientation were reduced and, in turn, they performed as well as FI learners. Additionally, FI learners outperformed FD learners in the index treatment. Furthermore, the results mostly showed that FD learners made more frequent use of the map, whereas FI learners used the index tool more frequently. These findings are supported by other studies (Wang et al., 2000; Chen, 2002a; Chen and Macredie, 2002) that have suggested that external conceptual support in the form of maps or menus help FD learners to gain an understanding of the relationship between sections in the learning content. This leads to learners' levels of disorientation being reduced and, consequently, helps them to perform as well as FI learners in the HLS (Wang et al., 2000; Chen, 2002a; Chen and Macredie, 2002).

However in Umar (1999) study, contradictory results were found. The results mostly showed that FI learners performed better than FD learners in all treatments, including the map. The author of this study concluded that no matter what types of instructional aids are provided, FI learners will still perform better than FD learners.

Having looked at Cognitive style (FD/FI), this section will now examine previous studies that are related to domain knowledge and maps in HLS. The studies that were reviewed in section 2.4.2 suggested that domain knowledge influences learners' learning in HLS. Those with high levels of domain knowledge experience fewer navigation and disorientation problems and, in turn, perform well in the learning tasks. In contrast, those with low levels of domain knowledge have more difficulties finding suitable learning paths through the HLS to meet their learning goals. In turn, they experience more disorientation problems and, consequently, perform less well in the learning tasks. Studies have suggested that visual navigational aids in the form of conceptual support, such as maps, might supplement the lack of conceptual structure of the learning content of learners with low levels of domain knowledge. In this way, their navigation efficacy may increase and their disorientation problems may decrease, and, as a result, they may be more able reach to the information that they need to achieve their learning goals (Chen et al, 2006; Amadieu at al., 2010).

The effectiveness of maps on the learning of users with low and high domain knowledge has received much interest in the HLS field (see, for example, the studies by McDonald and Stevenson, 1998b; Hoffman and Van Oostendorp, 1999; Farrell and Moore, 2001; Calisir and Gurel, 2003; Goumi et al., 2003; Potelle and Rouet, 2003; Minetou et al., 2008; Amadieu et al., 2009a; Amadieu et al., 2009b; Amadieu et al., 2010). These studies used sample sizes between 12 and 146 participants, with participants being either high school students, undergraduate students, graduate students or university staffs. In the studies, the split of the participants was such that half of them had knowledge and the other half had no knowledge about the subject matter covered in the HLS. The participants were tested individually in these studies. In most of the studies noted, a HLS with at least two treatments – conceptual structure (in the form of map) and network structure (in the form of alphabetical list or index) – were developed. Typically, the participants interacted with a HLS to learn a prescribed topic before completing a set of learning tasks. In these studies, learning performance was measured in terms of navigation efficacy, the number of correct paths visited or the number of questions answered correctly.

The results of these empirical studies (McDonald and Stevenson, 1998b; Farrell and Moore, 2001; Calisir and Gurel, 2003; Potelle and Rouet, 2003; Minetou et al., 2008; Amadieu et al., 2009a; Amadieu et al., 2009b; Amadieu et al., 2010) confirmed that maps supported the learners with low levels of domain knowledge to learn effectively in the HLS. For example, when maps were provided, the learners with low levels of domain knowledge opened nodes repeatedly, leading them to reduce their levels of disorientation. Additionally, the maps helped these learners to develop a clear representation of the topics and sub-topics, the concepts and their relationships. In turn, they reviewed most of the learning materials, which consequently, improved their learning performance. In general, these studies suggested that learners with low levels of domain knowledge favoured the maps whereas, learners with levels of domain knowledge preferred to learn with index or alphabetical list.

However, in two of the studies noted (Hofman and Van Oostendrop, 1999; Goumi et al., 2003), contradictory results were found. The results of these two studies showed that learners with low levels of domain knowledge described the maps (which showed the global structure of the HLS) as having too many choices, making the system more complicated and difficult to use. The results of these studies also showed that learners with low levels of domain knowledge scored significantly lower in the map treatment than in the list treatment. It was also reported in these two studies that, overall, the learners preferred the alphabetical list than the map. The researchers from these studies concluded that a map may hinder the understanding of users who have low levels of domain knowledge because it draws their attention to the global structure at the expense of attention to the local structure of the text/content.

Moving onto computer experience, as discussed in section 2.4.3 the literature suggests that level of experience has an effect on learners' learning in HLS. Learners with high levels of computer experience possess appropriate navigation techniques, experience fewer navigation (and lower levels of disorientation) problems in the HLS and, as a result, tend to learn more from the learning content and perform well in learning tasks. A lack of appropriate navigation techniques that they are able to apply in the use of HLS leads learners with low levels of computer experience to experience higher levels of navigation and disorientation problems in the HLS; this causes them to miss sections in the learning content and, as a result, hinders their learning performance. Research suggests that providing concrete models, for example maps, can assist users with low levels of computer experience to form a mental representation of the document structure in the HLS (Chen and Macredie., 2010), which, in turn, can facilitate their navigation, can reduce their levels of disorientation and can lead to improvements in their learning performance.

Fan (2005) examined the effects of navigation tools (map and index) and levels of computer experience in relation to learning performance and attitudes in HLS. 61 undergraduate and postgraduate students took part in this study. The students had to interact with the HLS to learn the learning content of HTML before completing a set of learning tasks. The results showed that users with high levels of computer experience performed significantly better than those with low levels of computer skill in both map and index versions.

Another finding in Fan's study was that, overall, the participants that had low levels of computer experience showed positive attitudes towards maps whereas those that had high levels of computer experience favoured the index. The results suggest that maps assisted those users with low levels of computer experience, guiding the structure of their internal representations. These results are supported by other research (Navarro-Prieto et al., 1999; Holsher and Strube, 2000) that examined the effect of computer experience on search performance in HLS. In these studies, no maps were provided. The findings from Navarro-Prieto et al. (1999) and Holsher and Strube (2000) showed that, unlike users with low levels of computer experience, those with high levels of computer experience possessed appropriate search strategies. Both sets of authors concluded that system and domain knowledge are both important while searching for the information that is required on the Web. This argument is supported by Fix et al. (1993), who suggested that learners with low levels of computer experience cannot develop mental representations themselves and thus fail to use information that is presented in the computer system.

However, Fix et al. (1993) argued that low levels of computer experience learners may fail to use maps in the HLS and may therefore develop a less complete representation of the learning system. This is consistent with the findings from previous studies (for example Laurillard et al., 2000), suggesting that users often disregard the conceptual aids in HLS because they are not always intuitive.

Brinkerhoff et al. (2001) conducted a study to examine the effects of overview mode and levels of computer experience on learning performance, attitudes and instructional time in a HLS. The participants who were college students had to read a hypertext unit that included structured overview, an unstructured overview, or no overview. Results indicated that students that had high levels of computer experience performed better than those with low levels of computer experience, and that, overview mode did not influence achievement. Additionally, participants in the structured or unstructured overview mode spent more time interacting with the HLS and showed more positive attitudes than those in the no overview mode.

It seems little consideration has been given to levels of computer experience and maps in HLS. Therefore, it is imperative to conduct more research in this area.

Moving on to gender and maps in HLS , as discussed in section 2.4.4 the literature suggests that males experience less disorientation and depend less on the instructional aids provided in HLS. In contrast, females experience more disorientation problems and depend more on the navigational aids in HLS. The literature also suggests that females perform less well and show more negative attitudes towards HLS when instructional aids are not provided for them. Studies suggest that visual navigational aids in the form of conceptual support, such as maps might supplement female learners' lack of mental representation of the information that is presented in the learning system. In turn, their navigation efficacy can be enhanced and their levels of disorientation may be decreased, leading to an improvement in learning performance.

A study was conducted by Schmitz and Grunau (2009) to look at the effects of gender differences and maps on student learning in HLS. Their results showed that female students tended to use the maps to navigate and complete the learning tasks more than male students. Similarly, Fan (2005) conducted a study to examine the effects of map and index and gender on learners' attitudes and learning performance in HLS. Fan's (2005) study showed that males and females did not significantly differ in their learning performance. However, the females tended to do better in the map treatment, whereas males did better in the index treatment. Fan's (2005) study also suggested that females had more positive attitudes towards maps, whereas males showed more positive attitudes towards the index aid. These results are supported by Ford and Miller (1996) and Ford et al.'s (2001) studies, with both suggest that females prefer to learn in a well-structured learning environment so as to escape from disorientation problems, which in turn can improve their learning performance.

The discussions in this section have mostly shown that, in relation to the set of individual differences considered in this thesis, visual navigational aids (in the form of maps) reduce disorientation and increase learning performance and positive attitudes in HLS. The next section will discuss the research on visual orientation cues and individual differences in HLS.

2.5.2 Individual Differences and Visual Orientation Cues in HLS

Previous studies suggest that, learners with different characteristics can also suffer high levels of disorientation in the following three ways: (i) "where am I", (ii) "where have I been previously", and (iii) "where can I go next in the HLS." To reduce these three types of disorientation, which in turn, may enhance efficiency of learning performance and satisfaction in HLS, the literature suggest of a set of visual orientation cues – graphical overview diagrams, breadcrumbs, highlighting context, link annotation, different link colours, history based mechanism, pagination and page labels (Chen, 2002a; Chen and Macredie, 2002; Chen and Paul, 2003, Alomyan, 2004; Fan and Macredie, 2006). The remainder of this section will examine the visual orientation cues that have been suggested by previous studies in relation to these three types of disorientation issues in HLS and the same set of individual differences considered in this thesis.

With regards to the first type of the disorientation ("where am I"), learners fail to find their current location while navigating through HLS (McDonald and Stevenson, 1998a; last et al., 2001; Chen et al., 2006). To reduce this type of disorientation, visual orientation cue of ‘breadcrumbs’ (Bowler et al., 2001; Blustein et al., 2005; Aery, 2007; Pardue et al., 2009) have been suggested (Chen et al., 2006, Fan and Macredie, 2006). Typically, ‘breadcrumbs’ can show the trail of links from home page to the current page. From the definition, it is clear that breadcrumb can help learners to find their way back to the starting point if they feel disorientated.

In addition to ‘breadcrumbs’, graphic visualisations (Mohageg, 1996; Nielsen, 2000; Mueller and Moeller, 2003) have been suggested to reduce the first type of disorientation problem in HLS (Chen and Macredie, 2002; Chen and Macredie, 2004; Chen et al., 2006). Typically, graphic visualisation illustrates in graphical form a visual representation of an overall view of the document structure of the HLS, and the relationship between different nodes of information that is presented in the HLS. It is suggested that graphic visualisation with highlighted node can inform learners about their current location in HLS (Chen et al., 2006). Highlighting context, for example, disabled and shaded links, and the text used for the links in different font sizes, styles and colours (De La Passadiere and Dufresne, 1992) can also inform learners about their current location within the text (Chen, 2002a; Chen and Macredie, 2002; Alomyan, 2004; Fan and Macredie, 2006; Chen et al., 2006) that is presented in the HLS.

The second type of disorientation that is experienced by learners in the HLS is – “where have I been previously.” It is argued that such type of disorientation can lead some learners to open unnecessary nodes or not to complete all the learning materials in relation to their overall learning goals, resulting of a waste of time and degradation in learning performance. Studies suggest that link annotation (Brusilovsky, 1998; Brusilovsky et al., 2006) which shows the information behind the links can reduce this problem (Chen, 2002a; Alomyan, 2004; Fan and Macredie, 2006; Chen et al., 2006). Davidovic et al. (2003) suggest that link annotation can support learners to find learn effectively in web-based learning. History based mechanism visual cue, which can show lists of latest previously visited nodes can also inform learners where they have been in the learning content (Pierrakos et al., 2003; Fan and Macredie, 2006). In turn, this can help them to learn effectively. Finally, it is suggested that different colours link (Nielsen, 2000; Chen, 2002a) can inform learners about where they have been previously in the

HLS (Chen et al., 2006). In this way, the risk of repeatedly opening the same page can be low.

The last type of disorientation in HLS – "where to go next." A consequence of this type of disorientation is that learners may miss some of the sections in the learning content that is presented in the HLS, and in turn, can hinder their learning performance. It is suggested that providing pagination, content summaries (Chen, 2002a) and page labels (Lewis and Polson, 1990; Chung 2006) – for example, headings and sub headings – can direct learners where best to go next in the HLS in relation to their learning goals (Chen and Macredie, 2002).

Other studies suggest that graphic visualisations can also reduce the third type of disorientation noted (de Jong and Van der Hulst, 2002). The fact that the graphic visualisation can support users to view their current location and other information that is available in the HLS, in turn, it makes it easier for learners to identify where best next to go in relation to their learning goals (Stevens and Stevens, 1995; Zizi and Beaudouin-Lafon, 1994).

Having examined research on individual differences and visual instructional aids (in the form of visual navigational aids and vision orientation cues) in HLS, this study will now examine the use of another form of instructional aids – audio elements in HLS.

2.6 Individual Differences and Audio Support in HLS

There has tended to be a focus on visual elements in HLS. As discussed in section 2.5, the visual elements have been used to reduce different types of disorientation in HLS which, in turn, can increase learning performance and learning satisfaction. However, there is less research on the use of audio in HLS, and the use of audio instructional aids in the form of speech and non-speech sounds. Speech sounds refer to a speaking menu that helps user to navigate and interact with the computer system to achieve certain goals (Arons, 1991; Yalla and Walker, 2007). Non-speech sounds refer to simple audio cues that are used in computer interfaces to provide information to the user about an interaction, object or event (Brewster, 1997; Garcia et al., 2006). One of the main purposes of non-speech sounds is to provide navigational cues in hierarchical menus ranging from graphical user interface to telephone-based interfaces (Barfield et al., 1991; Brewster, 1998; Walker et al., 2006).

There seem to be a small number of studies which have looked at the use of audio instructional aids in HLS, so it may be useful to consider the potential of audio in HLS. The remainder of this section will examine existing studies on audio in HLS in relation to the three themes that were considered in relation to visual cues – (i) navigation/disorientation, (ii) learning performance and (iii) attitudes – to organise the discussion.

The relationship between audio instructional aids (in the form of speech and non-speech sounds) and disorientation/navigation in HLS has been examined by a small set of studies (Brewster, 1998; Morley et al, 1998; Shajahan and Irani, 2003; Riedel and Wunschmann, 2004; Lokki and Grohn, 2005; Walker and Lindsay, 2006; Walker et al., 2006; Barreto et al, 2007). The studies performed their research within the context of either hierarchical structures or virtual environments. In these studies, the HLS included the audio instructional aids in the form of speech and non-speech sounds. The studies used samples sizes between 9 and 181 participants, with participants being mostly undergraduate students. The studies either used one or both of the following type of participants: sighted and non-sighted.

The results of these studies mostly showed that the audio reduced disorientation and increased navigation efficacy in HLS. For instance, the audio supported the non-sighted participants in the following ways: (i) it supported them to successfully navigate and orientate through the HLS while they were performing their learning; and (ii) it assisted them in differentiating between headings, sub headings and paragraphs in the learning content, which increased comprehension. As far as sighted learners are concerned, they benefited from the audio, too. The audio instructional aids helped the sighted learners to navigate effectively through the content in the HLS to complete the tasks in relation to their learning goals. Additionally, they enabled them to successfully indicate their position in a hierarchy of information that was presented in the HLS.

The findings suggest that audio instructional aids can assist learners to reduce their levels of disorientation and to increase their navigation efficacy when learning in HLS. Such audio instructional aids may support specific individual difference types, helping learners to reduce their levels of disorientation and to facilitate navigation when learning in HLS. Therefore, it would be valuable to examine the effects of individual differences and audio in relation to navigation/disorientation in HLS, especially since little consideration seems to have been given to individual differences and disorientation in HLS.

Besides navigation/disorientation, some researchers have also provided a focus on the impact of audio instructional aids on learners' attitudes in HLS (Berenato and Maynard, 1997; Morley et al., 1998; Poon and Nunn, 2001; Shajahan and Irani, 2003; Frauenberger et al., 2004; Frohlich and Hammer, 2004; Frauenberger et al., 2005, Hodges et al., 2005). These studies also conducted their research within the context of hierarchical structures and virtual environments used samples sizes between 9 and 181 participants, and used mostly undergraduate students as participants. Again, sighted or non-sighted participants, or a mix of the two, took part in the studies, which used either one or both of the speech and non-speech sounds. In most of the studies noted, questionnaires and interviews were used to gather learners' attitudes towards the HLS. Typically, the learners had to navigate through the given hypermedia system to complete a set of prescribed tasks.

The results from the studies revealed that non-sighted learners showed positive attitudes towards the audio cues that were incorporated in the HLS. For instance, these participants said that they appreciated the speech sounds as they helped them to navigate effectively and to find the information that they needed easily and quickly in the HLS. Additionally, they asserted that they were able to successfully orientate themselves within the menu structure that was provided in the audio. Furthermore, they reported that the audio cues that there used to identify different command executions were easy to remember. Finally, they said that the audio motivated and encouraged them to use the HLS for longer, and that, overall, they were satisfied learning in the HLS that incorporated audio as a form of instructional aids.

However, with regards to the sighted users, the results from these studies mostly showed mixed results. Some learners showed positive while others showed negative attitudes towards the audio cues that were provided in the HLS. These studies further suggested that, in general, the sighted learners had a strong preference towards the combination of speech and non-speech sounds in HLS.

The findings from these studies mostly showed that audio increased learners' satisfaction in HLS. This suggests that audio may be useful in motivating and enhancing the satisfaction of learners with different characteristics when using HLS. In order to find out whether, with regards to individual differences, audio can increase learners' satisfaction in relation to HLS, it is, though, imperative to conduct more research as researchers have seemed to neglect the study of individual differences in this context.

Finally, previous work related to the effects of audio on learning performance in HLS will now be examined. A number of studies have looked at the relationship between audio and learning performance in HLS (Hirschberg et al, 1999; Lee et al., 2003; Shajahan and Irani, 2003; Gunther et al., 2004; Hodges et al., 2005; Dingler et al., 2008). As with the other audio-related research, the studies used contexts of virtual environments, HLS or hierarchical structures. The sample sizes for these studies were between eight and 108, with participants being mostly undergraduate and graduate students. The studies used either one or both of sighted and non-sighted participants, and used one or both of the following forms of audio: speech and non-speech sounds. In these studies, learning performance was evaluated through time efficacy, search efficacy or the accuracy of the answers.

The results from the studies suggested that audio reflected learning performance in the HLS. With the provision of the audio, both type of learners (sighted and non-sighted) were able to reach the information that they required in the HLS. In turn, they learned more and, consequently, performed well in learning tasks and enhanced their time efficacy. The results also showed that sounds were an effective means of delivering learning instructions for learners, especially for those who were blind or visually impaired. It is suggested that this form of instructional aid may help learners with different characteristics to improve their learning performance when using HLS, suggesting that the relationship between audio and individual differences in relation to learning performance in HLS needs to be examined through further research.

The studies that were reviewed in this section mostly show that with the provision of audio in HLS, learners' disorientation can be decreased, learning performance improved, and navigation efficacy and satisfaction increased. However, there seems to be a lack of research in relation to audio, individual differences (especially those considered in this thesis), navigation/disorientation, learning performance and attitudes in HLS. More research is needed to fill these gaps, and this will be further discussed in Chapter 3.

2.7 Summary

In this chapter, a review of literature related to individual differences (cognitive style, domain knowledge, computer experience and gender), instructional aids (in the form of visual and audio elements), navigation/disorientation, learning performance and attitudes, and HLS has been presented. The empirical findings show that individual differences influence levels of disorientation, navigation, learning performance and attitudes in HLS. Additionally, the literature reveals that with regards to individual differences, visual instructional aids – maps and a set of visual orientation cues – support learners to reduce their levels of disorientation, which in turn, can improve their learning performance and enhance their satisfaction in HLS. Furthermore, the literature has provided evidence that audio instructional aids can also be used for navigation and orientation purposes in HLS which, in turn, may decrease disorientation, improve learning performance, and increase positive attitudes towards non-linear environment. However, based on the findings related to individual differences, visual elements, audio elements and HLS, there are specific research gaps and issues that merit further consideration. For this reason, Chapter 3 will discuss in detail these gaps, using them to develop research questions and hypotheses that will be explored in the remainder of this thesis.

Chapter 3: Research Questions and Hypotheses

3.1 Introduction

In Chapter 2, literature related to HLS, individual differences (cognitive style, domain knowledge, computer experience, and gender difference), instructional aids (in the form of visual and audio elements) and student learning was reviewed and analysed. The empirical findings from the studies that were considered mostly showed that individual differences influence learners' levels of disorientation, learning performance and attitudes in HLS. Many of the studies concerned with visual support in HLS have suggested that instructional aids – such as visual navigational aids in the form of a map and visual orientation cues – can help to support learners with different characteristics to reduce their levels of disorientation, which may improve learning performance and learning satisfaction. Additionally, findings from the empirical studies concerned with audio mostly showed that instructional aids in the form of audio elements tended to reduce disorientation and increase learning performance and positive attitudes in HLS.

Despite the fact that a number of studies have looked at instructional aids in the form of visual and audio elements in HLS, a number of shortcomings exists in these studies that have been reported. Firstly, with regards to the set of individual differences discussed in this thesis, there is a lack of research where the map visual navigational aid and visual orientation cues have been integrated in a single HLS. This means that there is a lack of evidence of their combined effects in relation to individual differences on learners' disorientation, learning performance and attitudes in HLS.

Secondly, little consideration has been given in published studies to individual differences (especially those considered in this thesis) when examining the effects of audio elements on learners' levels of disorientation, learning performance and attitudes in HLS. Examining these areas may provide results which can help designers to gain a deeper understanding of the relationships between the HLS' visual and audio features, individual differences and students' disorientation, learning performance and attitudes. For this reason, this chapter will look at these gaps in detail and will further develop the research questions and research hypotheses that will be explored in this study. The structure of this chapter is as follows.

Section 3.2 discusses the gaps identified from the studies presented in Chapter 2 in relation to individual differences, visual instructional aids and HLS. Section 3.3 considers the gaps identified from studies presented in Chapter 2 related to individual differences, HLS and audio instructional aids. Section 3.4 then proposes the research hypotheses developed from the analysis of the visual and audio instructional aids in relation to individual differences and HLS. Lastly, Section 3.5 presents a summary of the chapter.

3.2 Gaps in Relation to Visual Instructional Aids and Individual Differences in HLS

The literature demonstrates that HLS is becoming a common learning environment for students in Higher Education. One of the features of HLS is that it supports learners to choose their own learning paths through such non-linear learning environments in order to meet their learning goals. However, some users who experience difficulties in navigating through HLS to reach the information that they need encountering disorientation. A consequence of this disorientation is that learners can miss at least some of the relevant learning content, which may hinder their learning performance.

Performing less well may lead these learners to show less interest in using HLS. There is also a related risk of these learners showing more negative attitudes towards HLS.

A number of empirical studies have been conducted to find out what causes some learners to have difficulties navigating in HLS. The results have found that the characteristics of the learner play an important part, implying that the individual differences that these characteristics represent are important in the design of HLS. A range of studies have looked at the relationship between individual differences and student learning in HLS, with the results mostly showing that individual differences, particularly cognitive style (FD/FI), domain knowledge, computer experience and gender difference influence learners' levels of disorientation, learning performance and attitudes in HLS.

Designing HLS to take into account individual differences such that there is a reduction in learners' levels of disorientation may help in two ways. Firstly, learners may enhance their learning performance. Secondly, they may show more interest in learning in such non-linear learning environments. To reduce levels of disorientation in HLS, visual instructional aids – the map visual navigational aid, and visual orientation cues – have been used or suggested. Although there have been many studies into the relationship between visual instructional aids and individual differences in HLS, gaps remain where further research would be useful. While examining the effects of maps on learners' disorientation, learning performance and attitudes, studies have not used all the individual differences presented in this thesis. Furthermore, the effects of visual orientation cues and all the individual differences considered in this thesis on learners' disorientation, learning performance and attitudes have not been examined. In relation to these two gaps noted, there is a lack of studies where a map and the visual orientation cues have been integrated in a single HLS. This means their combined impact on students' levels of disorientation, learning performance and attitudes for learners with different characteristics have not been examined. Therefore the remainder of this section will look in detail at these gaps.

3.2.1 Gaps that exist in Relation to Visual Navigational Aids and Individual Differences in HLS

With regards to the set of individual differences presented in this thesis, findings from existing studies (as shown in section 2.5.1) mostly show that the use of the map visual navigational aid in HLS reduce disorientation and increase learning performance and positive attitudes. The remainder of this section first discusses these studies. Then, the gaps that exist from these studies will be identified.

The studies related to cognitive style (FD/FI) show that the provision of a map in HLS favours FD learners in different ways. Firstly, maps help FD learners to supplement their passive approach to learning. Secondly, maps assist FD learners in comprehending and recalling information needed to achieve their learning goals. Thirdly, where HLS have maps FD learners perform equally as FI learners. Finally, FD learners seem to be more motivated to learn in HLS when maps are provided than when they are not; and show more positive attitudes towards HLS that provide maps.

In addition to cognitive style (FD/FI), a number of empirical studies have considered maps to be useful for learners with different levels of domain knowledge when learning in HLS. The findings from these studies mostly show that maps help low domain knowledge learners imposing a structure on the HLS learning content. In this way, these learners are able to find the information through the HLS needed to achieve their learning goals. Also, they show more positive attitudes towards HLS which include maps.

The relationship between maps and computer experience in HLS has also been examined. Existing studies have shown that a lack of computer knowledge hinder learners with low computer experience from successfully navigating and orientating through the HLS to reach the information that they need. To reduce this problem, which in turn can increase learning performance and learning satisfaction in HLS, studies have proposed the use of maps.

The final individual difference considered is gender. Studies mostly show that females tend to depend on instructional aids like maps to reduce their levels of disorientation. There also seems to be different effects of maps on learning performance and attitudes depending on gender. For example, females depend more on maps to perform learning tasks than males in HLS; and positive attitudes towards maps tend to be shown by females whereas positive attitudes towards index tools tend to be shown by males.

This section has reviewed the studies presented in Chapter 2 in relation to visual navigational aid of map and individual differences in HLS. The discussion from this section argues that visual navigational aid in the form of maps reduce levels of disorientation in HLS and improve learning performance and positive attitudes to learners with different characteristics. The discussion also suggests that existing studies have provided a focus on the following attributes of individual differences: cognitive style (FD/FI); computer experience, domain knowledge and gender. However, in relation to disorientation, learning performance and attitudes, these studies have not considered the effects between all of these attributes in combination with maps in HLS. Instead, they tend to examine the effects of only one or two of the set of individual differences presented in this thesis. Examining the effects of maps on learners' disorientation, learning performance and attitudes in relation to the set of individual differences presented in this study may provide results which can help designers in the following way. The results may help to determine, with regards to individual differences, whether maps reduce disorientation, and increase learning performance and attitudes to all the users or whether they create some problems to some of them, especially to those who do not need any instructional aids. Depending on these results, designers may design a single HLS that adapt by a range of individual differences or to design one HLS for each of the attribute of the individual differences so as to maintain of an enhance in learning performance and learning satisfaction.

The next section will first discuss the studies that were presented in section 2.5.2 in relation to visual orientation cues, disorientation and individual differences. Then, the gaps identified from these studies will be discussed.

3.2.2 Gaps that exist in Relation to Visual Orientation Cues and Individual Differences in HLS

In addition to maps, in section 2.5.2, a number of studies suggest that visual orientation cues can also reduce disorientation to learners with different characteristics in HLS, which may increase learning performance and learning satisfaction. In the studies noted, the same set of individual differences presented in this thesis has been used. The studies also classify three different types of disorientation that are normally experienced by learners, namely; 'where are they?', 'where have they been?' and 'where can they go next?' For each type of disorientation, these studies suggest certain visual orientation cues (as shown in Table 3.1) as a remedy.

Table 3.1: Different types of disorientation and visual orientation cues

Disorientation type	**Suggestion of visual orientation cues**
Where are they?	Breadcrumbs, pagination, graphical visualisations and highlighting context (in the form of different size, fonts, colours).
Where have they been?	Link annotation, link colours and history-based mechanism.
Where can they go next?	Page labels (in the form of page numbers, content summaries, heading and sub-headings) and link hiding.

The findings in section 2.5.2 have shown that a number of studies have suggested that the visual orientation cues listed in Table 3.1 can reduce disorientation in HLS for learners with different characteristics. Despite the fact that these studies have used the same set of individual differences considered in this research and have considered the visual orientation cues listed in Table 3.1, an important gap remains. There are no studies where all of these individual differences and all of the visual orientation cues listed in Table 3.1 have been considered in the study of a single HLS. This implies that the combined effects of all of these individual differences and all of these visual orientation cues on learners' disorientation, learning performance and attitudes in HLS have not been examined. Examining this gap may provide results which can help designers and developers to gain a better understanding of the relationship between HLS' instructional aids (all the visual orientation cues listed in Table 3.1), individual differences and learners' disorientation, learning performance and learning satisfaction.

With respect to the gaps identified in section 3.2.1 and 3.2.2, the next section will identify a major gap that remains in research related to HLS.

3.2.3 Gaps Related to Visual Navigational Aids, Visual Orientation Cues and Individual Differences in HLS

Consolidating the gaps identified in section 3.2.1 and 3.2.2 suggests that a major gap remains, which will frame three main research questions in this study. The remainder of this section will frame three research questions that reflect the gaps identified in 3.2.1 and 3.2.2. There are no studies where researchers have integrated a map as well as all of the visual orientation cues listed in Table 3.1 in a single HLS. Furthermore, the effects between the individual difference factors (cognitive style, domain knowledge, computer experience and gender) considered in this study on learners' disorientation when using this type of HLS have not been examined.

This study originally sought to examine the effects between the four individual differences (cognitive style, domain knowledge, computer experience and gender – also known as independent variables (IVs) but four or more IVs are rarely used because of the complexity of interpreting the results. Therefore, a decision was made to consider three individual differences and the reasons for choosing them are now discussed. Though, as discussed in section 2.4.4, there are studies indicating that there are gender differences in learning in HLS (for example, Liaw, 2002; Roy and Chi, 2003; Roy et al., 2003b; Liu and Huang, 2008 and others), other studies have argued that there are no gender differences (Kuhang and Durante, 2003; Liu, 2004; Hupfer and Detlor, 2006 and others). Furthermore, other studies suggest that it is not gender differences, but rather another factor – level of computer experience – which influences learning in HLS (Mustafa, 2005; Protopsaltis and Bouki, 2008). What can be stated with certainty is that there are conflicting views in relation to research on gender differences in learning in HLS.

Conversely, research on cognitive style (for example, Dufresne and Turcotte, 1997; Chen and Macredie, 2004; Lee at al., 2005 and others), domain knowledge (for example, Last et al., 2001; Mishra and Yadav, 2006; White et al, 2009 and others) and computer experience (for example, Reed and Oughton, 1998; Kim, 2001; Cagiltay et al., 2006 and others) in learning in HLS has yielded consistent findings. For these reasons, this study decided to use the three individual differences of cognitive style, domain knowledge and computer experience, and chose not to look at gender.

Referring back to the argument in relation to the HLS (with map and visual orientation cues), the effects between the three chosen individual differences (cognitive style, domain knowledge and computer experience) on learners' disorientation has not been examined, offering the study the chance to make novel contributions to the field. This frames the following research question for the study:

Research Question 1(a)

What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?

In addition to disorientation, another relevant theme is the relation between individual differences (cognitive style, domain knowledge and computer experience) and learning performance in a HLS that incorporates a map and visual orientation cues. This leads us to the following research question:

Research Question 1(b)

What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?

Finally, no consideration has been given to learners' attitudes when providing a HLS that combine both maps and all of the visual orientation cues in relation to the set of individual differences considered in this study. The lack of current evidence in this area leads us to frame the following research question:

> **Research Question 1(c)**
> *What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?*

The three research questions proposed in this section (as presented in Table 3.2) will be the focus of part of the practical work in this study.

Table 3.2: The study's research questions related to visual instructional aids and individual differences in HLS

Research Question 1(a): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?
Research Question 1(b): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?
Research Question 1(c): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?

The next section discusses the gaps that exist from previous studies presented in Chapter 2 and these studies are related to instructional aids (in the form of audio elements), HLS, individual differences and student learning.

3.3 Research Gaps Related to Audio Instructional Aids and Individual Differences in HLS

In chapter 3, it is argued that instructional aids (in the form of audio elements) can also assist learners to reduce their levels of disorientation, which in turn may increase learning performance and learning satisfaction in HLS. However, a major gap remains in these studies. Little consideration seems to have been given to individual differences, especially those considered in this thesis, in spite of the effectiveness of audio in HLS. This leads this study to frame three research questions related to audio. The remainder of this section will discuss in detail the gaps and the resulting research questions.

In section 2.6, the results from the empirical studies mostly showed that audio helped learners to reduce their levels of disorientation in HLS. However, these studies have not considered the role of individual differences. As explained in section 3.2.2, this study will consider the following three individual differences – cognitive style, domain knowledge and computer experience, leading to the following research question:

> **Research Question 2 (a)**
> *What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?*

With respect to learning performance, the empirical studies presented in section 2.6 mostly argued that when audio is provided in HLS learners are able to complete all prescribed learning tasks that are required to achieve their learning goals. The provision of audio in HLS also assists them to accomplish their learning within shorter periods of time. In turn, their learning performance is enhanced. However, these studies have not provided a focus on individual differences. This shows us that there is a lack of evidence to show that the effects between individual differences (cognitive style, domain knowledge and computer experience) and instructional aid (in the form of audio elements) on learning performance in HLS have been examined. This lack of evidence frames a second audio-related research question for this study:

Research Question 2(b)

What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?

Finally, in terms of attitudes, the findings from the studies presented in section 2.6 suggested that, in general, learners show positive attitudes towards HLS that provide instructional aids in the form of audio elements. For instance, audio motivates and encourages learners to use HLS for longer. Additionally, they can easily remember the audio that identifies different commands. However, in these studies, researchers seem to neglect individual differences, such as cognitive style, domain knowledge and computer experience, while looking at the relationship between audio elements as instructional aids and attitudes in HLS. Based on this gap, the following research question is proposed:

Research Question 2(c)

What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?

Answering these research questions (shown in Table 3.3), will be another objective of conducting this study.

Table 3.3: The study's research questions related to audio instructional aids and individual differences in HLS

Research Question 2(a): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?
Research Question 2(b): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?
Research Question 2(c): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?

The next section will propose research hypotheses developed from the research questions (presented in Tables 3.2 and 3.3).

3.4 Research Hypotheses

Earlier in section 3.2 and section 3.3, the gaps that exist between the instructional aids (in the form of visual and audio elements) and individual differences in HLS were identified. The research questions (as presented in Table 3.2 and Table 3.3) suitable for this study were also addressed. In this section, the research hypotheses developed from the analysis in section 3.2 and section 3.3 are addressed. This section is divided into two parts. Section 3.4.1 proposes the research hypotheses developed from the analysis of providing instructional aids (in the form of visual elements) in a HLS in relation to individual differences. In section 3.4.2, the research hypotheses developed from the analysis of providing instructional aids (in the form of audio elements) in a HLS in relation to individual differences are proposed.

3.4.1 Visual Instructional Aids, Individual Differences, HLS and Research Hypotheses

This section proposes the research hypotheses developed from the analysis of providing visual instructional aids in HLS in relation to the following set of individual differences: cognitive style – FD/FI, domain knowledge (DK) and computer experience (CE). Research question 1(a) in Table 3.2 was proposed to examine the effects between individual differences on students' levels of disorientation when using a HLS that provides a map and the visual orientation cues and when using a HLS without any instructional aids. In attempting research question 1(a), the following research hypotheses can be drawn:

Research Hypothesis 1

FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will experience higher levels of disorientation in the HLS that provides no instructional aids than FI users with the same experience profile.

Research Hypothesis 2

Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will not experience higher levels of disorientation in the HLS that incorporates visual instructional aids.

In addition to research question 1(a), the purpose of research question 1 (b) was to examine the effects between individual differences on learning performance when using a HLS which includes a map the visual orientation cues when using a HLS without instructional aids. With respect to this research question, the following hypotheses are proposed for investigation in this study:

Research Hypothesis 3

FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform less well in the HLS that provides no instructional aids than FI users with the same experience profile.

Research Hypothesis 4

Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform equally well in the HLS that incorporates visual instructional aids.

Finally, the aim of third research question in Table 3.2 was to examine the effects between individual differences on learners' attitudes when using a HLS that includes a map and the visual orientation cues and when using a HLS without any instructional aids. This leads to the following research hypotheses:

Research Hypothesis 5

FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show more negative attitudes towards the HLS that provides no instructional aids than FI users with the same experience profile.

Research Hypothesis 6

Both FD and FI users with the same experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show positive attitudes towards the HLS that incorporates visual instructional aids.

The research hypotheses presented in this section (summarised in Table 3.4) will be tested later in this study.

Table 3.4: Research hypotheses related to visual instructional aids in HLS, individual differences and students' learning

Research question 1(a) related to disorientation, individual differences and HLS (without instructional aids and with visual instructional aids)	**Research Hypothesis 1** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will experience higher levels of disorientation in the HLS that provides no instructional aids than FI users with the same experience profile.	**Research Hypothesis 2** Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will not experience higher levels of disorientation in the HLS that incorporates visual instructional aids.
Research question 1(b) related to learning performance, individual differences and HLS (without instructional aids and with visual instructional aids)	**Research hypothesis 3** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform less well in the HLS that provides no instructional aids than FI users with the same experience profile.	**Research Hypothesis 4** Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform equally well in the HLS that incorporates visual instructional aids.
Research question 1(c) related to attitudes, individual differences and HLS (without instructional aids and with visual instructional aids)	**Research Hypothesis 5** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show more negative attitudes towards the HLS that provides no instructional aids than FI users with the same experience profile.	**Research Hypothesis 6** Both FD and FI users with the same experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show positive attitudes towards the HLS that incorporates visual instructional aids.

The next section presents research hypotheses related to audio elements, disorientation, learning performance, attitudes and individual differences.

3.4.2 Audio Instructional Aids, Individual Differences, HLS and Research Hypotheses

The aim of research question 2(a) was to examine the effects between individual differences on students' disorientation when using a HLS which provides instructional aids (in the form of audio elements) in HLS and when using HLS without instructional aids. In attempting to answer research question 2(a), this study will test the following research hypotheses:

Research Hypothesis 7

FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will experience higher levels of disorientation in the HLS that provides no instructional aids than FI users with the same experience profile.

Research Hypothesis 8

Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will not experience higher levels of disorientation in the HLS that incorporates instructional aids (in the form of audio elements).

Research question 2(b) aims to explore the effects between individual differences on learning performance when using a HLS which provides instructional aids in the form of audio elements, and when using a HLS without these instructional aids, leading to the following research hypotheses:

Research Hypothesis 9

FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform less well in the HLS that provides no instructional aids than FI users with the same experience profile.

Research Hypothesis 10

Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform equally well in the HLS that incorporates instructional aids (in the form of audio elements).

Finally, research question 2(c) relates to the gaps that exist between individual differences and audio instructional aids in HLS in relation to attitudes, leading to the following research hypotheses:

Research Hypothesis 11

FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show more negative attitudes towards the HLS that provides no instructional aids than FI users with the same experience profile.

Research Hypothesis 12

Both FD and FI users with the same experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show positive attitudes towards the HLS that incorporates instructional aids (in the form of audio elements).

The research hypotheses presented in this section (summarised in Table 3.5) will be tested later in this study.

Table 3.5: Research hypotheses related to audio instructional aids in HLS, individual differences and students' learning

Research question 2(a) related to disorientation, individual differences and HLS (without instructional aids and with audio instructional aids)	**Research Hypothesis 7** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will experience higher levels of disorientation in the HLS that provides no instructional aids than FI users with the same experience profile.	**Research Hypothesis 8** Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will not experience higher levels of disorientation in the HLS that incorporates instructional aids (in the form of audio elements).
Research question 2(b) related to learning performance, individual differences and HLS (without instructional aids and with audio instructional aids)	**Research Hypothesis 9** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform less well in the HLS that provides no instructional aids than FI users with the same experience profile.	**Research Hypothesis 10** Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform equally well in the HLS that incorporates instructional aids (in the form of audio elements).
Research question 2(c) related to attitudes, individual differences and HLS (without instructional aids and with audio instructional aids)	**Research Hypothesis 11** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show more negative attitudes towards the HLS that provides no instructional aids than FI users with the same experience profile.	**Research Hypothesis 12** Both FD and FI users with the same experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show positive attitudes towards the HLS that incorporates instructional aids (in the form of audio elements).

3.5 Summary

In this chapter, the studies considered in chapter 2 – related to HLS, instructional aids (in the form of visual and audio elements), individual differences, disorientation, learning performance and attitudes – were reviewed. This chapter also identified gaps in the literature and developed associated research questions and hypotheses to be addressed through an empirical study. In the next chapter, this thesis will discuss the appropriate research methodology needed to answer these research questions and to test the research hypotheses.

Chapter Four: Research Methodology

4.1 Introduction

In Chapter 3, relevant gaps from the studies presented in Chapter 2 were identified leading to the identification of research questions and hypotheses. This chapter will develop the research methodology used to address these research questions and to test these research hypotheses. The aim of the practical studies developed to achieve this was to examine the effects of and between cognitive style, domain knowledge and computer experience on disorientation, learning performance and attitudes in relation to two different types of instructional aids (visual and audio) in a HLS. Generally, this study employed an experimental research approach, where two experiments were conducted to test the hypotheses and to answer the research questions. Additionally, user data was gathered using an open-ended questionnaire, direct observation and semi-structured interviews in order to provide additional evidence in relation to the research questions.

The structure of this chapter is as follows. Section 4.2 identifies an appropriate research design for this study. Sections 4.3 to 4.6 present the methods used within the design, and explains the sample, data collection instruments and procedures. Section 4.7 determines the data analysis techniques used with respect to both the experimental study and the additional user data. Section 4.8 provides a summary of the chapter.

4.2 Research Design

This section identifies the research design that was deemed most appropriate for this study. As discussed in chapter 3, the two aims of this study were to:

1. examine the effects of and between a set of individual differences (cognitive style, domain knowledge and computer experience) on learners' disorientation, learning performance and attitudes when using a HLS with instructional aids (in the form of visual elements) and when using a HLS without any instructional aids;
2. examine the effects of and between a set of individual differences (cognitive style, domain knowledge and computer experience) on learners' disorientation, learning performance and attitudes when using a HLS with instructional aids (in the form of audio elements) and when using a HLS without any instructional aids.

To meet these aims, six research questions (presented in Tables 3.2 and 3.3) were identified, leading to 12 research hypotheses (presented in Tables 3.4 and 3.5). To answer these research questions and to test the resulting research hypotheses, this study employed the scientific method (in the form of a quantitative approach) known as Experimental Research (Ross and Morrison, 1996; Walliman, 2001; Johnson et al., 2007). Two experiments were undertaken in this study: experiment 1 was conducted to meet the first aim; and experiment 2 was conducted to meet the second aim. For each experiment, a set of independent variables and dependent variables were identified and used. The independent variables were the HLS features and the users' individual differences. With respect to the HLS features, three HLS, one without instructional aids, one with instructional aids (in the form of visual elements) and one with instructional aids (in the form of audio elements), were required. The design and development of the three HLS are explained in detail in sections 4.4.1-4.4.3.

With respect to the users' individual differences, as discussed in Chapter 3, the set of individual differences used in this study comprised cognitive style, domain knowledge and computer experience. The measurement of these independent variables is explained in section 4.4. The dependent variables in this experimental study were learning performance, disorientation and attitudes towards the given HLS. The measurement of these dependent variables is also explored in section 4.4.

For each experiment, a between-subjects design was used. This means that, for each experiment, one half of the sample used a HLS which provided instructional aids (visual or audio) whereas the second half of the sample used a HLS that provided no instructional aids. A between-subjects design was deemed to be suitable for this research as it avoided participants' scores being influenced by factors such as fatigue or boredom as a result of participating in the two treatments (with and without instructional aids).

This study also aimed to gather detailed user information on individual differences, learners' attitudes, feelings, preferences, suggestions, and their experience of disorientation with respect to the HLS which they used in the study. Additionally, this study wanted to gain an improved understanding of users' interaction behaviour with the HLS (with instructional aids; and without instructional aids) in terms of navigation, disorientation, and so on. Since it would not have been possible to achieve these aims using the experimental study on its own, a descriptive study was also employed (using a qualitative approach), in which learners were observed, surveyed and interviewed (Ross and Morrison, 1996; Hoff and Witt, 2000; Kruger, 2003; Straub et al., 2004; Myers, 2009). The data collection techniques and the associated instruments, needed to perform this descriptive study are discussed in detail in section 4.4.

In order to conduct the experimental and descriptive research, the following methods and issues had to be determined/addressed: sample; materials and data collection instruments; pilot study; and procedures. These will be covered in sections 4.3 to 4.6 event.

4.3 Sample

This section discusses the sample chosen for the experimental and descriptive study. The sample was drawn from university students across London. University students were considered to be a suitable sample for two reasons. Firstly, as mentioned in Chapter 1, since this study is concerned with research that is related to students and HLS in higher education, using university students as the target sample was deemed appropriate. Secondly, it was easy to contact a large number of students at universities in the London region from which to recruit the sample.

Since this study used a three-way ANOVA (which is discussed in detail in section 4.7.1), a minimum of 12 participants were needed in each group to ensure a sample that had the potential for revealing significant results (see Tables 4.1 and 4.2), giving a total of 384 participants (192 in experiment 1; 192 in experiment 2).

Table 4.1: Experiment 1and distribution of participants needed according to their cognitive style, DK and CE

Experiment 1							
HLS that provided no instructional aids				**HLS that incorporated visual instructional aids**			
	FI	FD	Total		FI	FD	Total
Low DK and low CE	12	12	24	Low DK and low CE	12	12	24
Low DK and high CE	12	12	24	Low DK and high CE	12	12	24
High DK and low CE	12	12	24	High DK and low CE	12	12	24
High DK and high CE	12	12	24	High DK and high CE	12	12	24
Total	48	48	96	Total	48	48	96
Total number of participants = 96 + 96 = 192							

Table 4.2: Experiment 2 and distribution of participants needed according to their cognitive style, DK and CE

Experiment 2							
HLS that provided no instructional aids				**HLS that incorporated audio instructional aids**			
	FI	FD	Total		FI	FD	Total
Low DK and low CE	12	12	24	Low DK and low CE	12	12	24
Low DK and high CE	12	12	24	Low DK and high CE	12	12	24
High DK and low CE	12	12	24	High DK and low CE	12	12	24
High DK and high CE	12	12	24	High DK and high CE	12	12	24
Total	48	48	96	Total	48	48	96
Total number of participants = 96 + 96 = 192							

The sample population was recruited as follows. Each potential participant first had his/her cognitive style, levels of DK and CE identified. Individuals with suitable combinations of characteristics were allocated to the relevant group; if the group was already at the required number (12), no more participants with that combination of characteristics were admitted to the group. The 'admitted' participants then undertook the subsequent stages of one of the two experiments (experiment 1 or experiment 2), using one of the three versions of the HLS (one without instructional aids, one with visual instructional aids, and one with audio instructional aids).

A total of 384 participants were involved in this study: 192 participated in the first experimental study; and the remaining 192 participated in the second experimental study. Out of the 192 students in experimental study 1, 96 used the HLS that provided no instructional aids and 96 used the HLS that provided instructional aids (in the form of visual elements). Out of the 192 students in experimental study 2, 96 used the HLS that provided no instructional aids and 96 used involved in the HLS that provided instructional aids (in the form of audio elements).

The participants were at undergraduate, postgraduate taught and postgraduate research levels and were registered on a range of courses. They were informed about the experimental study through a discussion forum, notice boards in the Students' Unions of universities across London and by word of mouth. They were also told that taking part in this study would help them to learn and to build their own web site, either for personal or business purposes, and that small incentives in the form of soft drinks, sweets and snacks would also be offered at the end of the practical study. The following instructions were delivered to the participants via email two days before the experiment was due to begin:

- The experimental study would take place in one of the usability labs at Brunel University;
- The identity of the subjects would be kept confidential;
- The data collected for each subject would remain strictly confidential;
- A small break would be given in between the tasks;
- The length of the experimental study would be of a maximum of two and a half hours.

Having discussed the sample, the next section describes the materials and data collection instruments used in the experimental study.

4.4 Materials and Data Collection Instruments

To conduct the two experiments, a range of materials and data collection instruments were used: (1) learning content for the three HLS; (2) HLS without any instructional aids for experiment 1 and experiment 2; (3) HLS with instructional aids (in the form of visual elements) for experiment 1; (4) HLS with instructional aids (in the form of audio elements) for experiment 2; (5) Cognitive Styles Analysis (CSA) instrument to identify students' field dependence; (6) Learning performance questions (in the form of pre-test and post-test questions, and practical task sheet); (7) questionnaires to gather data on students' disorientation and attitudes towards specific features of the HLS; (8) an interview form to gain an improved understanding on students' levels of disorientation and attitudes towards the HLS; and (9) an observation form to gather data on users' interaction behaviour with the HLS. The remainder of this section describes each of the materials and instruments.

4.4.1 Learning Content for the HLS

This section justifies the learning content that was chosen for the three HLS in this study. Generally, the participants were required to interact with one of the HLS to learn a learning content. Having done so, they needed to complete a set of learning tasks (in the form of a post-test and practical task). The learning content and learning tasks were essential as this study needed to evaluate the effects of the HLS' features on users' learning performance in relation to individual differences.

The learning content chosen for each HLS was an Extensible Hypertext Mark-up Language (XHTML) tutorial. This learning content was selected for the following three reasons. Firstly, in order to find out whether a specific feature of HLS influences users' learning, it was vital to include a tutorial on a subject which was not likely to be understood by the respondents. In this way, more interaction with the HLS would be needed if the subjects were to learn the material. Secondly, this learning content would assist in determining whether, with regards to individual differences, learners' learning performance (in term of conceptual and procedural aspects) were influenced when using the HLS. Thirdly, it was felt that learning to design and build web pages would be of wide interest and would help to attract participants.

The XHTML tutorial was comprised of seven lessons, each with a minimum of three and a maximum of seven sections. The lessons covered:

- Introducing XHTML;
- How to create, save and view XHTML documents;
- Basic XHTML formatting;
- Creating Lists;
- How to use images;
- How to insert links within a page;
- How to create tables.

Each lesson had an introduction at the top of the page and instructions alongside relevant pseudocode, as can be presented in figure 4.1.

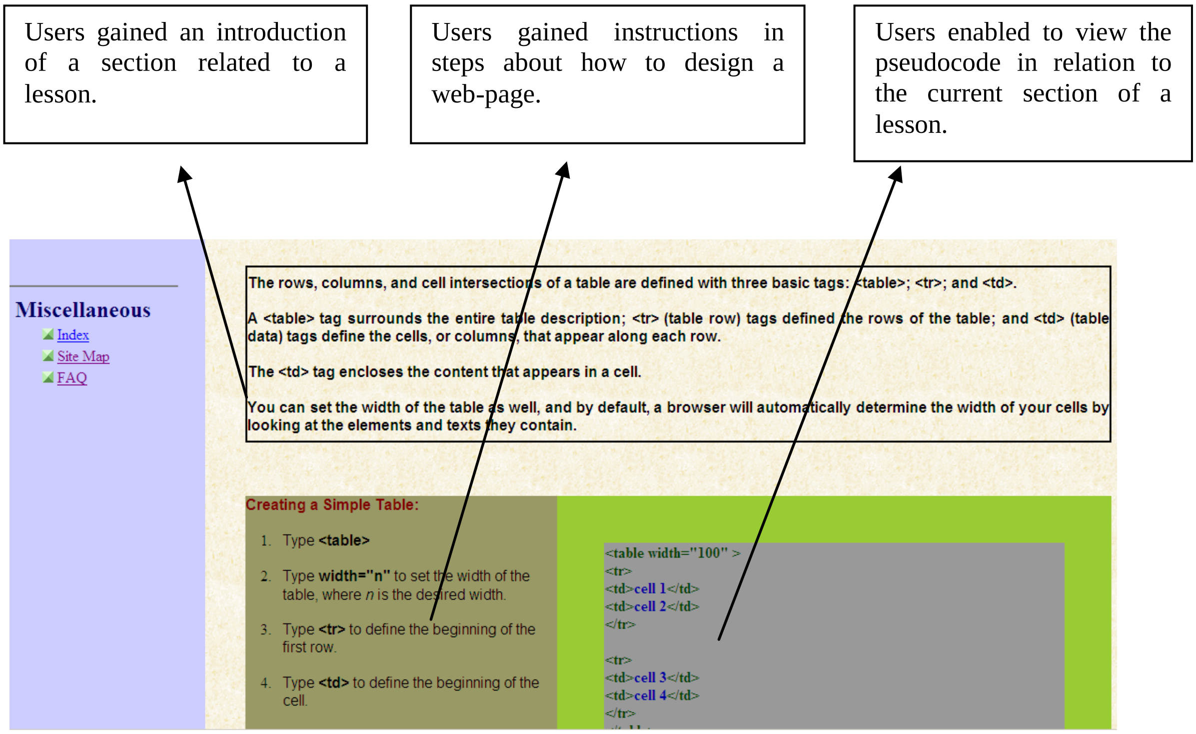

Figure 4.1: Introduction and instructions in relation to the XHTML tutorial

Sections 4.4.2 to 4.4.4 discuss the design and development of the three HLS (one with no instructional aids; one with visual instructional aids; and one with audio instructional aids) used in this study.

4.4.2 HLS without Instructional Aids for Experiment 1 and Experiment 2

As part of experiment 1 and experiment 2, a HLS without instructional aids was designed and developed. The HLS presented the XHMTL tutorial using a non-linear structure. Users could set their own learning paths to meet their learning goals in the HLS, and had more control over the tutorial in the HLS. For example, as can be seen in figure 4.2, the users could navigate the HLS to access content in accordance with their information needs and navigation preferences. Additionally, the backward and forward buttons that were provided by default by the browser permitted users to navigate (respectively) backward and forward in the HLS.

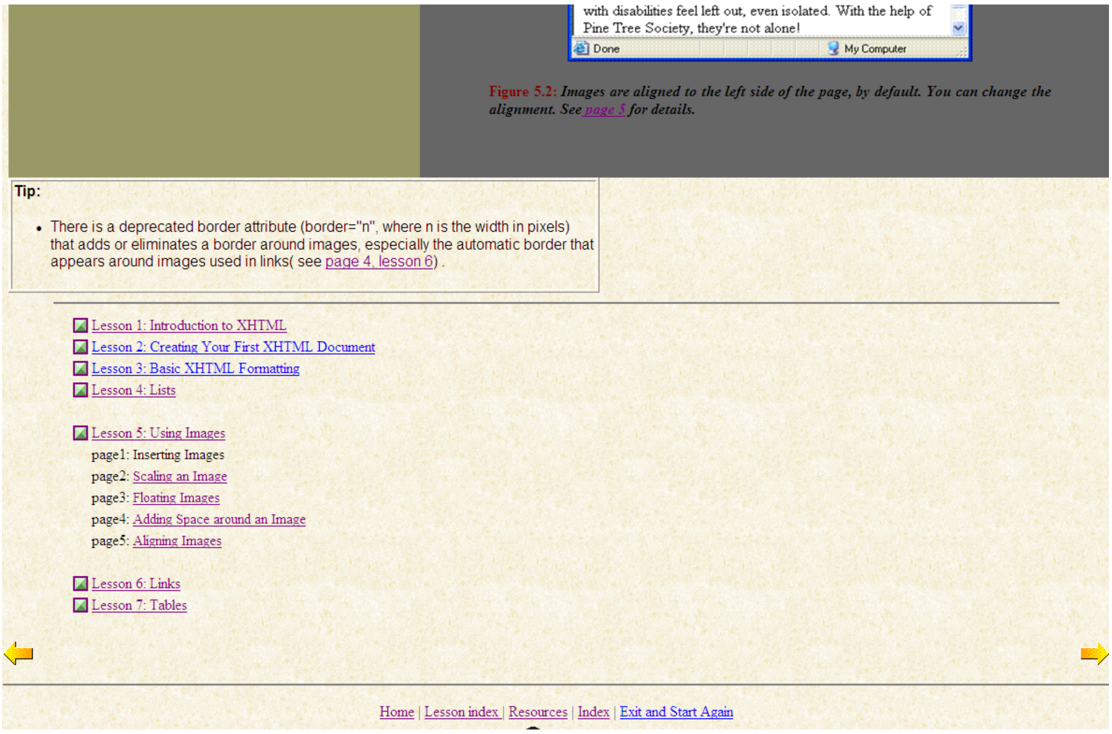

Figure 4.2: HLS and non-linear structure

The section further considers the index navigation tool that was offered in the HLS.

The index navigation tool showed a list of the links in relation to the XHTML content in alphabetical order. The users were able to open the desired links irrespective of their order. For instance, with regards to figure 4.3, the users could view a list of the links in relation to the XHTML tutorial, which was organised in alphabetical order. The users could also click on any of those links to reach specific information that they needed in relation to their learning goals.

Figure 4.3: HLS and index navigation tool

Section 4.4.3 presents the design and the development of the second HLS incorporating visual instructional aids, which was used to conduct experiment 1.

4.4.3 HLS with Instructional Aids (Visual Elements) for Experiment 1

For experiment 1, a HLS incorporating visual instructional aids (map and a set of visual orientation cues listed in Table 3.1) was designed and developed. The visual navigational aid was in the form of a map and the visual orientational cues were in the form of: link colours; link annotation; breadcrumbs; pagination; page labels in the form of heading and sub-heading; history based mechanism; graphic visualisation; and highlighting context. The section starts with a discussion of the visual navigational aid offered by the map, and the visual cues offered by the link colours.

The map assisted users in three ways. Firstly, the map represented the global overview of the XHTML tutorial that was presented in the HLS. This overview representation gave students an idea of how many topics were in the tutorial. Secondly, the map offered users a representation of the relationships between the information presented in the HLS. For instance, as seen in figure 4.4, the main menu is related to the five main sections: home;

lesson index; resources; index; and Frequently Asked Question (FAQ). Figure 4.4 also shows that the lesson index is related to lesson 1, lesson 2, and so on. Lesson 1 has three sub-sections: introducing XHTML; How XHTML works; and XHTML Syntax. The visual representation provided by the map allowed users to gain an understanding of the relationship between the information that was presented in the HLS.

Thirdly, the conceptual structure of the information presented in the HLS that the map provided assisted users in navigating through the tutorial to find the information that they needed in order to achieve their learning goals. Users could click on the links to navigate directly to a desired location in the HLS.

The different colours link colours informed users about the pages that they had visited. This approach prevented them from repeatedly opening the same page they had visited earlier, hence, a save of time. For instance, as can be seen in figure 4.4, the visited pages were home, lesson index, resources and so on.

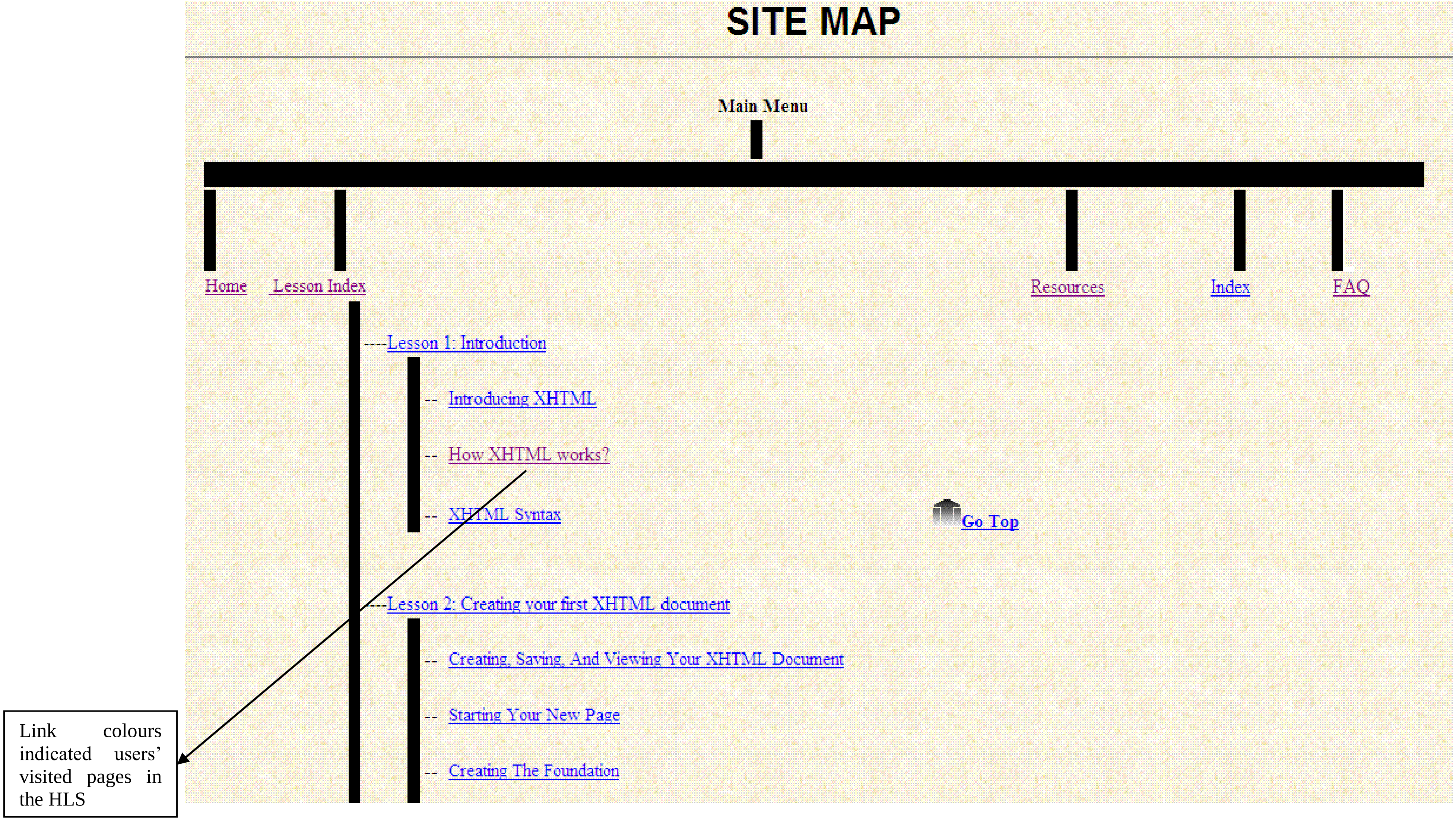

Figure 4.4: Visual instructional aids, showing map and link colours

The section will now consider four more visual orientation cues provided by the HLS: breadcrumbs; pagination; page labels; and the annotation of links.

The 'breadcrumb' visual orientation cue assisted users in finding their current location in the HLS and the path that led them there. As seen in figure 4.5, users can observe two things from the visual cue. Firstly, they can see that they are currently on page 3: TARGETTING LINKS. Secondly, they can see the paths that have led them to their current location, which is from the home page through lesson index and lesson 6 home pages.

The 'pagination' visual cue served the following purposes. Firstly, it allowed users, especially those with low domain knowledge, to gain an idea of how many pages were included in relation to the section that they were currently viewing. Secondly, with regards to a section that they were exploring in the tutorial as their current goals, the pagination assisted users in finding the following: the page they were on; the number of pages they had viewed; and how many pages they had left to view in relation to their learning goals. Generally, the pagination facilities directed users, especially with low domain knowledge where best to go in the tutorial in order to achieve their learning goals. For instance, as can be seen in figure 4.5, the pagination labelled as 'page 3 of 4' clearly showed users that they were currently on page 3 of 4 in relation to the section that they were viewing in the tutorial. Furthermore, in relation to this section, the pagination tended to inform users of the following: there were four pages for the section; they had visited pages 1-3; and that they needed to complete the last page.

The 'page labels' cue, in the form of heading and sub-heading, assisted users in deciding the appropriate coherent paths in relation to their current learning goals. For instance, in figure 4.5, the page had a heading of 'lesson 6: LINKS' and a subheading of 'TARGETTING LINKS'. Users could also easily differentiate between the heading and the sub-heading from the size and colour used.

The link annotation cue provided users with information about a link in relation to the XHTML tutorial. For instance, with regards to figure 4.5, when users moved their mouse over the link labelled 'Lesson Index?' they were presented with the following information - 'This link will take you to the lesson index page where you can view or open all the lessons that are presented in this tutorial.' Being given such information, users, especially those with low domain knowledge, could be confident that they were opening the right node in relation to their current learning goals.

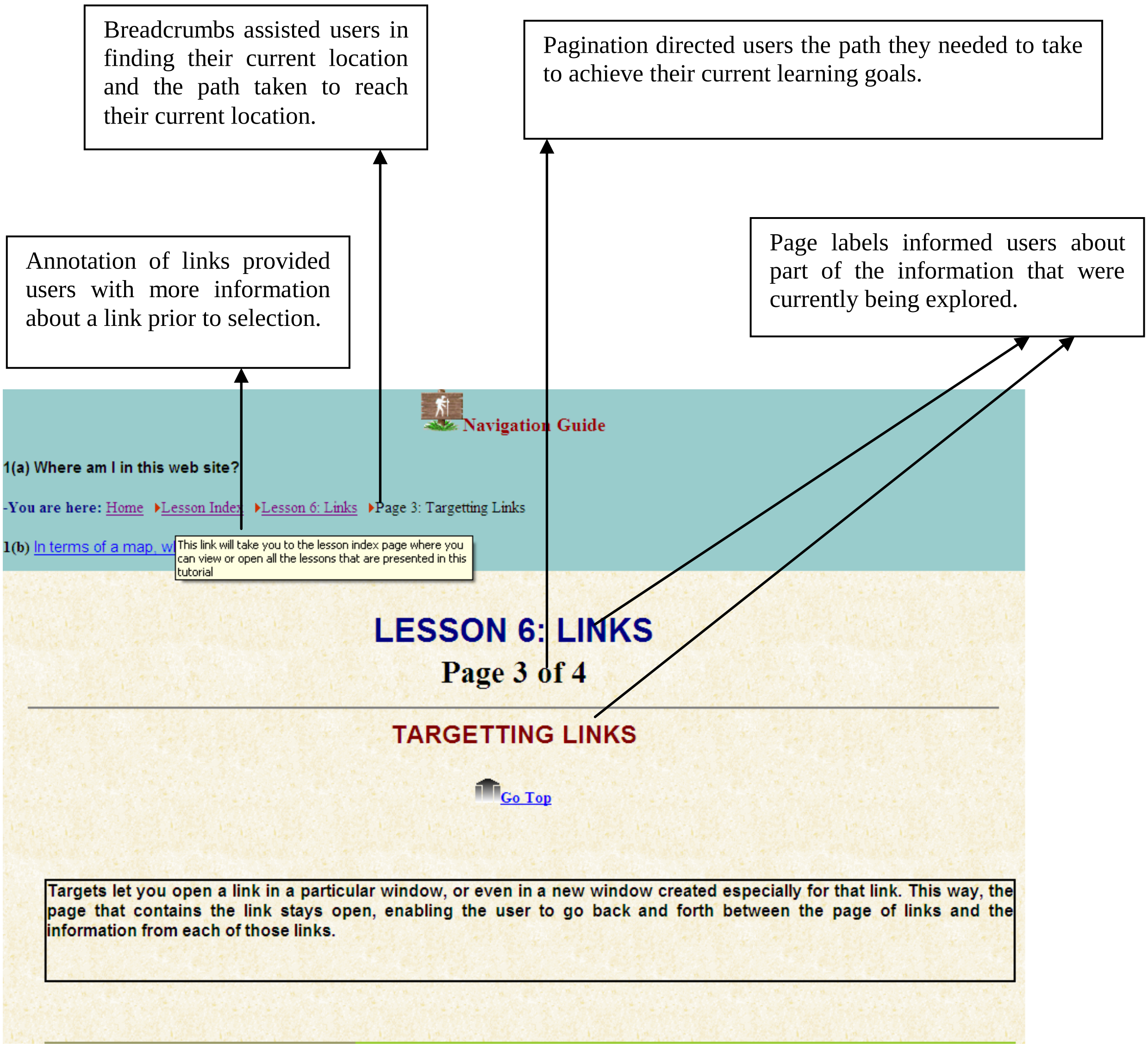

Figure 4.5: Orientation cues of breadcrumbs, pagination, and link annotation and page labels

The section will now consider another visual cue: the history- based mechanism. The 'history-based mechanism' cue allowed users to view and access the last two visited pages in relation to the tutorial. With this visual cue, the chance of unintentionally opening repeated nodes was reduced. For instance, with regards to figure 4.6, the two most recently visited pages were lesson 4 and lesson 1, and learners could click on the links related to these lessons to access the relevant learning content.

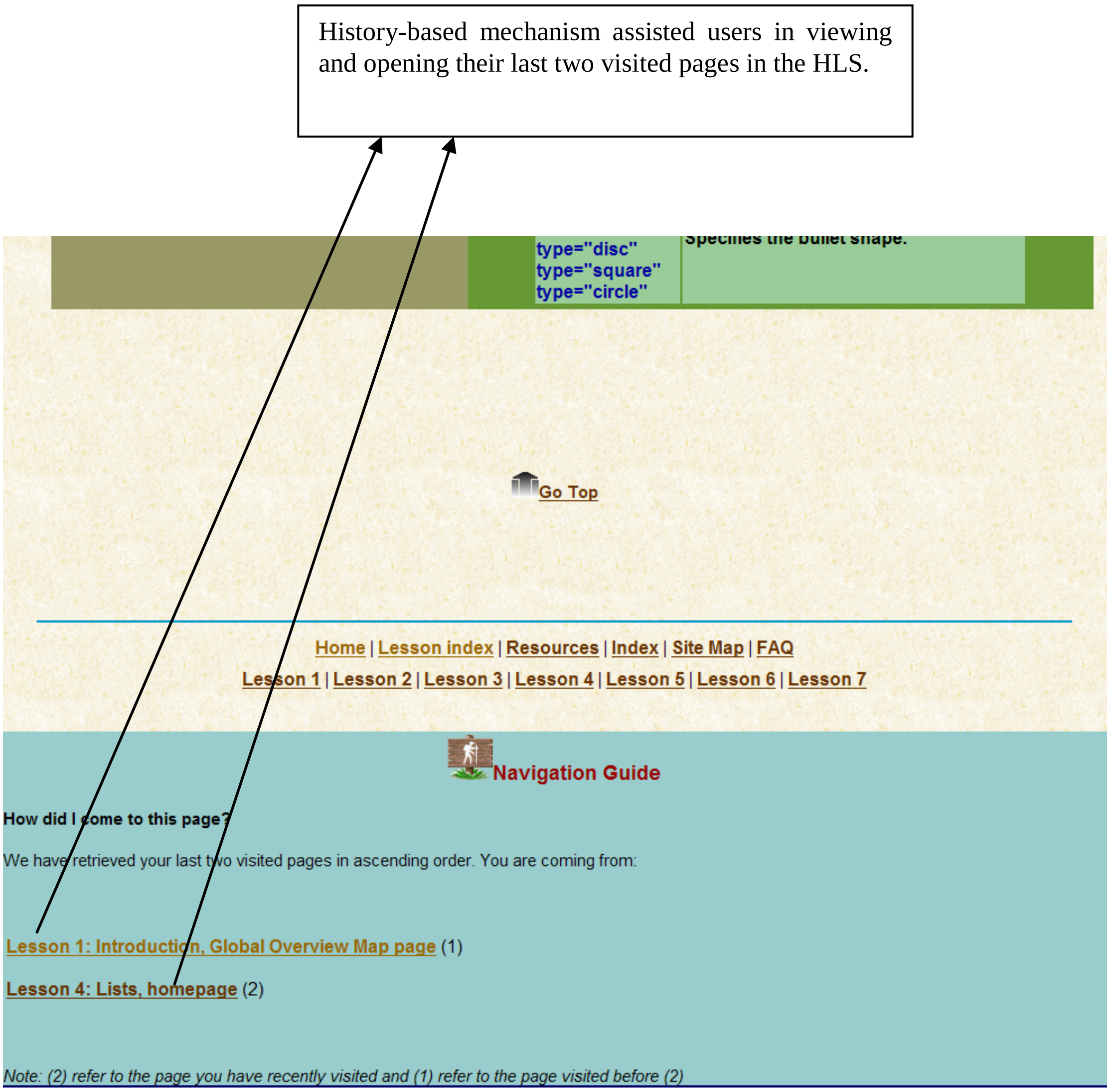

Figure 4.6: Visual cue of history-based mechanism

Finally, the section will consider two visual cues: the graphic visualisation and highlighting context.

The graphic visualisation assisted users in the following ways. Firstly, similar to the map, it showed: the global overview of the information that was presented in the HLS; and the relationship among the information that was represented in the HLS. Secondly, the conceptual structure of the information presented in the HLS that graphic visualisation provided assisted users in navigating through the tutorial.

The 'highlighting context' visual cue took the form of a disabled and a different colour node (node representing links) in the graphic visualisation, with the text used for the nodes being in different font sizes, styles and colours. The two purposes for using the 'highlighting context' approach were to alert users to: (i) their current position in relation to the part of the information being explored in the tutorial; and (ii) their position among the global overview of the information that was presented in the HLS. For instance, as seen in figure 4.7, the link (node) labelled as 'page 1 of 3: introducing XHTML' was different from other links (nodes) in the graph; this link (node) was disabled and presented using a red background. Additionally, the text that represented this link (node) was in orange/blue, bold and font size of 11. 'Highlighting context' clearly showed that the learner was currently exploring page 1, related to 'introducing XHTML', of lesson 1.

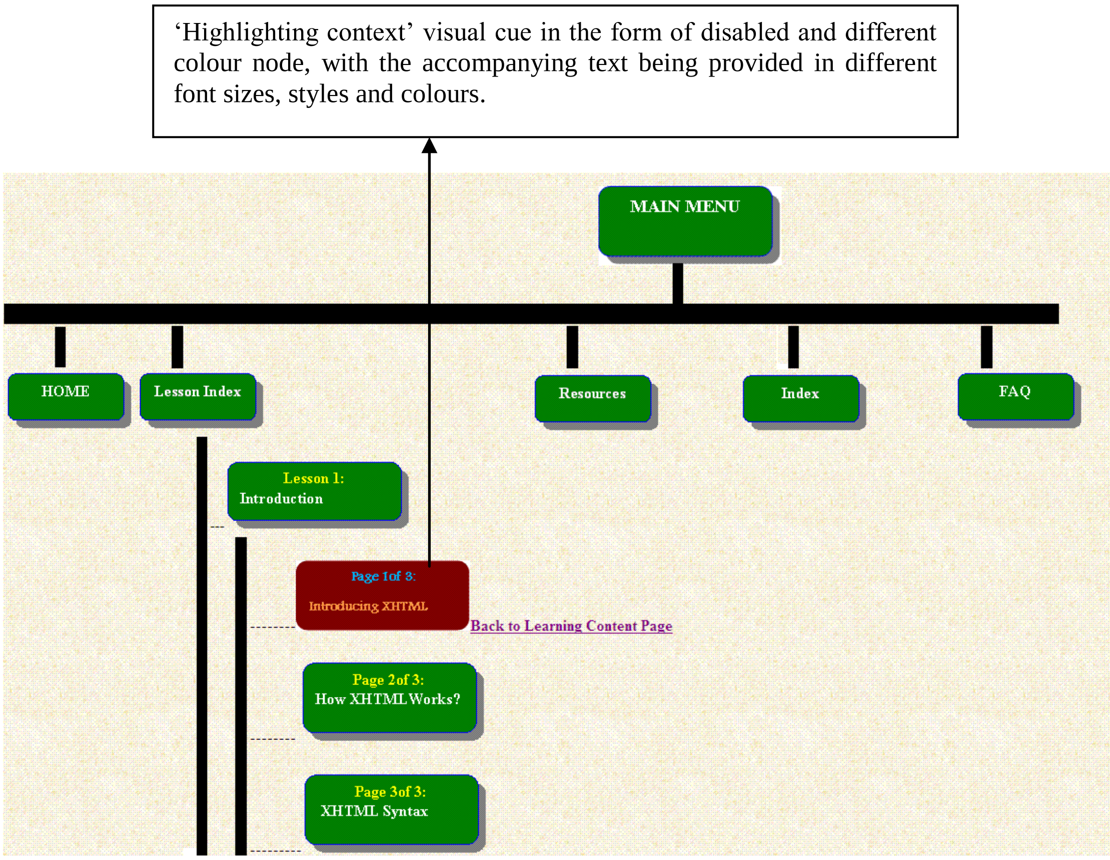

Figure 4.7: Visual cue of graphic visualisation and highlighting context

Section 4.4.4 presents the design and the development of the second HLS incorporating audio instructional aids, which was used to conduct experiment 2.hour.

4.4.4 HLS with Instructional Aids (Audio elements) for Experiment 1

As part of experiment 2, a HLS incorporating instructional aids in the form of audio elements was designed and developed. As no visual elements in the form of back and forward buttons, an index tool, or hyperlinks were provided, users had to navigate through the HLS via audio and key presses to accomplish learning tasks. One of the reasons for not providing visual elements was that this study wanted to evaluate in isolation, with respect to individual differences, the effects of the audio elements on students' learning performance, disorientation and attitudes in the HLS. The remainder of this section explains how the audio could be used by users to navigate through the tutorial to achieve their learning goals.

When users opened the HLS for the first time, they were shown the home page. In the home page, users were advised by an audio clip to play the icon labelled 'welcome' (as can be seen in figure 4.8) to receive further instructions in relation to how to use the audio to interact with the HLS in order to complete learning tasks. To navigate through the HLS to reach the information that they needed, the users interacted with the audio and used the keys on the keyboard. For example, if users wanted to enter a section in the tutorial, they performed the following steps. First, they pressed the key 'alt m' via the keyboard to enter the main menu which read all of the sections in relation to the tutorial – home; lesson index; resources; frequently asked question (FAQ); and guide – that were available in the tutorial. They then pressed the appropriate key (given by the audio clips) via the keyboard to open the desired section. When the participants were transferred to their requested section (for example, page 3 of lesson 3) in the tutorial, the following message was played –"welcome to lesson 3 -- Basic XHTML formatting, page 3 of 5 -- specifying font sizes". This meant that the participants knew that they had successfully navigated to their requested section, which consisted of 5 pages in total. The participants could also use the audio to access content in accordance with the information that they needed in the HLS. Additionally, the users did not need to listen to all of the options presented (in form of messages in the audio clip) if they knew where to go in the tutorial. They were able to simply skip through the messages to reach their desired location.

The play icon advised the users to read the content on the current page to gain an understanding about how to use the audio to navigate through the HLS.

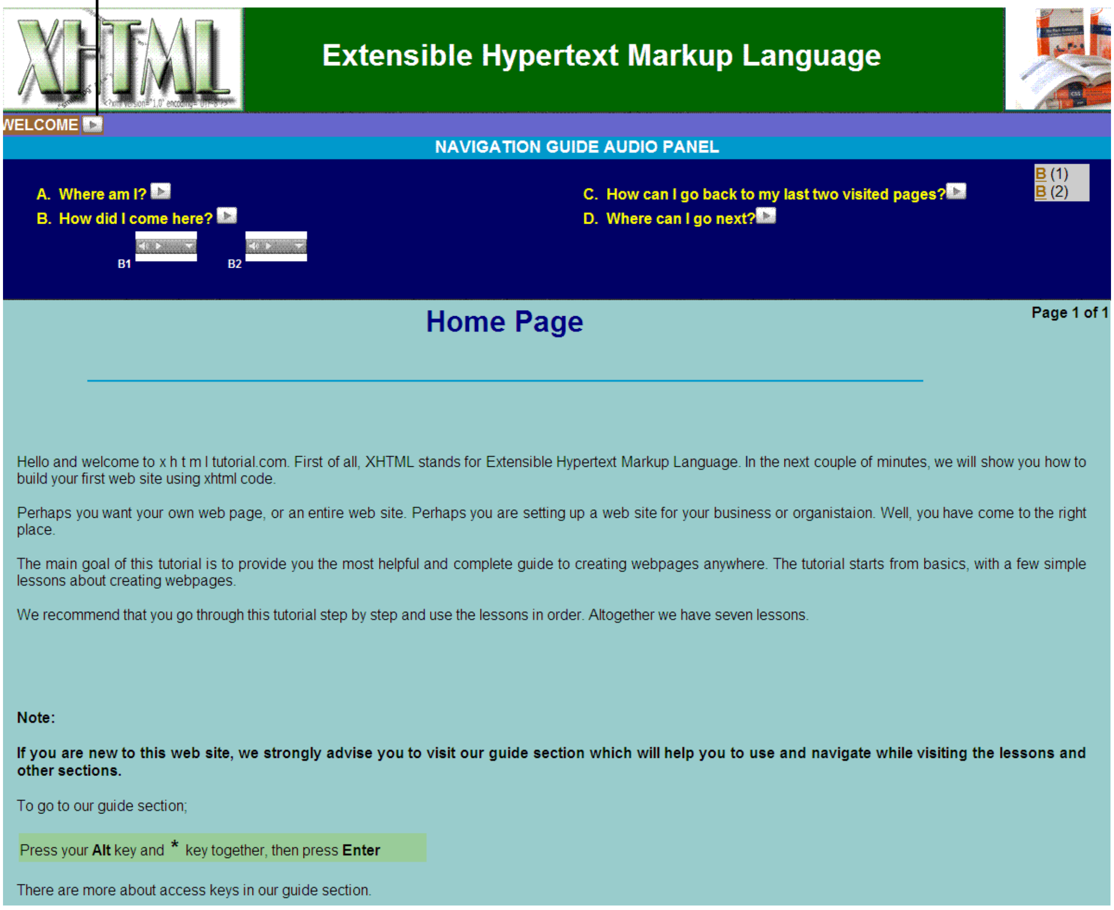

Figure 4.8: Audio as instructional aids

This section further considers the purpose of the audio for navigational and orientational purposes in the tutorial.

The ‘play’ icon, labelled as ‘welcome’, played a summary of the content that was displayed on the page in relation to the tutorial. Gaining this information permitted the users to identify their current location in the HLS and the content that they were going to explore. For instance, as can be seen in figure 4.9, when the users moved their mouse over the ‘play’ icon, an audio clip provided the following message: *‘Welcome to lesson2, creating XHTML documents, and page 5 of 7, creating sub headers. In this page we will show you the six levels of headings and where to insert them in the XHTML document. The reading content is below, highlighting with content’.*

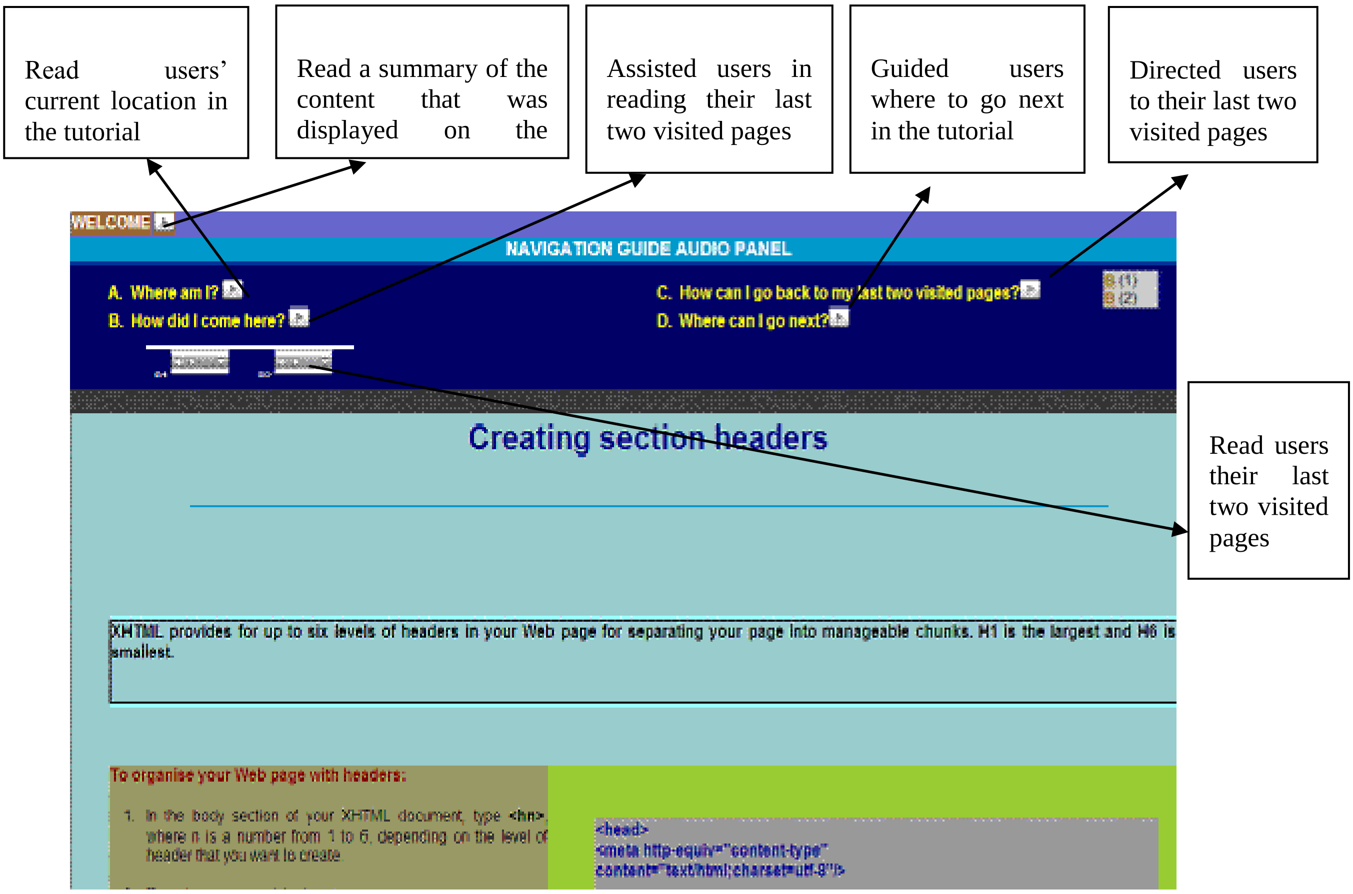

Figure 4.9: Audio for navigational and orientation purposes

The 'play' icon labelled as 'where am I' assisted users in listening to their current location in the tutorial. As can be seen in figure 4.9, by moving their mouse over the 'play' icon labelled 'where am I', the following message was heard: *'you are currently in lesson 2, creating XHTML documents, page 5 of 7, creating section headers.'*

The 'play' icon labelled 'How did I come here', instructed users how to listen to their last two visited pages in the tutorial. Furthermore, below this icon, the audio control panel B1 and B2 directed users in listening to their last two visited pages. For instance, with regards to figure 4.9, when users moved their mouse over the 'play' icon, the following message was played: "we *have retrieved your last two visited pages in reverse order. To listen to your first, that is, to your most recent visited page, click on the audio control panel B2 below. To listen to your second visited page, play the audio control panel B1* *below."* It was at this point that the users could employ control panels B1 and B2 to listen to the last two pages that they had just visited.

Similarly, the 'play' icon labelled 'How can I go back to my last two visited pages' and the links B1 and B2 directed users to their last two visited pages. For example, as shown in figure 4.9, when the user moved their mouse over the play 'icon', labelled 'How can I go back to my last two visited pages', they heard the following message: *'To go to your recently visited page, click on the link B2. To go your second most recently visited page, click on the link B1.'*

The 'play' icon labelled 'Where can I go next' performed the following functions. Firstly, it reminded users about their current location in the tutorial. It then informed the users to choose one of the following options:

- *'to select the key (given by the audio) via the keyboard to navigate to the next page of the section that they were currently in;'*
- *'to select the key (given by the audio) via the keyboard to listen to or to enter the pages of the section that they were currently in;'*
- *'To use the main menu to open other sections of the tutorial.'*
- *'To use section B and section C from the navigation guide audio panel to go back to their last two visited pages.'*

For example, as can be seen in figure 4.9, the user was currently on page 2 of lesson 2 related to 'creating section headers'. When the user moved his/her mouse over the 'play' icon labelled 'Where can I go next', he/she would first listen to his/her current location in the page, and then was asked to select one of the following options:

- *'To go to the next page, select s;'*
- *'To listen or to enter the pages of this lesson, select y;'*
- *'For other sections, use the main menu. Press alt m to enter the main menu;'*
- *'To go back to your last two visited pages, use section B and section C.'*

Based on the suggestions collected from the pilot study, which will be discussed in detail in section 4.5, the voice used for the speech in the audio was changed from'English' to an 'American-English' accent.

Having discussed the design and development of the three HLS, section 4.4.5 presents the instrument of Cognitive Style Analysis (CSA) that was used to measure students' cognitive style in this study.

4.4.5 Cognitive Style Analysis (CSA)

As discussed in Chapter 3, this study aimed to examine the effects of individual differences and HLS' features on students' learning. Cognitive style (FD/FI) was among the set of individual differences that were considered in this thesis. In order to identify students' field dependence this study required a suitable instrument. In Chapter 2, it was noted that there are a number of instruments used to measure field dependence including Riding's (1991) Cognitive Style Analysis (CSA) and Wilkins et al. (1971) Group Embedded Figures Test (GEFT).

CSA differs from GEFT in the sense that its wholist/analytic test consists of two sub-tests. In the first test, participants are given pairs of complex geometrical figures and they have to answer whether they are similar or different. The second sub-test, similar to the GEFT, consists of a simple shape and a more complex figure and the participants have to indicate whether the simple shape is contained within the complex figure. The first sub-test is a task requiring a Field-Dependent (FD) capacity whereas the second sub-test is a task requiring the disembedding capacity associated with Field Independence (FI). A criticism of the GEFT is that FD learners' competence is inferred from poor FI capability rather than being positively measured. This shortcoming is addressed by the CSA (Riding, 1991), which was used in this study.

Following Riding's (1991) classification, FD and FI users were identified with the following scores: those who scored less than 1.02 were classed as FD and those who scored 1.36 and above were classed as FI. Those falling between 1.03 and 1.35 were classed as Field Mixed (FM); only FI and FD users were included in the analysis. Participants were given instructions and guidance when completing the CSA test as part of this study.

In addition to the three HLS and the CSA, this research made use of a set of pre-test questions, post-test questions and a practical task sheet to collect data on participants' learning performance. Section 4.4.6 introduces and explains these instruments.

4.4.6 Pre-Test and Post-test Questions, and Practical Task Sheet

Since this study aims to determine the effects of HLS' instructional aids (visual and audio) on participants' learning performance (in the form of declarative and procedural knowledge), as recommended by previous studies (Chen and Macredie, 2004; Chen, 2005; Mitchell et al., 2005b; Wang, 2007) a set of instruments were used. Pre-test and post-test instruments were respectively applied to measure the participants' declarative knowledge of the learning material (XHTML) prior to and after the use of the prescribed HLS.

Each test contained 20 multiple-choice questions, with each question having four possible answers and an "I do not know" option. Participants were asked to circle the answer that they thought was correct. The answers to all of the questions were available in the tutorial. Ensuring that the pre-test and post-test questions were comparable was achieved by either rewriting the question and providing the possible answers in a different order or, where appropriate, by substituting different numbers or variables into the questions. The pre-test and post-test questions are shown in Appendices A.8-A.9.

To assess procedural knowledge, a practical task sheet as recommended by previous studies was designed and developed. The task sheet comprised eight questions related to the construction of web pages. The key areas addressed by the questions related to the insertion of images and links, building tables, formatting text, creating lists, and creating, saving and viewing a document in the browser. Based on the suggestions collected from the pilot study (which is discussed in detail in section 4.5), the questions in the practical task sheet were reduced from eight to five. The versions of the practical task sheet designed for the pilot and the main study are presented in Appendices A.10a-A.10b.

Section 4.4.7 discusses the questionnaire instruments that were used to collect data on participants': demographic information; levels of expertise in using computers, XHTML and other programming languages; levels of disorientation; and attitudes towards the HLS in this study.

4.4.7 Questionnaires

As shown in Tables 3.2 and 3.3, one of the objectives of this study was to examine the effects of individual differences on learners' levels of disorientation when using the HLS with instructional aids (in the form of visual and audio elements) and when using a HLS without any instructional aids. Additionally, this study aimed to examine the effects of individual differences on learners' attitudes towards a HLS with and without instructional aids. As discussed in section 4.2, this study also aimed to develop an improved understanding on learners' attitudes towards the HLS' features. To accomplish these aims, data was collected using closed question and open-ended questionnaires (Williams, 2003; Marshall, 2005; Johnson et al., 2007). The remainder of this section discusses the design of four questionnaires in this study.

The first questionnaire presented closed questions to gather information on: gender; age; and course area and level. The second questionnaire presented closed questions to measure participants' levels of computer experience, domain knowledge in relation the tutorial's subject content (XHTML) and familiarity with other programming languages (such as Visual Basic, C++ and Java), using a three-point Likert scale (1 representing "novice", and 3 representing "expert"). The design for these two questionnaires is shown in Appendices A.2-A.3.

The third questionnaire presented closed choice questions to measure participants' levels of the four types of disorientation: (i) I know my current location in the HLS; (ii) being on the current page, I know where I was previously in the HLS; (iii) being on the current page, I know where to go next in the HLS; and (iv) I know how to reach my desired location in the HLS. A Likert scale was used for all questions in the questionnaire, with the scale items comprising 0 (strongly disagree) to 6 (strongly agree). Participants were required to circle the response that most closely reflected their answer to each question.

The fourth questionnaire was divided into two parts; one with one open-ended question and the other with closed questions. The open-ended question allowed participants to briefly present their views about the given HLS (with and without instructional aids), without being influenced by the surveyor (William, 2003; Johnson et al., 2007).

The closed questions limited the participants to the set of alternatives being offered when asking them their attitude towards different aspects of the HLS: structure, navigation, overall level of disorientation, dependency on and distraction by the instructional aids (visual and audio) and so on. A seven-point Likert scale was used, with options ranging from 0 (strongly disagree) to 6 (strongly agree). Participants were required to circle the responses that most closely reflected their opinion. Based on the pilot study, which is discussed in detail in section 4.5, some amendments were made to the closed questions. The questionnaires that were used in the study, in pre and post-pilot study forms, are presented in Appendix: A.4a and A.4b; A.5a and A.5b; A.6a and A.6b; and, A.7a and A.7b.

Section 4.4.8 introduces and explains the semi-structured interview form.

4.4.8 Semi-Structured Interview Form

As discussed in section 4.2, this study also wanted to obtain a better understanding of the participants' levels of disorientation, feelings, experiences, preferences, opinions and attitudes towards the given HLS. This study also sought to identify new issues that may have not been considered or identified in relation to HLS. In order to meet this aim, the interview technique was employed to allow more open discussion through which new issues might emerge (McNamara, 1999; Gena et al., 2001; Turner, 2010).

There are a range of approaches to interviewing, from completely unstructured through semi-structured to highly structured interviews (Britten, 1995; Punch, 1998). Unstructured interviews are more conversational in the sense that the questions are open-ended and freely cover a wide range of topics. In semi-structured interviews, the topics and their questions are raised by the interviewer to interviewees, but without preventing interviewees from stating freely their ideas and opinions on the topics of interest (Rubin and Rubin, 1995). Structured interviews are similar to closed questionnaires where interviewees only reply to what they have been asked (Britten, 1995), making the topics covered more constraint. Semi-structured interviews were employed in this study as they permitted scope for the researcher to obtain new ideas and opinions from the respondents in relation to the research questions.

A semi-structured interview form was designed to present a set of questions prepared under major themes, for example, HLS structure, navigation, disorientation, and audio and visual element features and so on. The semi-structured form with its questions is given in Appendices A.11-A.13.

The next section discusses the use of observation form needed to collect data on students' interaction behaviour with the HLS.

4.4.9 Observation Form

As discussed in section 4.2, this study wanted to collect an improved understanding about users' interaction behaviour with the HLS. Specifically, the study was interested in: how the participants were navigating through the HLS (with instructional aids - in the form of visual and audio elements and without instructional aids) to complete the XHTML tutorial and the practical task; participants' levels of disorientation in the HLS; whether the participants were making full use of the features (in terms of instructional aids – visual or audio elements) while completing the tutorial and the practical task; whether the participants interacted a lot with the HLS to complete the exercises in the practical task; whether they visited all the lessons or all the pages of a lesson in the tutorial; the possibility of discovering new things this study was not aware of (Mack et al., 2005); and acquiring information the participants were unaware of or could not find in the questionnaires. Since these aims would be difficult to collect through questionnaires, interviews and achievement tests, observation was employed (Spinuzzi, 2003; Rosenbaum, 2005).

Observation can be direct (Taylor and Steel, 1996; Johnson et al., 2007) or indirect (Johnson et al., 2007). Direct observation refers to sitting next to the participant which they using the HLS; indirect observation refers to the use of video or audio recording to capture users' interaction behaviour with the HLS. This study employed the direct method as it was more flexible, cheaper and easier to administer.

In preparing for the observation, an observation form was designed. The observation form included a number of themes related to the users' interaction behaviour, discussed earlier in this section, which this study was interested in. Additionally, the form included some spaces so as to collect any additional and relevant information in relation to users' interaction behaviour which may have been of value to this study. The observation form is presented in Appendices A.14-A.15.

Section 4.4 has presented the materials and instruments which were employed to collect the data for this study. However, before the materials/instruments could be finalised for use in the main study, a pilot study was performed to evaluate the validity and reliability of the approaches. This is discussed in the next section.

4.5 Pilot Study

A pilot study was conducted two months before the official experiment was scheduled. The purpose of the pilot study was to examine whether the methodological approach selected for the official study had any deficiencies (as recommended by Lancaster et al., 2006; Arain et al., 2010). For instance, the pilot study was used to identify any potential problems with the design of the three HLS (that were introduced in sections 4.4.2 to 4.4.4).

Additionally, the pilot study enabled this research to test the questions in the questionnaires. The pilot study also allowed this study to examine the design of the pre-test and post-test questions, practical task sheet, observation form and semi-structure interview form. Finally, the pilot study was used to check whether additional instructions and guidance were needed for the CSA test.

The participants in the pilot survey comprised five final-year PhD students, from the Department of Information Systems and Computing at Brunel University. The students first took part in the CSA test and then interacted with each of the HLS. The questionnaires, semi-structured interview form, observation form, pre-test questions, post-test questions and practical task sheet were also used by these participants.

Once the pilot study has ended, the participants were encouraged to provide feedback about any problems related to the CSA test and the design of the instruments. The participants made suggestions that resulted in the reduction in the number of questions from eight to five in the practical task. The five questions still provided coverage of all the topics (in the form of the seven lessons) that were included in the tutorial but more focused. One of the reasons for cutting three questions from the practical task was that, it would reduce the risk of the participants experiencing fatigue or boredom in this part of study.

In addition to the practical task sheet, the participants suggested that since the attitude questionnaire made use of a seven-point Likert scale (ranging from 'strongly disagree' to 'strongly agree'), labelling each of the points would make sure that the participants were selecting the right level of agreement (Krosnick and Berent, 1993), increasing the reliability and validity of results. This suggestion was also adopted.

The participants also commented on the HLS that incorporated the instructional aids (in the form of audio elements). The participants mostly suggested that the voice used in the audio might be difficult to understand, especially by participants in the official experiments for whom English was not a first language, because the accent which was of 'UK-English'. They suggested that changing the voice to 'US-English' might lead to the voice being clearer and easier to understand. Changes were made to address this comment. All of the changes made as a result of the pilot study are shown in Appendix: A.4a and A.4b; A.5a and A.5b; A.6a and A.6b; A.7a and A.7b; and, A.10a and A.10b.

Having made these changes, the two experiments were then conducted, as discussed in section 4.6.process.

4.6 Procedures

This section considers about how the experiments were conducted. Each experiment followed the same set of stages and in the same order. Each experiment was performed over a number of sessions in one of the computer usability laboratory at Brunel University. Each session contained a small group of participants, each working individually on a PC. As can be seen in figure 4.10, each experimental study was divided into 11 stages. The remainder of this section discusses each of the stages.

In the first stage, the researcher briefly explained (as presented in Appendix A.1) the purpose of conducting the study. Participants were also free to ask any questions in relation to the study. In the second stage, the participants took the CSA test to determine their level of field dependence (classified into FD, FM and FI) according to their CSA score.

Stage 1
A brief explanation of the study.

Stage 2
CSA test to determine participant’s level of field dependence.

Stage 3
Questionnaire to determine participant’s: level of expertise in using computers, XHTML and other programming languages; and demographic information.

Stage 4
Pre-test to evaluate participant’s prior knowledge of XHTML.

Stage 5
Interaction with the HLS to complete the content related to XHTML. Observation was also conducted during interaction with the HLS.

Stage 6
Interaction with the HLS to perform the practical task in relation to XHTML. Observation was also conducted during interaction with the HLS to complete the practical task.

Stage 7
Post-test to evaluate participant’s learning performance.

Stage 8
Questionnaire to measure participant’s levels of the four type of disorientation.

Stage 9
Questionnaire to gather participant’s data in relation to attitudes towards and opinions of the HLS.

Stage 10
Semi-structured interview with participant in relation to attitudes, opinions, feelings, preferences, experiences towards the HLS.

Stage 11
End of the study and agreed incentive provided.

Figure 4.10: Experimental study stages and order

The participants then moved in the third stage where they had to complete two questionnaires to determine their level of expertise in using computers, XHTML and other programming languages and to gather demographic information. In the fourth stage, participants were given a maximum of 15 minutes to complete the pre-test to practically determine their prior knowledge of XHTML.

In the fifth stage, participants were assigned to use one of the three HLS (with instructional aids – visual elements; with instructional aids – audio elements; and without any instructional aids) to complete the online instructional content of the XHTML tutorial. Observation of users' interaction behaviour with the HLS was also undertaken in this stage.

Having gone through the online instructional content related to XHTML in the fifth stage, the participants' learning performance (in the form of procedural knowledge) was measured in stage six. The measurement was undertaken through a set of exercises (five in total) in the form of a practical task which they had to complete using the Notepad application. Unlike the pre- and post-test, the participants were allowed to interact with the given HLS to find the answers. Participants were also observed during their interaction with the HLS to complete the practical task.

Once the participants had completed the prescribed task in stage six, a 15 minutes break was given so as to reduce the risk of boredom or fatigue. The participants then entered into stage seven where they were given a maximum of 15 minutes to answer the post-test so as to measure their learning performance (in the form of declarative knowledge).

In the eighth stage, the disorientation questionnaire was administered to measure participants' levels of the four types of disorientation.

In stage nine, the participants were given the attitude questionnaire (divided into two parts: with open-ended question; and with closed questions) to record their attitudes to, and opinions of the HLS that they used. They could also refer to the HLS that they had used.

In stage ten, a semi-structured interview was conducted to understand the respondents' feelings, attitudes, preferences, experiences and suggestions in relation to the HLS that they had used. The participants were interviewed on a one-to-one basis to provide a setting that easily allowed the expression of personal opinions in a private setting (as advocated by Khan, 2008). The interview was also conducted with a fairly open framework which allowed conversational and two-way communication.

Finally, in stage 11, the researcher thanked the participants for participating in this study and provided an agreed incentive to each participant.

Having described the stages of the study, section 4.7 presents the data analysis subsequently used.

4.7 Data Analysis

In order to analyse the data collected from the experimental and descriptive study, which is central to being able to answer the research questions and to test the research hypotheses set out in Chapter 3, appropriate analysis techniques were employed. In section 4.7.1, the approach to the data analysis of the data collected quantitatively from the experimental study (through achievement tests and closed questionnaires) is presented. Section 4.7.2 discusses the analysis of the data collected qualitatively from the descriptive study (through direct observation, semi-structured interview and open-ended questionnaire).

4.7.1 Quantitative Data Analysis

This section discusses the analysis of the quantitative data collected through the achievement test and closed questionnaire. The analysis of these quantitative data involved three steps: quantitative data preparation; description of the statistics; and the undertaking of inferential statistical tests. In the first step, the data preparation involved checking the data for accuracy and entering them manually into a statistical program called Statistical Package for Social Sciences (SPSS, 2001). The descriptive statistics step involved developing a clear description of the data in this study and the provision of a summary about the sample and the measures used.

In the final step, inferential statistical tests were used to test the research hypotheses that were developed in this study to seek answers to the research questions set out in Chapter 1. Appropriate statistical tests were needed to support this. The selection of statistical test depends on the research questions and on the samples or groups selected in the study design (Foster, 2001; Patton, 2002). As discussed in section 4.2, this study aimed to examine the effects of three independent variables (IVs) on a dependent variable (DV) when using a HLS without instructional aids and when using a HLS with visual instructional aids. To accomplish this aim, a Factorial Analysis of Variance (ANOVA), including a three-way ANOVA was employed (as recommended by Cazalla et al., 1999; Pallant, 2001, p. 201; Karpinski, 2006).

Factorial ANOVA measures whether a combination of IVs predict the value of a DV. The term ‘way’ is used to describe the number of IVs that are used in the ANOVA. For example, to assess the effect of one IV on a DV, a one-way ANOVA is employed; a two-way ANOVA is used to assess the effect of two IVs on a DV; and the effect of three IVs on a DV involves a three-way ANOVA – the approach that is relevant to this study.

An example of a research question where the use of a one-way ANOVA is suitable would be: ‘Is there a significant difference between different gender groups in terms of driving performance when driving a car with an automatic gear box?’ In this example ‘gender’ (categorised as taking one of two values: male or female) is the IV and ‘driving performance’ is the DV.

An example of a research question where a two-way ANOVA is suitable would be: ‘What is the effect of the brand of laundry detergent and temperature levels on the amount of dirt removed from your laundry?’ In this example the two IVs are: ‘brand of laundry detergent’ and ‘temperature level’; the DV is ‘the amount of dirt removed from your laundry.’ Although different categorisations can be developed for the IVs, in this example, the ‘brand of laundry detergent’ variable could be categorised as taking one of a number of values according to brand (e.g., Ariel, Persil, Fairy), and the ‘temperature level’ variable could be categorised as taking one of the three values: cold (30 Celsius) warm (45 Celsius) or hot (70 Celsius).

An example of a research question where a three-way ANOVA is suitable would be: 'What is the effect of age, internet experience and gender on the time taken to successfully complete a pre-defined online banking task?' In this example, the three IVs are: 'age'; 'internet experience'; and 'gender'. The DV is the 'time taken to successfully complete a pre-defined online banking task.' Different categorisations can, of course, be developed for the IVs. For example, the IV of 'age' could be categorised as taking one of the three values – under 30, 31-49 or over 50; 'internet experience' could categorised as taking one of two values - novice or expert; and 'gender' could be categorised as taking one of two values – male or female. The categorisations of these IVs are simply examples, but they are relevant to those used in this study.

Although ANOVA (two-way or greater) tests can show a significant main or interaction effect between IVs and a DV, they do not tell us where the differences lie. To overcome this limitation, the Newman Keuls post-hoc test was performed.

In this study, a multiple three-way analysis was carried out. The three-way ANOVA analysis was used to seek answers to the research questions developed in Chapter 3. Firstly, what is the effect of and between individual differences (cognitive style, domain knowledge and computer experience) on users' learning performance when using the two versions of the HLS: one that provided no instructional aids; and one that incorporated instructional aids (in the form of visual or audio elements)? Secondly, what is the effect of and between individual differences (cognitive style, domain knowledge and computer experience) on users' levels of disorientation when using the two versions of the HLS: one that provided no instructional aids; and one that incorporated instructional aids (in the form of visual or audio elements)? And, lastly, what is the effect of and between individual differences (cognitive style, domain knowledge and computer experience) on users' attitudes when using the two versions of the HLS: one that provided no instructional aids; and one that incorporated instructional aids (in the form of visual or audio elements)?'

Within the three-way ANOVAs conducted, the three IVs were: cognitive style; domain knowledge; and computer experience. The DVs (one for each three-way ANOVA) were: learning performance; levels of disorientation; and attitudes. As discussed earlier, different categorisations could have been developed for the IVs. in this study, but the categorisations chosen were as followed: the ‘cognitive style’ variable was categorised as taking one of the two values FD or FI; the ‘domain knowledge’ variable was categorised as taking one of the two values ‘novice’ (low domain knowledge) or ‘expert’ (high domain knowledge); the ‘computer experience’ variable was categorised as taking one of the two values ‘novice’ (low computer experience) or ‘expert’ (high computer experience). In addition to the ANOVA test, the Newman Keuls post-hoc test was used to identify whether there were significant differences between the sub-groups or not. The level of significance for both ANOVA and post-hoc test analysis was set at $p<0.05$ (as recommended by previous studies).

4.7.2 Qualitative Data Analysis

As discussed in sections 4.4.7-4.4.9, the qualitative data collected in this research were gained through direct observation, semi-structured interviews and open-ended questionnaires. This section explains how the data collected from each technique were analysed.

With respect to semi-structured interviews, their purpose was to collect detailed information on participants’ opinions, attitudes, preferences, experiences and suggestions in relation to the following themes: structure; navigation; disorientation; distraction, and overall satisfaction towards the HLS that they used. These themes were chosen so as to gain an improved understanding on: the types of structure they are comfortable or prefer to learn with; any difficulties they experienced while navigating through the tutorial; any levels of disorientation they meet while completing learning tasks; any distraction caused by any of the instructional aids; and their motivation of learning in the HLS.

To analyse the interview data, the following steps were taken in line with advice given by Rabiee (2004). Firstly, with regards to the HLS (without instructional aids), the responses collected from each of the themes were transcribed. Secondly, with respect to the transcribed data related to each theme, the similarities that were found among the set of individual differences (cognitive style, domain knowledge and computer experience) were considered. Finally, a report was prepared in relation to the similarities. The same steps were taken to analyse the interview data in relation to the HLS incorporating instructional aids (audio and visual).

With regards to observation, the qualitative data related to users' interaction behaviour when using the HLS to complete the tutorial and the practical task. The interaction behaviours were related to the following themes: navigation efficacy, levels of disorientation; how much do they interact with the HLS to complete the practical task or do they visit all the lessons or all the sections of a lesson when using the HLS to complete the tutorial; and how often do they use the instructional aids to perform their learning in the HLS. These themes were chosen so as to allow this study to gain an improved understanding of whether participants' learning performance were hindered, levels of disorientation were influenced and navigation efficacy was decreased when using a HLS with and without instructional aids. To analyse the data collected from the observations, the following stages were completed. With regards to the HLS (without instructional aids) and each of the themes, the observation data were read and transcribed. Similarities in the data for each theme that were found among the set of individual differences (cognitive style, domain knowledge and computer experience) were considered. A report was then prepared to present these similarities. The same stages were used to analyse the observation data in relation to the version of the HLS that provided instructional aids (visual and audio).

Finally, in terms of open-ended questionnaire, the purpose was to gain an insight of participants' views about the HLS that they used to complete learning tasks. To analyse these data, the following steps were taken. The responses related to the views about the HLS (without instructional aids) were first read and transcribed. Then, with regards to the transcribed data, any similarities among the set of individual differences (cognitive style, domain knowledge and computer experience) was considered. Finally, a report was prepared to present the similarities. The same method was applied for the responses that were related to the views about the HLS incorporating audio or visual instructional aids.

4.8 Summary

This chapter has identified the appropriate research design (in the form of experimental and descriptive study) to allow this study to test its research hypotheses and to answer its research questions. The methods, including the sample, materials, data collection instruments, pilot survey and the procedures, needed to conduct this study were also discussed. Finally, this chapter identified appropriate data analysis techniques to meet the objectives set by this study.

Within the identified research methodology needed to answer the research questions and research hypotheses addressed in this study, two experiments supported by users data will be reported. Experiment 1 examined the effects of and between individual differences and visual elements (visual navigational aid and visual orientational cues) on learners' disorientation, learning performance and attitudes in HLS. The results collected from Experiment 1 will be discussed in detail in Chapter 5. In Experiment 2, the effects of and between individual differences and audio elements on learners' disorientation, learning performance and attitudes in HLS are examined. The findings from Experiments 2 will be presented in detail in Chapter 6.

Chapter Five: Experiment 1

5.1 Introduction

This chapter reports the findings that were gathered from experiment 1. As discussed in Chapter 4, the aim of experiment 1 was to address three research questions (shown in Table 5.1).

The data that were gathered from the practical tasks/achievement tests and closed questionnaires were analysed to support this study in answering the research questions. Additionally, the user data that were gathered from the open-ended questionnaires, semi-structured interviews and observation of the participants were analysed to provide additional evidence in relation the research questions.

The structure of this chapter is as follows: section 5.2 describes relevant characteristics of the sample; sections 5.3-5.8 report the findings from the analysis of the quantitative and qualitative data gathered in relation to the research questions; section 5.9 distils the high level findings from the detail reported in sections 5.3-5.8; and, lastly, section 5.10 provides a brief summary of the chapter.

Table 5.1: Research questions in relation to experiment 1

Research Question 1(a): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?
Research Question 1(b): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?
Research Question 1(c): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?

5.2 Description of the Participants

192 university students participated in this experimental study. 96 of them used the HLS that provided no instructional aids; the remainder used the HLS that incorporated visual instructional aids. The distribution of the participants according to their cognitive style (FD or FI), domain knowledge (DK) and computer experience (CE) to each HLS is presented in Table 5.2 (re-stated in section 4.3).

Table 5.2: Distribution of participants according to their cognitive style (FD or FI), DK and CE

HLS that provided no instructional aids				**HLS that incorporated visual instructional aids**			
	FI	FD	Total		FI	FD	Total
Low DK and low CE	12	12	24	Low DK and low CE	12	12	24
Low DK and high CE	12	12	24	Low DK and high CE	12	12	24
High DK and low CE	12	12	24	High DK and low CE	12	12	24
High DK and high CE	12	12	24	High DK and high CE	12	12	24
Total	48	48	96	Total	48	48	96

The next section reports the findings in relation to Research Question 1 (a).

5.3 Results from Disorientation Questionnaire Study

With regards to Research Question 1(a) (re-stated in section 5.1), this study aimed to examine the effects of and between cognitive style, domain knowledge and computer experience on participants' levels of disorientation when using the HLS that provided no instructional aids and when using the HLS that provided visual instructional aids. As discussed in Chapter 4, levels of four types of disorientation (see Table 5.3) were measured through the use of a questionnaire.

The remainder of this section presents and considers the findings from the disorientation questionnaire study in relation to the HLS that provided no instructional aids and the HLS that incorporated visual instructional aids.

Table 5.3: Four types of disorientation in the HLS

Disorientation Types	
1.	I know my current location in the HLS
2.	Being on a current page I know what I was reading previously in the HLS
3.	Being on a current page, I know where to go next in the HLS
4.	I know how to reach my desired location in the HLS

With regards to the HLS that provided no instructional aids, a significant effect was found between cognitive style, domain knowledge and computer experience on the four types of disorientation. The analysis of the Newman Keuls post-hoc tests also revealed some significant differences between the groups. Tables 5.4(a) and 5.4(b) summarise the ANOVA and post-hoc test results.

For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact on participants' levels of disorientation. FD participants with one of these experienced profiles experienced much higher levels of the four types of disorientation than FI participants with the same experience profile.

However, for the group of participants that had high DK and high CE, cognitive style did not have a significant impact on views related to levels of disorientation in the HLS – both FD and FI users in this group: knew their current location; knew what they were reading previously; knew where to go next; and knew how to reach the location they needed to achieve their learning goals.

With respect to the HLS that incorporated visual instructional aids, using the three-way ANOVA, no significant effect was found between cognitive style, domain knowledge and computer experience on the levels of the four types of disorientation. With regards to all four experience profiles, FD and FI users with the same experience profile tended to agree equally with the statement that they did not experience the four types of disorientation in the HLS. A summary of the ANOVA results can be found in Appendix C.1.

Table 5.4(a): Analysis of variance of disorientation

Question 1: "I know my current location in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	2.000		3.500		2.333		3.917		2.250		4.333		5.500		5.083	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	3	25	0	0	1	8.3	1	8.3	1	8.3	0	0	0	0	0	0
Disagree	2	16.7	1	8.3	4	33.3	0	0	4	33.3	1	8.3	0	0	0	0
Slightly disagree	4	33.3	4	33.3	3	25	2	16.7	3	25	2	16.7	0	0	1	8.3
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	1	8.3	2	16.7	2	16.7	3	25	3	25	1	8.3	1	8.3	1	8.3
Agree	2	16.7	5	41.7	2	16.7	5	41.7	1	8.3	5	41.7	4	33.3	5	41.7
Strongly agree	0	0	0	0	0	0	1	8.3	0	0	3	25	7	58.3	5	41.7
Significance	$F(1,88)= 4.207$, $p= 0.043$															
Question 2: "Being on the current page I know what I was reading previously in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.500		4.583		1.583		4.583		2.583		4.667		5.417		5.167	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	2	16.7	0	0	3	25	0	0	2	16.7	0	0	0	0	0	0
Disagree	6	50	0	0	5	41.7	0	0	1	8.3	0	0	0	0	0	0
Slightly disagree	2	16.7	1	8.3	1	8.3	1	8.3	4	33.3	2	16.7	0	0	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	2	16.7	6	50	3	25	5	41.7	3	25	2	16.7	2	16.7	2	16.7
Agree	0	0	1	8.3	0	0	3	25	2	16.7	4	33.3	43	25	6	50
Strongly agree	0	0	4	33.3	0	0	3	25	0	0	4	33.3	7	58.3	4	33.3
Significance	$F(1,88)= 4.518$, $p= 0.036$															

Table 5.4(b): Analysis of variance of disorientation

Question 3: "Being on the current page, I know where to go next in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.417		4.333		1.583		4.583		2.000		4.333		5.667		5.417	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	4	33.3	0	0	2	16.7	0	0	2	16.7	0	0	0	0	0	0
Disagree	5	41.7	1	8.3	6	50	1	8.3	3	25	0	0	0	0	0	0
Slightly disagree	0	0	1	8.3	2	16.7	1	8.3	4	33.3	2	16.7	0	0	0	0
Neither	0	0	0	0	0	0	0	0	0	0	1	8.3	0	0	0	0
Slightly agree	3	25	3	25	1	8.3	2	16.7	2	16.7	1	8.3	0	0	1	8.3
Agree	0	0	5	41.7	1	8.3	4	33.3	1	8.3	7	58.3	4	33.3	5	41.7
Strongly agree	0	0	2	16.7	0	0	4	33.3	0	0	1	8.3	8	66.7	6	50
Significance	F(1,88)= 5.806, p= 0.018															
Question 4: "I know how to reach my desired location in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	2.167		4.167		2.167		4.500		1.917		4.750		5.583		5.333	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	2	16.7	0	0	1	8.3	0	0	2	16.7	0	0	0	0	0	0
Disagree	3	25	2	16.7	4	33.3	1	8.3	3	25	0	0	0	0	0	0
Slightly disagree	3	25	0	0	4	33.3	1	8.3	4	33.3	2	16.7	0	0	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	3	25	3	25	1	8.3	2	16.7	3	25	2	16.7	0	0	1	8.3
Agree	1	8.3	6	50	2	16.7	5	41.7	0	0	3	25	5	41.7	6	50
Strongly agree	0	0	1	8.3	0	0	3	25	0	0	5	41.7	7	58.3	5	41.7
Significance	F(1,88)= 9.024, p= 0.003															

Learning performance results in relation to both versions of the HLS are now reported.

5.4 Results in Relation to Learning Performance

As discussed in section 5.1, this study aims to address Research Question 1(b). Learning performance was measured through achievement tests – post-test score, gain score, practical task score and time efficacy. Section 5.4.1 presents and considers the results from the analysis of the learning performance data in relation to the version of the HLS that provided no instructional aids; section 5.4.2 presents and considers the results from the analysis of the learning performance data in relation the version of the HLS that incorporated the visual instructional aids.

5.4.1 Learning Performance Results in Relation to the HLS with no Instructional Aids

This aspect of the study aimed to look at the effects of and between cognitive style, domain knowledge and computer experience on learning performance (in terms of post-test score, gain score, practical task score and time efficacy – the time taken to complete the XHTML tutorial and the practical task) when using the HLS that provided no instructional aids.

The section first presents and considers the learning performance results related to post-test and practical task scores. A three-way ANOVA revealed a significant effect between cognitive style, domain knowledge and computer experience on post-test and practical task score. With regards to the Newman Keuls post-hoc tests analysis, some significant differences were found between the groups. Table 5.5 summarises the results.

For the group of participants that had either low DK and low CE, or low DK and high CE, cognitive style had a significant impact on their post-test and practical task scores. FD participants with one of these experience profiles scored lower in the post-test and in the practical task compared to FI participants with the same experience profile.

However, for the group of participants that had either high DK and low CE, or high DK and high CE, cognitive style showed no significant impact: both FD and FI participants with the same experience profile performed equally well in the post-test and in the practical task.

Table 5.5: Learning performance results related to post-test and practical task score

Post-test score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	7.000	13.167	7.750	15.750	16.333	17.917	18.500	18.333
Significance: F(1,88) = 5.623, p = 0.020								
Practical task score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	21.000	41.167	22.667	38.250	47.917	47.583	47.750	47.917
Significance: F(1,88) = 5.235, p = 0.025								

This section now presents and considers the learning performance data in terms of test gain scores (the difference between the pre-test and post-test score). Using a three-way ANOVA, a significant effect was found between cognitive style, domain knowledge and computer experience. Additionally, the post-hoc tests results identified significant differences between the groups. Table 5.6 presents the relevant summary data from the analysis of the ANOVA and post-hoc tests.

Table 5.6: Learning performance data related to test-gain score

Test-gain score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	6.250	11.917	7.083	14.917	1.750	3.750	3.333	3.000
Significance: F(1,88) = 5.685, p = 0.019								

For participants with the experience profiles low DK and low CE, and low DK and high CE, cognitive style had a significant impact on test gain score, with FD participants with one of these experience profiles having lower gain scores than FI participants with the same experience profile.

However, cognitive style had no significant impact on test gain score for those participants that had one the following experience profiles: (i) high DK and low CE; or (ii) high DK and high CE. FD and FI users with the same experience profile achieved low gain scores. It is argued that this could be because their prior knowledge of the learning content of XHTML allowed them to score higher marks in the pre-test prior, leaving less scope to improve after having used the tutorial.

Finally, this section considers and presents the learning performance results in terms of time efficacy. In this study, time efficacy relates to the length of time taken to complete the XHTML tutorial and the practical task. A three-way ANOVA revealed significant findings between cognitive style, domain knowledge and computer experience on length of time to complete the XHTML tutorial and the practical task. The analysis of the post-hoc tests also revealed some significant differences between the groups. The results are summarised in Table 5.7.

Table 5.7: Learning performance results related to time efficacy

Time efficacy – length of time taken to complete the XHTML tutorial								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	60.417	34.833	55.000	36.083	13.500	12.417	11.000	11.083
Significance: $F(1,88) = 4.696$, $p = 0.033$								
Time efficacy – length of time taken to complete the practical task								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	61.250	38.583	58.750	30.667	17.417	17.833	17.583	17.583
Significance: $F(1,88) = 4.951$, $p = 0.029$								

For the group of participants that had either low DK and low CE, or low DK and high CE, cognitive style had a significant impact on the length of time taken to complete the XHTML tutorial and the practical task. FD participants with one of these experience profiles took more time to complete the XHTML tutorial and the practical task than did FI participants with the same experience profile.

However, for the group of participants that had either high DK and low CE, or high DK and high CE, cognitive style seemed to have little impact on their time efficacy in the tutorial and in the practical task. FD participants with one of these experience profiles took almost the same amount of time to complete the tutorial and the practical task as did FI participants with the same experience profile.

In the next section, the learning performance results in relation to the version of the HLS that incorporated visual instructional aids are discussed.

5.4.2 Learning Performance Results in Relation to the HLS with Visual Instructional Aids

In addition to the version of the HLS that provided no instructional aids, this study examined the effects of and between cognitive style, domain knowledge and computer experience on learning performance when using the version of the HLS that incorporated visual instructional aids. A three-way ANOVA did not find any significant effect between cognitive style, domain knowledge and computer experience on post-test score, practical task score, and time efficacy in the tutorial. For all four experience profiles – (i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE, and (iv) high DK and high CE) – both FD and FI users within the same experience profile performed well in the post-test and practical task, and took broadly the same amount of time to complete the tutorial.

Additionally, a three-way ANOVA did not reveal any significant effect between cognitive style, domain knowledge and computer experience on test-gain score. For the group of participants that had low DK and low CE, or low DK and high CE, both FD and FI users with the same experience profile achieved higher gain scores. For the group of participants that had either high DK and low CE, or high DK and high CE, both FD and

FI users with the same experience profile achieved lower gain scores. Appendix C.2 presents summary of the ANOVA results.

However, with respect to the length of time taken to complete the practical task, the results from the three-way ANOVA revealed a significant impact between cognitive style, domain knowledge and computer experience. The analysis of the post-hoc tests also revealed some significant differences between the groups. A summary of the ANOVA and the post-hoc tests results is presented in Table 5.8. For the group of participants that had either low DK and low CE, or low DK and high CE, cognitive style had a significant impact on the length of time taken to complete the practical task. FD participants with one of these experience profiles spent more time completing the practical task than FI participants with the same experience profile.

However, for the group of participants that had either high DK and low CE, or high DK and high CE, cognitive style did not have a significant impact, with both FD and FI with the same experience profile spending almost the same amount of time to complete the practical task as each other.

Table 5.8: Learning performance results related to time efficacy in the practical task

Completion of the practical task and time efficacy								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	41.500	33.583	44.500	31.583	14.250	12.000	14.000	12.917
Significance: $F(1,88) = 5.498$, $p = 0.021$								

Having considered the ANOVA results in relation to learning performance, the next section reports the closed questionnaire data related to attitudes towards the HLS.

5.5 Results from the Closed Questionnaires in Relation to Attitude Towards the HLS

As discussed in section 5.1, according to Research Question 1(c), this study aimed to examine the effects of cognitive style, domain knowledge and computer experience on participants' attitudes towards the HLS in terms of their views on the following themes: structure; navigation; disorientation; dependency on and distraction by the visual instructional aids; and overall satisfaction. Additionally, it was explained in chapter 4 that, in order to meet this aim, a closed questionnaire was employed. The remainder of this section presents and considers some of the findings from each of these themes in relation to the two versions of the HLS – one that provided no instructional aids, and one that incorporated visual instructional aids.

5.5.1 Participants' Views of the Structure

The section first presents and considers participants' views of the structure in the version of the HLS that provided no instructional aids (See Table 5.9 for summary results). Using a three-way ANOVA, a significant effect was found between cognitive style, domain knowledge and computer experience. The analysis of the Newman Keuls post-hoc tests also showed significant differences between the groups.

Table 5.9: Results related to participants' attitudes towards the HLS structure

Question 1: "Overall, I like the structure that is offered in the HLS																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.583		3.250		1.750		3.667		1.667		4.500		5.417		5.250	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	3	25	1	8.3	2	16.7	1	8.3	5	41.7	0	0	0	0	0	0
Disagree	4	33.3	2	16.7	3	25	1	8.3	1	8.3	1	8.3	0	0	0	0
Slightly disagree	2	16.7	3	25	5	41.7	2	16.7	2	16.7	1	8.3	0	0	1	8.3
Neither	1	8.3	0	0	0	0	0	0	1	8.3	0	0	0	0	0	0
Slightly agree	2	16.7	2	16.7	2	16.7	2	16.7	3	25	2	16.7	2	16.7	1	8.3
Agree	0	0	3	25	0	0	5	41.7	0	0	5	41.7	3	25	3	25
Strongly agree	0	0	1	8.3	0	0	1	8.3	0	0	3	25	7	58.3	7	58.3
Significance	$F(1,88) = 7.009, p=0.010$															

For the group of participants that had experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style seemed to have a significant impact on their attitudes towards the HLS's structure. FD participants with one of these experience profiles showed more negative attitudes towards the structure that was offered in the HLS than did FI participants with the same experience profile. However, for the group of participants that had high DK and high CE, cognitive style did not have a significant impact. FD participants with this experience profile had just as strong a preference for the structure that was offered in the HLS as did the FI participants with the same experience profile.

This section will now present and consider participants' views of HLS structure in the version of the HLS that incorporated visual instructional aids. A three-way ANOVA did not reveal significant effects between cognitive style, domain knowledge, and computer experience on attitudes towards the HLS structure. A summary of the ANOVA results is presented in Appendix C.3. With regards to participants in all four experience profile groups ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), cognitive style had no significant impact, with all participants showing positive attitudes towards the structure.

Having considered the HLS' structure, the next section reports the participants' views of navigation in the two versions of the HLS.

5.5.2 Participants' Views of Navigation

Participants' views of navigation efficacy in the HLS with which they interacted were gathered from the closed questionnaire. In terms of the HLS that provided no instructional aids, a three-way ANOVA revealed a significant effect between cognitive style, domain knowledge and computer experience. The post-hoc tests analysis also showed some significance differences between the groups. Table 5.10 shows a summary of the ANOVA and post-hoc tests results.

For the participants with experience profiles of low DK and low CE, low DK and high CE, and high DK and low CE, cognitive style had a significant impact on their views related to navigation. FD participants with one of these experience profiles responded that they experienced more difficulties navigating through the HLS than did FI participants with the same experience profile. However, for the group of participants that possessed high DK and high CE, cognitive style showed no significant impact: both FD and FI participants in this group responded that their navigation efficacy was enhanced in the HLS.

Table 5.10: Results related to participant's attitudes towards navigation efficacy

Question 2: " I experience difficulties navigating through the HLS to perform my learning"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.167		3.917		1.000		4.583		1.833		4.500		5.500		5.583	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	3	25	0	0	2	16.7	1	8.3	5	41.7	0	0	0	0	0	0
Disagree	4	33.3	2	16.7	4	33.3	1	8.3	1	8.3	1	8.3	0	0	0	0
Slightly disagree	2	16.7	4	33.3	5	41.7	2	16.7	2	16.7	1	8.3	0	0	1	8.3
Neither	1	8.3	0	0	0	0	0	0	1	8.3	0	0	0	0	0	0
Slightly agree	2	16.7	2	16.7	1	8.3	2	16.7	3	25	2	16.7	2	16.7	1	8.3
Agree	0	0	3	25	0	0	5	41.7	0	0	5	41.7	3	25	3	25
Strongly agree	0	0	1	8.3	0	0	1	8.3	0	0	3	25	7	58.3	7	58.7
Significance	$F(1,88)= 14.646$, $p=0.000$															

The results related to the version of the HLS that incorporated visual instructional aids are now discussed. A three-way ANOVA revealed no significant effect between cognitive style, domain knowledge and computer experience on participants' views related to navigation, irrespective of experience profile (see Appendix C.3). FD and FI participants with the same experience profile generally felt that they enhanced their navigation efficacy in the HLS to the same degree.

In addition to navigation efficacy, participants were asked to give their views of the levels of freedom of navigation in the HLS. With regards to the HLS that provided no instructional aids, a three-way ANOVA revealed a significant effect between cognitive style, domain knowledge and computer experience. Furthermore, the analysis of the post-hoc tests revealed significant differences between the groups. Table 5.11 summarises the results.

Table 5.11: Participants' views related to freedom of navigation in the HLS with no instructional aids

Question 3: " I enjoy the levels of freedom of navigation that are offered in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.167		3.917		1.000		4.583		1.833		4.500		5.500		5.583	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	4	33.3	0	0	5	41.7	1	8.3	3	25	0	0	0	0	0	0
Disagree	4	33.3	1	8.3	5	41.7	0	0	3	25	0	0	0	0	0	0
Slightly disagree	3	25	3	25	0	0	0	0	3	25	2	16.7	0	0	0	0
Neither	0	0	0	0	1	8.3	0	0	0	0	0	0	0	0	0	0
Slightly agree	1	8.3	2	16.7	1	8.3	2	16.7	2	16.7	3	25	0	0	0	0
Agree	0	0	4	33.3	0	0	7	58.3	1	8.3	4	33.3	6	50	5	41.7
Strongly agree	0	0	2	16.7	0	0	2	16.7	0	0	3	25	6	50	7	58.3
Significance	$F(1,88)= 10.132, p= 0.002$															

For participants with experience profiles of low DK and low CE, low DK and high CE, and high DK and low CE, cognitive style had a significant impact on their attitudes towards the levels of freedom of navigation in the HLS. FD participants with one of these experience profiles responded that they disagreed with the statement that they enjoyed the levels of freedom of navigation in the HLS. In contrast, the FI participants with the same experience profile agreed with the statement that they enjoyed the levels of freedom of navigation in the HLS.

However, cognitive style had no significant impact for those users with the experience profile of high DK and high CE: both FD and FI users in this group agreed that they enjoyed the levels of freedom of navigation in the HLS.

With respect to the HLS that incorporated visual instructional aids, similar results gathered in the version of the HLS that provided no instructional aids were identified. The summary results of the ANOVA and post-hoc tests are presented in Table 5.12.

Table 5.12: Participants' views of freedom of navigation in the HLS with visual instructional aids

Question 3: " I enjoy the levels of freedom of navigation that are offered in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.583		4.083		1.000		5.000		.917		5.000		5.333		5.500	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	2	16.7	0	0	4	33.3	0	0	6	50	0	0	0	0	0	0
Disagree	5	41.7	1	8.3	4	33.3	0	0	4	33.3	0	0	0	0	0	0
Slightly disagree	3	25	2	16.7	4	33.3	0	0	1	8.3	1	8.3	0	0	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	2	16.7	2	16.7	0	0	3	25	0	0	2	16.7	0	0	1	8.3
Agree	0	0	6	50	0	0	6	50	1	8.3	4	33.3	8	66.7	4	33.3
Strongly agree	0	0	1	8.3	0	0	3	25	0	0	5	41.7	4	33.3	7	58.3
Significance	F(1,88)= 36.394 ,p= 0.000															

Participants' views of levels of disorientation when using the HLS are now presented and considered.

5.5.3 Participants' Views of Overall Levels of Disorientation

In addition to the disorientation questionnaire that was used to measure levels of disorientation, participants were also asked in the attitude questionnaire to give their views of overall levels of disorientation in the HLS. With respect to the version of the HLS that provided no instructional aids, the results from the three-way ANOVA revealed a significant effect between cognitive style, domain knowledge and computer experience. The analysis of the post-hoc tests also showed some significant differences between the groups. Table 5.13 presents the summary results of the ANOVA and the post-hoc tests.

For participants who had low DK and/or low CE (i.e., those with one of the following experience profiles: low DK and low CE; low DK and high CE; or high DK and low CE), cognitive style had a significant impact on the views related to overall levels of disorientation. FD participants with one of these experience profiles reported much higher levels of disorientation when using the HLS than did FI participants with the same experience profile.

Table 5.13: Results related to participants' overall levels of disorientation

Question 4: "Overall, I experience high levels of disorientation in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	4.750		1.750		4.667		1.667		3.833		1.250		.583		.583	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	0	0	3	25	0	0	2	16.7	0	0	5	41.7	7	58.3	5	41.7
Disagree	0	0	3	25	0	0	6	50	0	0	3	25	3	25	7	58.3
Slightly disagree	1	8.3	3	25	2	16.7	1	8.3	4	33.3	2	16.7	2	16.7	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	2	16.7	3	25	2	16.7	2	16.7	3	25	2	16.7	0	0	0	0
Agree	7	58.3	0	0	4	33.3	1	8.3	4	33.3	0	0	0	0	0	0
Strongly agree	2	16.7	0	0	4	33.3	0	0	1	8.3	0	0	0	0	0	0
Significance	F (1,88) = 5.811, p = 0.018															

However, with regards to those users with high DK and high CE, cognitive style had no significant impact on the views related to overall levels of disorientation: both FD and FI participants with this experience profile disagreed with the statement that they experienced high levels of disorientation when using the HLS.

With respect to the HLS that incorporated visual instructional aids, a three-way ANOVA found no significant effects between cognitive style, domain knowledge and computer experience. For all four experience profiles ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), FD and FI users with the same experience profile tended to disagree equally strongly with the statement that they experienced high levels of disorientation in the HLS. The Summary results of the ANOVA can be viewed in Appendix C.3.

Participants' views in relation to their dependency on the visual instructional aids are presented and considered in the next section.

5.5.4 Participants' Views Related to Dependency on the Visual Instructional Aids

Participants who used the version of the HLS that incorporated visual instructional aids were asked whether they were totally dependent on the visual instructional aids to reduce their levels of disorientation. Using a three-way ANOVA, a significant effect was found between cognitive style, domain knowledge and computer experience. The results from the analysis of the post-hoc tests also showed significant differences between the groups. Table 5.14 presents the relevant summary data.

Table 5.14: Results related to participants' dependency on the visual instructional aids

Question 5: "I am totally dependent on the visual instructional aids to reduce my levels of disorientation in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	5.417		1.667		4.750		1.250		4.917		1.250		.417		.500	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	0	0	4	33.3	1	8.3	4	33.3	0	0	4	33.3	0	0	6	50
Disagree	0	0	4	33.3	0	0	5	41.7	0	0	6	50	0	0	6	50
Slightly disagree	0	0	0	0	0	0	1	8.3	1	8.3	0	0	0	0	0	0
Neither	0	0	0	0	0	0	1	8.3	0	0	0	0	0	0	0	0
Slightly agree	1	8.3	4	33.3	1	8.3	0	0	2	16.7	1	8.3	0	0	0	0
Agree	5	41.7	0	0	7	58.3	1	8.3	5	41.7	1	8.3	5	41.7	0	0
Strongly agree	6	50	0	0	3	25	0	0	4	33.3	0	0	7	58.3	0	0
Significance	$F(1,88) = 11.455$, $p = 0.001$															

For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact on the views related to dependency on the visual instructional aids. FD participants with one of these experience profiles depended more on the visual instructional aids to reduce their levels of disorientation in the HLS than did FI participants with the same experience profile.

However, for the group of participants that had high DK and high CE, cognitive style showed no significant impact, with both FD and FI participants in this group responding that they did not depend on the visual instructional aids to reduce disorientation in the HLS.

The next section presents the findings in relation to participants' views of distraction by the visual instructional aids that were provided in the HLS.

5.5.5 Participants' Views Related to Distraction by the Visual Instructional Aids

The group of participants who used the version of the HLS that incorporated visual instructional aids were asked whether they were distracted by those visual instructional aids when using the system. A three-way ANOVA revealed no significant effect between cognitive style, domain knowledge and computer experience. With regards to all four experience profile groups ((i) low DK and low CE, (ii) low DK and high CE, (iii) high DK and low CE, and (iv) high DK and high CE), cognitive style had no significant impact on the reported distraction caused by the visual instructional aids. FD and FI participants with the same experience profile mostly responded that they were not distracted by the visual instructional aids when performing their learning in the HLS. Appendix C.3 summarises the ANOVA results.

Finally, participants' views of overall satisfaction with the HLS are presented and considered.

5.5.6 Participants' Views of Overall Satisfaction with the HLS

The last question in the closed questionnaire related to participants' views of their overall satisfaction with the HLS with which they interacted. With regards to the HLS that provided no instructional aids, the three-way ANOVA identified a significant effect between cognitive domain knowledge and computer experience. Additionally, post-hoc tests analysis revealed significant differences between the groups. Table 5.15 presents the summary results.

For the groups of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact on the views related to overall satisfaction with the HLS. FD participants with one of these experience profiles were less satisfied with the HLS than were FI participants with the same experience profile.

Table 5.15: Results related to participants' overall satisfaction with the HLS that provided no instructional aids

Question 7: "Overall, I am satisfied learning in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	2.000		3.667		2.333		4.417		1.750		4.750		5.333		5.500	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	2	16.7	0	0	0	0	0	0	2	16.7	0	0	0	0	0	0
Disagree	4	33.3	0	0	5	41.7	0	0	4	33.3	0	0	0	0	0	0
Slightly disagree	2	16.7	5	41.7	3	25	2	16.7	4	33.3	2	16.7	0	0	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	4	33.3	2	16.7	3	25	5	41.7	1	8.3	1	8.3	1	8.3	1	8.3
Agree	0	0	4	33.3	1	8.3	1	8.3	1	8.3	5	41.7	6	50	4	33.3
Strongly agree	0	0	1	8.3	0	0	4	33.3	0	0	4	33.3	5	41.7	7	58.3
Significance	$F(1,88) = 8.801$, $p = 0.018$															

However, for the group of participants that had high DK and high CE, cognitive style showed no significant impact on reported satisfaction with the HLS. FD participants with this experience profile reported learning satisfaction in the HLS at the same levels as FI participants with the same high-experience profile.

With respect to the version of the HLS that incorporated visual instructional aids, a three-way ANOVA revealed no significant effect between cognitive style, domain knowledge and computer experience (see Appendix C.3). For all four experience profiles ((i) low

DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), both FD and FI participants in these groups reported being satisfied learning in the HLS.

The next section reports the results from the open-ended questionnaires related to attitudes and opinions of the HLS.

5.6 Results From the Open-ended Questionnaire

Chapter 4 argued that using an open-ended questionnaire might provide insights into how individuals felt about the HLS which would not be gained by using a closed questionnaire. Section 5.6.1 presents and considers responses to the open-ended questionnaires in relation to the version of the HLS that provided no instructional aids. Section 5.6.2 presents and considers responses in relation to the version of the HLS that incorporated visual instructional aids. Where statements related to the participants are cast in technical language associated with the HLS and its use, they are paraphrased versions of the original participant utterances. The reason for the paraphrasing was to locate the participants' feelings, beliefs, and opinions in relation to the HLS features with which they interacted to perform their learning tasks, which was one of the focuses of this study.

5.6.1 Participants' Responses in Relation to the HLS with No Instructional aids

The findings from the open-ended questionnaires mostly suggested that, when considering the three independent variables (cognitive style – FD or FI, DK and CE) together, they seemed to influence participants' overall views of the version of the HLS that provided no instructional aids. Table 5.16 presents and considers some of the participants' overall views of the HLS that provided no instructional aids.

For the group of participants that possessed low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style showed a significant impact on their overall views of the HLS with which they interacted. FD participants with one of these experience profiles showed greater dislike for the HLS than did FI participants with the same experience profile. As can be seen from quotes (1-3), the FD participants in these experience profile groups said that they had difficulties learning in the HLS because they could not impose a conceptual structure on the 'XHTML' learning content, could not map a mental representation of the document structure in the HLS which, in turn, prevented them from exploring the tutorial or completing other learning tasks. The FD participants in these experience profile groups also reported that they preferred to be given a learning system which offered a linear structure or a HLS that incorporated instructional aids. In contrast, as can be seen from quotes (4-6), the FI participants in these experience profile groups said that they were satisfied learning in the HLS because they were allowed to set their own learning paths to meet their learning goals.

Table 5.16: Participants' overall views of the HLS that provided no instructional aids

	Experience profiles: low DK and low CE; low DK and high CE; high DK and low CE		**Experience profile: High DK and high CE**	
FD	1.	"I dislike the HLS. I suffer high levels of disorientation, and in turn hinder my learning performance. I prefer a learning system with linear structure." *(Low DK and low CE)*	7.	"I like the flexibility that is offered in the HLS. I can start from anywhere I want in the tutorial. I can also reach the information I need in relation to my learning goals easily and quickly."
	2.	"Despite possessing high DK, I find it difficult to learn in such learning system. This is because I cannot map the physical arrangement of the document in the HLS. I prefer to have some instructional aids." *(High DK and low CE)*	8.	"High levels of freedom of navigation. More control of the tutorial."
	3.	"I do not like the HLS because I find it difficult to impose a structure on the learning content in the HLS." *(Low DK and high CE)*	9.	"I enjoyed learning in the HLS because the learning content of the XHTML is presented in non-linear structure."
FI	4.	"The HLS allows me to set my own learning paths in relation to the information I need in the tutorial." *(High DK and low CE)*	10.	"The HLS allows me to have more control of the tutorial."
	5.	"Having possessed low domain knowledge and low computer experience, navigating through the HLS might be a bit tricky for the first time. But, overall, I am happy learning in the HLS because it provides flexibility in the tutorial." *(Low DK and low CE)*	11.	"Be able to jump among the subs-sections of a lesson. Be able to go backward and forward within a lesson as well. Index tools direct me easily and quickly to specific information I needed, especially, when performing the practical task."
	6.	"Overall, I am satisfied learning in the HLS as I can enjoy some levels of freedom of navigation. I will continue to use such learning system in the future." *(Low DK and high CE)*	12.	"I can access and sequence the information in accordance with the information that I need in relation to the tutorial."

However, for the group of participants that had high DK and high CE, cognitive style seemed to have no impact on their overall views of the HLS with which they interacted. The FD participants with this experience profile favoured the HLS as much as did the FI participants with the same experience profile. As can be seen from quotes (7-12), both FD and FI participants in this group said that the non-linearity in the HLS offered high levels of flexibility in the tutorial, and permitted them to enjoy high levels of freedom of navigation. The FD and FI participants in this group further added that they were permitted to access and sequence the information according to the information that they needed, and could go back to their previously-visited pages in the tutorial easily and quickly. Finally, the FD and FI participants in this group said that they were able to have more control over the XHTML tutorial in the HLS.

The findings from the open-ended questionnaire in relation to the HLS that incorporated visual instructional aids are reported next.

5.6.2 Participants' Responses in Relation to the HLS that provided Visual Instructional Aids

The findings from the open-ended questionnaires suggested that, overall, the participants showed positive attitudes towards the HLS and were satisfied with learning using the HLS. However, when considering cognitive style (FD or FI), DK and CE together, they seemed to have an impact on participants' reasons for showing positive attitudes towards, and satisfaction of learning in, the HLS. Table 5.17 presents the summary results related to this finding.

For the group of participants that had experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style seemed to have an impact on their reasons for showing positive attitudes towards, and satisfaction of learning in, the HLS. As can be seen from quotes (1-3), the FD participants in these groups explained that they favoured the HLS because they were able to use the visual instructional aids – for example maps, graphical overview diagrams, highlighting context, the history-based mechanism, link annotation, page numbers and so on – on which they depended a lot to impose a structure on the learning content or to map a mental representation of the information that was presented in the HLS.

In contrast, as can be seen from quotes (4-6), the FI participants in these groups mostly replied that they favoured the HLS mainly because they were allowed to set their own learning paths to achieve their learning goals in the tutorial. The FI participants in these groups also mentioned that they only used selected visual instructional aids on the infrequent occasions that they found it very difficult to impose a structure on the learning content or to map a mental representation of the information presented in the HLS.

Table 5.17: Participants' overall views of the version of the HLS that incorporated visual instructional aids

Experience profiles: low DK and low CE; low DK and high CE; high DK and low CE			**Experience profile: high DK and high CE**	
FD	1.	"The visual instructional aids [maps, highlighting context, history-based mechanism, page labels and so on] in the HLS which I am totally dependent on assist me in reducing my levels of disorientation and in achieving my learning goals." *(Low DK and low CE)*	7.	"I enjoy learning in the HLS and I do not get distracted by the visual instructional aids at all."
	2.	"I like the HLS as the visual orientation cues and navigational aids assisted me in reducing my orientation and navigation problems." *(High DK and low CE)*	8.	"Be able to enjoy the non-linearity feature offered by the HLS without being distracted by the visual instructional aids."
	3.	"I enjoy learning in the HLS because the visual instructional aids [such as maps, graphical overview diagrams, history based mechanisms, link annotations] assist me in increasing my navigation efficacy and in reducing my levels of disorientation." *(Low DK and high CE)*	9.	"I can have more control of the tutorial in the HLS and I do not get disturbed by the visual instructional aids."
FI	4.	"I like the HLS because firstly, it offers flexibility, and secondly, I can use the visual instructional aids if I am experiencing high levels of disorientation." *(Low DK and high CE)*	10.	"The HLS allows me to enjoy high levels of freedom of navigation. Overall, I am satisfied learning in the HLS."
	5.	"The visual instructional aids assist me in finding the information I need whenever I experience high levels of disorientation in the tutorial." *(Low DK and low CE)*	11.	"I can enjoy high level of flexibility in the HLS, irrespective of the visual instructional aids."
	6.	"I have a strong preference for the HLS because I can set my own learning paths in the tutorial. I do not get distracted by the visual instructional aids which I do not use." *(High DK and low CE)*	12.	"I do no need the visual instructional aids for navigation or orientation purposes. However, I enjoy learning in this type of HLS as I can still enjoy the feature of nonlinearity."

Furthermore, the FI participants in these groups tended to show some negative attitudes towards to the history-based mechanism because the mechanism only offered them the opportunity to revisit their last two pages in the tutorial. Lastly, they reported that though they did not use all of the visual instructional aids, neither were they distracted by them when performing their learning.

However, for the group of participants that had high DK and high CE, cognitive style seemed not to have an impact. As reflected in quotes (7-12), both FD and FI participants in this group said that they favoured the HLS mainly because of its non-linearity, permitting them to have a lot of control of the tutorial and to enjoy high levels of freedom of navigation. They also said that, despite the fact that they did not use the visual instructional aids when performing their learning, they were not disturbed by these visual instructional aids.

Having considered some of the responses from the open-ended questionnaires, section 5.7 reports the findings from the semi-structured interview.

5.7 Results From the Semi-Structured Interview

As discussed in Chapter 4, with regards to research question 1(c) (recapped in section 5.1), in order to gain an improved understanding of participants' attitudes, opinions, feelings, preferences, experiences and suggestions in relation to the HLS in terms of structure, navigation, levels of disorientation and overall satisfaction, semi-structured interviews were carried out with participants. The findings from the semi-structured interviews in relation to the version of the HLS that provided no instructional aids and the version of the HLS that incorporated visual instructional aids are presented in sections 5.7.1 and 5.7.2 respectively. In the same vein as was the case for the open-ended questionnaire data, statements from the semi-structured that contain technical language associated with the HLS and its use are paraphrased versions of the original participant utterances.

5.7.1 Participants' Views of the HLS that provided No Instructional Aids

The findings from the semi-structured interview mostly showed that was an effect between cognitive style (FD or FI), DK and CE on participants' views of this version of the HLS in terms of structure, navigation, levels of disorientation and overall satisfaction.

For the participants with experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style seemed to have a large impact on their views of the structure, navigation, levels of disorientation and overall satisfaction. Table 5.18 presents and considers the participants' in these experience profile groups views of the HLS in terms of structure, navigation, disorientation and overall satisfaction and in relation to cognitive style.

As can be seen from quotes (1-6), FD participants with one of these experience profiles showed more negative attitudes towards the structural arrangement in the HLS than did FI participants with the same experience profile. For instance, the FD participants with one of these experience profiles explained that the non-linearity in the HLS offered a lot of flexibility, making it more difficult for them to impose a structure of the learning content or to map a mental representation of the document structure of the HLS document. These participants also suggested that a HLS with instructional aids or a learning system with a linear structure could have reduced these issues. In contrast, the FI participants with the same experience profile reported that they were satisfied with the structure that was offered in the HLS precisely because it offered flexibility in the tutorial which they normally preferred when learning.

With respect to navigation, quotes (7-12) illustrate that FD participants with one of these experience profiles showed more negative attitudes towards navigation in the HLS than did FI participants with the same experience profile. For instance, the FD participants in these experience profile groups reported that the high levels of flexibility provided in the non-linear structure made it difficult for them to navigate effectively through the HLS to reach the information that they needed in relation to their learning goals. In contrast, the FI participants with the same experience profile reported that they were allowed to set their own learning paths in the HLS. Additionally, they mentioned that, although they experienced some difficulties navigating through the tutorial, they were able to reach the information that they needed in relation to their learning goals efficiently and effectively.

With respect to disorientation, as quotes (13-18) suggest, FD participants with one of these experience profiles reported higher levels of disorientation in the HLS than did FI participants with the same experience profile. FD participants with one of these experience profiles explained that they suffered the following types of disorientation in the HLS: they did not know where they were; they did not know where they were coming from; they did not know where and how to reach the information that they needed; and when they knew what information they needed, they could not find it. Conversely, the FI participants with the same experience profile reported that they experienced only low levels of disorientation and that they were able to address these concerns.

Finally, in terms of overall satisfaction, as quotes (19-24) illustrate, FD participants with one of these experience profiles reported greater dissatisfaction with the HLS than did FI participants with the same experience profile. The FD participants with either low DK and low CE, or low DK and high CE argued that they were not happy learning in the HLS because they experienced high levels of disorientation and, in turn, failed to explore the tutorial, which may consequently have hindered their learning performance. These participants further reported that they preferred to learn in a learning system which provided instructional aids or which presented learning material using a linear structure. Additionally, FD participants with high DK and low CE reported that their high prior knowledge of the learning content of XHTML encouraged them not to go through the whole tutorial in the HLS. However, these participants argued that, because they failed to map a mental representation of the physical arrangement of the document specified by the HLS, they experienced difficulties navigating through the HLS and, in turn, lost interest in using the learning system.

In contrast, the FI participants in these four experience profile groups ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), said that they were satisfied learning in the HLS because they enjoyed the flexibility that it offered, allowing them to set their own learning paths in the tutorial. The FI participants in these experience profile groups also reported that, although they experienced some low levels of disorientation, they knew how to reach the information that they needed to achieve their learning goals.

Table 5.18: Participants' views of the HLS that provided no instructional aids in relation to cognitive style for the following experience profile groups: (i) low DK and low CE; (ii) low DK and high CE; and (iii) high DK and low CE

		Structure		Navigation		Disorientation		Satisfaction
FD	1.	"I do not like the structure in the HLS. I do not know where to start and where to go so as to complete my learning. A HLS with instructional aids may be useful." *(low DK and high CE)*	7.	"I have difficulties navigating through the HLS to reach the information I need." *(Low DK and low CE)*	13.	"Knowing where to go, I find it hard to reach my destination in the HLS. I feel disorientated in such HLS." *(High DK and low CE)*	19.	"I simply do not like the HLS. The non-linear structure makes it difficult for me to complete the tutorial which is needed to achieve my learning goals." *(Low DK and low CE)*
	2.	"The non-linear structure in the HLS offers a lot of flexibility makes it difficult to navigate through and to complete the tutorial. I prefer a linear structure where I can have lot of guidance." *(Low DK and low CE)*	8.	"There is no direction about where I am going, where I am, where and how I can reach a destination in relation to my current learning goals." *(Low DK and high CE)*	14.	"I experience difficulties navigating through the tutorial to achieve my learning goals. I experience high levels of disorientation in the HLS." *(Low DK and low CE)*	20.	"I am unsatisfied with the HLS. A learning system with linear structure or a HLS with instructional aids may be useful." *(Low DK and high CE)*
	3.	"The non-linear structure makes it difficult for me to map a mental representation of the document structure in the HLS." *(High DK and low CE)*	9.	"I find it difficult to navigate through the HLS to find information I want to explore in relation to the XHTML tutorial." *(High DK and low CE)*	15.	"I cannot impose a structure of the learning content and in turn I experience high levels of disorientation." *(Low DK and high CE)*	21.	"I cannot map a mental representation of the physical arrangement of the document that is presented in the HLS. I will not use this learning system in the future." *(High DK and low CE)*
FI	4.	"I like the structure in the HLS as it offers flexibility in terms of navigation." *(High DK and low CE)*	10.	"At start it is a bit difficult to navigate through the HLS. Later, I feel comfortable navigating the tutorial to complete learning tasks." *(Low DK and high CE)*	16.	"At the start it was a bit difficult to navigate and orientate in the HLS but after a while, I experienced little disorientation." *(Low DK and low CE)*	22.	"I am still satisfied learning in this HLS because I can enjoy the flexibility that is given in the tutorial." *(Low DK and low CE)*
	5.	"The non-linear structure allows me to set my own learning paths in the tutorial." *(Low DK and low CE)*	11.	"The HLS permits me to set my own navigation paths while performing my learning." *(Low DK and low CE)*	17.	"I feel low levels disorientation in the HLS, but I can address these concerns." *(Low DK and high CE)*	23.	"Overall, I am satisfied with the HLS as I can achieve my learning goals when using it." *(High DK and low CE)*
	6.	"I am happy with the structure as it provides some levels of flexibility in the tutorial." *(low DK and high CE)*	12.	"Be able to set my own navigation paths in the HLS which I normally preferred when learning." *(High DK and low CE)*	18.	"Overall, I experience very low levels of disorientation which does not hinder my learning at all." *(High DK and low CE)*	24.	"I am happy to learn in this HLS as I can set my own learning paths." *(low DK and high CE)*

However, for the group of participants that had high DK and high CE, cognitive style seemed not to influence their views of the HLS in terms of structure, navigation, levels of disorientation and overall satisfaction. Table 5.19 summarises high DK and high CE participants' views of the HLS without instructional aids provided in relation to cognitive style. As can be seen from quotes (1-6), FD participants with this experience profile favoured the structure in the HLS as strongly as did FI participants with the same experience profile. Both FD and FI participants with this experience profile mentioned that the non-linearity in the HLS allowed them to have more control over the tutorial.

In addition to HLS structure, both FD and FI participants in this group affirmed that they enjoyed high levels of freedom of navigation in the HLS. They further explained that the index tool permitted them to reach easily and quickly specific information in relation to their learning goal. Finally, they reported that they were able to access and sequence the information in accordance with the information that they needed in the tutorial. Quotes (7-12) reflect these views.

With regards to disorientation, both FD and FI participants in this group asserted that they did not experience disorientation in the HLS (see quotes (13-18)). For example, FD and FI participants in this group informed the interviewer that, in relation to the tutorial, they knew: where they were; where they were coming from; what they viewed; where best to go in relation to their learning goals; and how to go back to their visited pages.

Finally, with respect to overall satisfaction with the HLS, as can be seen from quotes (19-24) both FD and FI participants in this group mentioned that they enjoyed using the HLS because it provided high levels of flexibility, permitting them a high degree of freedom of navigation in the tutorial. Furthermore, both FD and FI participants in this group said that they were able to access and sequence information in relation to their learning goals, which increased their cognitive flexibility. Lastly, the participants with this experience profile affirmed that they enjoyed having more control over the tutorial in the HLS.

Table 5.19: High DK and high CE participants' views of the HLS without instructional aids in relation to cognitive style

		Structure		Navigation		Disorientation		Satisfaction
FD	1.	"The non-linear structure offers flexibility in the HLS, which permits me to have more control of the tutorial."	7.	"The index tool allows me to reach for particular information which I am interested, especially during the practical task, easily and quickly."	13.	"I do not experience any level of disorientation in the HLS. I know where to go, where I am and how to revisit previous pages."	19.	"I am satisfied with the HLS as I can learn at my own pace."
	2.	"There is high level of flexibility as I can go anywhere I want in the tutorial."	8.	"I can set my own learning paths to reach the information I need in the tutorial. Hence, I enjoy high levels of freedom of navigation."	14.	"The HLS provides me high levels of freedom of navigation. I can navigate effectively without experiencing disorientation."	20.	"Flexible structure and high levels of freedom of navigation motivates me to perform my learning in the HLS."
	3.	"I enjoy the non-linear structure, but I will not use a linear structure as it is too constraint."	9.	"The flexibility offered by the structure in the HLS permits me to enjoy high levels of freedom of navigation in the tutorial."	15.	"I can impose a structure on the learning content and can map a mental representation of the information in the HLS, preventing me from disorientation"	21.	"Overall, I am happy with the HLS because I enhance my learning satisfaction as well as my learning performance."
FI	4.	"The structure offered in the HLS allows me to enjoy high levels of freedom of navigation."	10.	"I am an expert in programming languages and have high computer skills. I have no difficulty navigating through the tutorial."	16.	"I can navigate and orientate effectively while completing the tutorial."	22.	"I am happy with the overall features that are offered by the HLS, particularly the flexibility in the tutorial."
	5.	"The non-linear structure allows me to go anywhere I want. I can start any lesson I want to explore in the tutorial."	11.	"Overall, I like such type of learning system as I can navigate effectively to achieve my learning goals."	17.	"I can easily navigate through the tutorial to achieve my learning goals without suffering disorientation."	23.	"I am totally satisfied with the HLS as I can enjoy freedom of navigation and can also enhance my learning performance."
	6.	"I can access and sequence the information in accordance with the information that I need."	12.	"The HLS permits me to set my own navigation paths when using the tutorial. I can also reach specific information easily and quickly."	18.	"I do not experience any levels of disorientation in the HLS."	24.	"I am satisfied with the HLS and I will like to use them in the future."

The next section reports the findings from the semi-structured interview in relation to the HLS that incorporated visual instructional aids.

5.7.2 Participants' Views of the Version of the HLS that Incorporated Visual Instructional Aids

The responses that were gathered from the semi-structured interviews mostly showed that the participants using this version of the HLS had a positive attitude towards the system's structure, enhanced their navigation efficacy, experienced little if any disorientation, and enjoyed learning in the HLS. However, with regards to their cognitive style, domain knowledge and computer experience, participants gave different reasons for these attitudes. For participants that had experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style seemed to influence their reasons for favouring the HLS in terms of structure, navigation, disorientation and satisfaction. Table 5.20 summarises the results in relation to cognitive style for these three experience profile groups.

As quotes (1-6) demonstrate, FD participants with one of these experience profiles gave different reasons for showing positive attitudes towards the structure of the HLS compared to FI participants with the same experience profile. The FD participants in these experience profile groups reported that they favoured the structure for the following reason: they explained that, irrespective of the non-linearity available in the HLS, the visual instructional aids – for example, maps and graphical overview diagram – helped create a linear structure for them, providing them with guided learning in the tutorial. In contrast, the FI participants in these experience profile groups gave a different reason: they reported that, though the visual instructional aids were present, they were happy with the structure of the HLS mainly because of its non-linearity, which allowed them to make use of the flexibility in the tutorial.

With respect to navigation, FD participants with one of these experience profiles gave different reasons for enhancing their navigation efficacy in the HLS than those given by the FI participants with the same experience profile. As can be seen from quotes (7-9), the FD participants in these experience profile groups said that they were enabled to navigate effectively through the HLS mainly because of the visual instructional aids. The

FD participants in these experience profile groups further explained that they were dependent on the visual instructional aids – the map, graphical overview diagram, history based mechanism and so on – to allow them to navigate effectively through the HLS and find information that they needed to achieve their learning goals. These participants made suggestions that the number of visited pages available in the history-based mechanism visual cue be increased from two to 10. Another suggestion was of the inclusion of an interactive map at the top of every page in the HLS. They argued that such visual a representation would have assisted them in visualising their path as they navigated through the tutorial, which could have prevented them from opening unnecessary nodes and have improved their time efficacy.

In contrast, as can be seen from quotes (10-12), the FI participants in these experience profile groups said that they had positive attitudes towards navigation in the HLS mainly because they were allowed to set their own navigation paths to reach the information that they needed in relation to their learning goals in the tutorial. They further added that they only made use of a visual instructional aid – the history based mechanism – on the rare occasions when they found it difficult to revisit the latest pages in the tutorial. However, they still suggested increasing the number of visited pages stored in the history-based mechanism.

With regards to disorientation, as can be seen from quotes (13-18), FD participants with one of these experience profiles gave different reasons for experiencing little or no disorientation in the HLS compared to FI participants with the same experience profile. The FD participants in these experience profile groups explained that they experienced little or no disorientation in the HLS mainly because of the visual instructional aids. They suggested that they were totally dependent on the visual instructional aids to impose a structure on the learning content or to map a mental representation of the document structure in the HLS which, in turn, prevented them from experiencing high levels of disorientation. For instance, they reported that the map and graphical overview diagram helped them in seeing relationships between different pieces of information presented in the HLS. Additionally, they said that the history based mechanism supported them to view and access their last two pages visited. Finally, the breadcrumb facilities, highlighting context, pagination, graphical overview diagram, link annotation, different colours link, and page labels in the form of headings and sub-headings, increased their orientation while navigating through the tutorial. In contrast, the FI participants in these experience profile groups argued that they experienced little or no disorientation because they were able to navigate effectively to reach the information that they needed in the tutorial. They also reported that they were not totally dependent on the visual instructional aids to reduce their levels of disorientation. They reported only using the visual instructional aids of breadcrumbs and history based mechanism on the rare occasions that they experienced high levels of disorientation in the tutorial.

Finally, when asking the participants why they were satisfied with the HLS, different reasons were given by FD and FI participants in these experience profile groups (as can be seen from quotes (19-24)). The FD participants in these experience profile groups answered that the visual instructional aids on which they were dependent assisted them in reducing their levels of disorientation and in increasing their navigation efficacy, which, in turn, led them to learn effectively and efficiently. In contrast, the FI participants in these experience profile groups gave three different reasons for their satisfaction: they were allowed to set their own learning paths to reach the information that they needed; they were able to use the visual instructional aids when they found it difficult to navigate through the HLS to achieve their learning goals; and lastly, though they did not use all of the visual instructional aids, neither were they distracted by them.

In addition to satisfaction, as quotes (20) and (22) illustrate, the FD and FI participants made different suggestions related to the provision of multimedia in the HLS. The FD participants argued that multimedia for navigation and orientation purposes might reduce visual workload in the HLS. In contrast, the FI participants asserted that having multimedia to explain the learning content in relation to pseudo-code in the tutorial might be useful and more interactive.

Table 5.20: Participants' views of the HLS that provided visual instructional aids in relation to cognitive style for the three experience profile groups: (i) low DK and low CE; (ii) low DK and high CE; and (iii) high DK and low CE

	Structure		Navigation		Disorientation		Satisfaction	
FD	1.	"The map and the graphical overview diagram are in the form of a linear structure, which guides me a lot to complete learning tasks." *(Low DK and low CE)*	7.	"With the map I can see the relationship between the information presented in the HLS, which permits me to reach my desired location easily and quickly." *(Low DK and high CE)*	13.	"The maps enable me to impose a structure on the learning content. The breadcrumbs permit me to find my current location and the path that led me to my current location in the HLS." *(Low DK and high CE)*	19.	"I am totally satisfied with the overall HLS. The visual instructional aids assisted me in accomplishing my learning goals." *(Low DK and low CE)*
	2.	"The instructional aids seem to offer linear structure, allowing me to meet less difficulty learning in HLS." *(Low DK and low CE)*	8.	"The graphical overview diagram and the map enhanced my navigation efficacy. I am totally dependent on the visual instructional aids to navigate effectively through the tutorial." *(Low DK and low CE)*	14.	"The highlighting context, page labels, and pagination increase my levels of orientation in the HLS. I am totally dependent on the visual instructional aids to reduce from disorientation." *(High DK and low CE)*	20.	"It is very easy to learn when visual instructional aids are provided. Multimedia for orientation and navigational purposes can be useful too."*(Low DK and high CE)*
	3.	"The map seems to be of linear structure, which offers guided learning." *(Low DK and high CE)*	9.	"The history based mechanism directs me to my recent visited pages without having to navigate the whole tutorial again." *(High DK and low CE)*	15.	"I am totally dependent on the visual instructional aids to escape from disorientation." *(Low DK and low CE)*	21.	"I will use the HLS on condition that the visual instructional aids are provided." *(High DK and low CE)*
FI	4.	"The structure offers some flexibility which allows me to learn at my own pace." *(Low DK and high CE)*	10.	"I have no major difficulties navigating through the HLS." *(Low DK and low CE)*	16.	"I will use the instructional aids if I am only experiencing high levels of disorientation." *(Low DK and high CE)*	22.	"Use of multimedia to explain a piece of pseudo code may be interactive." *(High DK and low CE)*
	5.	"The flexibility that was offered in the non-linear structure permits me in increasing my cognitive flexibility." *(Low DK and high CE)*	11.	"I can manage to set my learning path to meet my learning goals but won't mind using instructional aids such as history based mechanism." *(Low DK and high CE)*	17.	"I experience little disorientation in the HLS. I will use the visual instructional if am only experiencing high levels of disorientation." *(Low DK and low CE)*	23.	"I am allowed to set my own navigation paths in the HLS and can use the visual aids if I am experiencing high levels of disorientation." *(Low DK and low CE)*
	6.	"I can make use of the flexibility that was offered in the tutorial." *(High DK and low CE)*	12.	"I enable to set my own navigation paths to reach the information I need in the tutorial." *(High DK and low CE)*	18.	"I do not totally depend on the visual instructional aids to reduce my levels of disorientation." *(High DK and low CE)*	24.	"I am satisfied with the HLS as It provides flexibility." *(Low DK and high CE)*

However, for the group of participants that had high DK and high CE, cognitive style did not seem to have an impact on their reasons for favouring the HLS. Table 5.21 summarises the results in relation to cognitive style for participants with the experience profile of high DK and high CE. With respect to structure, quotes (1-6) illustrate that both FD and FI participants in this group showed positive attitudes towards the structure, irrespective of the visual instructional aids, because the learning content was presented in a non-linear structure. Both FD and FI participants in this group further explained that the nonlinearity in the HLS permitted them more control over the XHTML tutorial.

Put another way, with regards to navigation both FD and FI participants in this group reported that the flexibility that was offered by the non-linearity allowed them to enjoy high levels of freedom of navigation in the HLS (as can be seen from quotes (7-12)). They also stated that they did not need any of the visual instructional aids for navigational purposes in the HLS.

With regards to levels of disorientation, both FD and FI participants with this experience profile reported that they did not experience disorientation problems in the HLS because their prior knowledge of the learning content of XHTML, and in using computers, allowed them successfully to navigate through the HLS to achieve their learning goals. Additionally, they asserted that since they did not experience disorientation in the HLS, they did not need any of the visual instructional aids to accomplish their learning goals. Quotes (13-18) reflect these views.

Finally, in terms of overall satisfaction, both FD and FI participants in this group said that they were satisfied learning in the HLS for the following three reasons. Firstly, they enjoyed high levels of freedom of navigation in the HLS. Secondly, they were able to learn at their own pace and had more control over the tutorial. Lastly, despite the fact that they did not use the visual instructional aids, neither were they distracted by them. They further explained that the visual instructional aids seemed to be ordinary hyperlinks or content in the HLS, which did not influence their learning. Quotes (19-24) illustrate these views.

Table 5.21: High DK and high CE participants' views of the HLS that incorporated visual instructional aids in relation to cognitive style

	Structure		Navigation		Disorientation		Satisfaction/distraction	
FD	1.	"Overall, I am happy with the structure in the HLS."	7.	"I enjoy the high levels of freedom of navigation in the HLS. Also, I do not need any of the visual instructional aids for navigational purposes."	13.	"I am comfortable navigating the HLS without suffering disorientation."	19.	"I do not get distracted when using the HLS that incorporates visual instructional aids to perform my learning."
	2.	"Irrespective of the visual instructional aids, the HLS provides flexible structure, allowing freedom of navigation."	8.	"Irrespective of the visual instructional aids, I am comfortable navigating through the HLS to meet my learning goals."	14.	"Since I possess high levels of computer experience and domain knowledge I did not experience disorientation in the HLS." Also, I did not require any of the visual instructional aids to complete the tutorial."	20.	"Irrespective of the visual instructional aids, I am satisfied with the HLS. I can enjoy the flexibility that are given in the tutorial and can learn at my own pace too."
	3.	"The non-linear structure enables me to have more control of the XHTML tutorial."	9.	"I can set my own navigation paths to accomplish learning tasks."	15.	"I do not experience disorientation in the HLS."	21.	"Overall, I am satisfied learning in the HLS since the visual instructional aids do not influence my learning performance."
FI	4.	"The HLS still provides the non-linear feature. I do not have problem learning in such learning system."	10.	"I am comfortable navigating through the HLS without being dependent on the visual instructional aids."	16.	"I can navigate and orientate through the tutorial without being dependent on the visual instructional aids."	22.	"What I enjoy with the HLS is that the learning content is presented in non-linear structure."
	5.	"The non-linear structure allows me to access and sequence the information in accordance with the information that I need."	11.	"I have high levels of computer experience and high levels of domain knowledge and hence I can navigate through the HLS without being dependent on the visual instructional aids."	17.	"My prior knowledge of using XHTML and computers allow me to impose a structure of the learning content and the information presented in the HLS, thus escaping from disorientation."	23.	"I will use the HLS as I can enjoy high levels of freedom of navigation in the tutorial. The fact that I do not use the visual instructional aids, I do not get distracted by them either."
	6.	"The non-linear structure provides high levels of flexibility, which permit me to enjoy high levels of freedom of navigation."	12.	"I can enjoy high levels of freedom of navigation in the tutorial."	18.	"Irrespective of the visual instructional aids, I can navigate and orientate through the tutorial to meet my learning goals."	24.	"Overall I am satisfied to learn in the HLS as it provides flexibility and high levels of freedom of navigation."

Having presented and considered perspectives from the open-ended questionnaires and semi-structured interviews, section 5.8 reports the findings from the observation activity.

5.8 Results From Observation

As discussed in Chapter 4, this study employed observational techniques to gain an improved understanding of the effect of cognitive style, domain knowledge (DK) and computer experience (CE) on participants' navigation, levels of disorientation, and learning performance and to highlight any unexpected observations/findings when using the HLS to complete the tutorial and the practical task. Section 5.8.1 reports the observation results in relation to participants' interaction with the version of the HLS that provided no instructional aids and section 5.8.2 reports the observation results in relation to participants' interaction with the version of the HLS that incorporated visual instructional aids.

5.8.1 Observation Results in the version of the HLS that provided no instructional aids

The findings from the observations mostly showed that, when considering cognitive style, domain knowledge and computer experience together, they seemed to influence participants' interaction behaviour in terms of navigation, levels of disorientation, and learning performance (time efficacy and number of questions completed in the practical task) when using the version of the HLS that provided no instructional aids. There were also some unexpected findings in relation to these themes.

This section first presents and considers the observational data in relation to navigation and cognitive style for the four experience profile groups. Table 5.22 summarises the observation results. For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, the observation results mostly showed that cognitive style had a significant impact on their navigation in the tutorial. It was observed that FD participants with one of these experience profiles seemed to more have difficulties navigating through the HLS to complete the tutorial than FI did participants with the same experience profile. The FD participants with one of these experience profiles seemed to experience greater difficulties imposing a structure on the learning content of the XHTML tutorial, mapping a mental representation of the information that was presented in the HLS, or understanding how to use non-linear systems to perform their learning than did the FI participants with the same experience profile.

For the group of participants that had low DK and low CE, or low DK and high CE, similar findings were identified in the practical task. For the group of participants that had high DK and low CE, the observational data related to navigation was not gathered in the practical task because both FD and FI participants in this group interacted less with the HLS to complete the exercises.

Table 5.22: Participants' interaction behaviour in terms of navigation

Experience Profiles	Navigation			
	In the Tutorial		In the Practical Task	
	Navigate effectively	**Navigate less effectively**	**Navigate effectively**	**Navigate less effectively**
(i) Low DK and low CE	FI	FD	FI	FD
(ii) Low DK and high CE	FI	FD	FI	FD
(iii) High DK and low CE	FD and FI		FD and FI users used less of the HLS, so the observation data related to navigation were not gathered	
(iv) High DK and high CE	FD and FI		FD and FI users used less of the HLS, so the observation data related to navigation were not gathered	

However, with regards to those users with an experience profile of high DK and high CE, cognitive style had no impact on their navigation. FD participants with this experience profile seemed to be as comfortable with the flexibility that was offered in the structure in the HLS as were the FI participants with the same experience profile. It was observed that both FD and FI participants navigated effectively through the HLS to explore the tutorial. The index tools were also used by FD and FI participants in this group to reach particular information in relation to the tutorial. In the practical task, the FD and FI participants with this experience profile barely used the HLS because they completed most of the exercises by themselves, without reference to the system.

Having considered navigation, the observation data in relation to the levels of disorientation are discussed next. Table 5.23 summarises the interaction behaviour of the participants in the four experience profile groups in terms of their levels of disorientation.

For the group of participants that had either low DK and low CE, or low DK and high CE, the observation results mostly showed that cognitive style had a significant impact on levels of disorientation when using the HLS. It was observed that FD users with one of these experience profiles seemed to experience higher levels of disorientation than FI users with the same experience profile. For example, the FD users with one of these two experience profiles often opened unnecessary nodes in relation to their current learning goals. Additionally, the FD users who had one of these two experience profiles kept returning to the same page. It seemed as though the FD participants in these profile groups were experiencing disorientation in the HLS related to 'where were they', 'where had they been', and 'what were they reading previously', or 'how to get to their desired page.' In contrast, FI users with one of these two experience profiles successfully reached the required locations in relation to their learning goals in the HLS. The number of times that the FI users with one of these two experience profiles opened unnecessary nodes was also very low. Similar observations were seen in relation to the practical task.

For the group of participants that had high DK and low CE, cognitive style had a significant impact on their levels of disorientation when completing the tutorial in the HLS, too. It was observed that FD participants with this experience profile experienced higher levels of disorientation in the HLS than FI participants with the same experience profile. It seemed that the FD participants with this experience profile knew what they needed and where to go to in relation to the content of the XHTML tutorial, but failed to reach their desired destination in the HLS. It seemed that these FD participants had difficulties mapping the physical arrangement of the document specified by the hypermedia nodes. This was the opposite for FI participants with the same experience profile. The FI participants in this group were able to reach the information that they needed in the tutorial effectively and efficiently. However, there was no opportunity to gather observational data in relation to the practical task to supplement these findings since both FD and FI participants with this experience profile completed the practical task without using much of the HLS.

Finally, for the group of participants that possessed high DK and high CE, cognitive style showed no significant impact on their levels of disorientation in the HLS when completing the tutorial. It was observed that both FD and FI participants with this experience profile seemed to navigate through the tutorial without experiencing disorientation. The FD and FI participants in this group knew: where they were; where they were coming from; where and how to reach the information in the tutorial that they needed. With respect to the practical task, since the FD and FI participants in this group had little interaction with the HLS to complete the task, relying on their knowledge rather than seeking information from the system, no data related to levels of disorientation was gathered through the observations.

Table 5.23: Participants' interaction behaviour in terms of levels of disorientation

<table>
<tr><th rowspan="3">Experience Profiles</th><th colspan="6">Levels of Disorientation</th></tr>
<tr><th colspan="3">In the Tutorial</th><th colspan="3">In the Practical Task</th></tr>
<tr><th>Low- level</th><th>High-level</th><th>None</th><th>Low-level</th><th>High-level</th><th>None</th></tr>
<tr><td>(i) Low DK and low CE</td><td>FI</td><td>FD</td><td></td><td>FI</td><td>FD</td><td></td></tr>
<tr><td>(ii) Low DK and high CE</td><td>FI</td><td>FD</td><td></td><td>FI</td><td>FD</td><td></td></tr>
<tr><td>(iii) High DK and low CE</td><td>FI</td><td>FD</td><td></td><td colspan="3">Observation data on disorientation was not gathered since both FD and FI had little interaction with the HLS.</td></tr>
<tr><td>(iv) High DK and high CE</td><td></td><td></td><td>FD and FI</td><td colspan="3">Observation data on disorientation was not gathered since both FD and FI had little interaction with the HLS.</td></tr>
</table>

This section now presents and considers the observational data in relation to time efficacy (in terms of time taken to complete the tutorial and the practical task). Table 5.24 summarises the interaction behaviour in terms of time efficacy of the participants in the four experience profile groups.

For the group of participants that had low DK irrespective of their level of CE (groups (i) and (ii) in Table 5.24), the results from the observations mostly suggested that cognitive style seemed to play an important role in the length of time taken to complete the tutorial and the practical task. It was observed that FD participants with one of these experience profiles took more time to complete the tutorial and the exercises in the practical task than did FI participants with the same experience profile. As suggested earlier in this section, high levels of disorientation that were experienced by FD participants with these experience profiles could explain the longer time taken to complete the tutorial and the practical task. However, both FD and FI users with the same experience profile tended to open all the lessons and all the pages in the tutorial; additionally, it seemed that they depended a lot on the tutorial in the HLS to complete the exercises in the practical task.

Table 5.24: Participants' interaction behaviour in terms of time efficacy

Experience Profiles	Time efficacy	
	In the Tutorial	In the Practical Task
(i) Low DK and low CE	FD spent more time than FI	FD spent more time than FI
(ii) Low DK and high CE	FD spent more time than FI	FD spent more time than FI
(iii) High DK and low CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI
(iv) High DK and high CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI

For the group of participants that had high DK and low CE, or high DK and high CE, cognitive style seemed to have little impact on time efficacy in the tutorial. It was observed that FD participants with one of these experiences profiles spent almost the same amount of time completing the tutorial and the practical task as did FI participants with the same experience profile. The observation results also showed that both FD and FI participants with the same experience profile tended not visit all the pages of a lesson or all the lessons in the tutorial, and had less interaction with the HLS when they were completing the exercises in the practical task.

The remainder of this section reports the observation data in relation to the number of exercises that were completed in the practical task by FD and FI users with the four experience profile groups. Table 5.25 summarises the observation results.

For participants that had experience profiles of either low DK and low CE, or low DK and high CE, cognitive style seemed to have a large impact. It was observed that FD users with one of these experience profiles failed to complete all of the exercises, unlike their FI counterparts. It is argued that this could be because of the FD users' high levels of disorientation in the HLS (as discussed earlier in this section) which may have hindered FD users in these groups from opening nodes relevant to content that was needed to complete the exercises. Another explanation could be that they tended to open unnecessary nodes in the tutorial, which may have led the FD users in these groups to experience time pressures in completing all the exercises. In contrast, the FI participants' low levels of disorientation in the HLS (as discussed earlier in this section) may have allowed them to have enough time to complete all of the exercises in the practical task.

For the group of participants who had either high DK and low CE, or high DK and high CE, cognitive style seemed not have a large impact: both FD and FI learners with the same experience profile completed all of the exercises in the practical task, although they had less interaction with the HLS in the practical task.

Table 5.25: Observation data in relation to number of exercises completed

Experience Profiles	**Number of exercises completed in the practical task**	
	some of the exercises	**all of the exercises**
(i) Low DK and low CE	FD	FI
(ii) Low DK and high CE	FD	FI
(iii) High DK and low CE		FD and FI
(iv) High DK and high CE		FD and FI

The next section considers and presents the observation results in relation to participants' interaction with the version of the HLS that incorporated visual instructional aids.

5.8.2 Observation Results in Relation to the HLS that Incorporated Visual Instructional Aids

The participants who used the version of the HLS that incorporated visual instructional aids to complete the tutorial and the practical task were also observed in terms of their navigation, levels of disorientation, time efficacy, and number of exercises that were completed in the practical task. Any unexpected findings in relation to these themes were also recorded. The observations revealed some significant results in relation to cognitive style, domain knowledge and computer experience, which are discussed next.

This section first presents and considers the observational data in relation to navigation and cognitive style for the four experience profile groups ((i) low DK and low CE, (ii) low DK and high CE), (iii) high DK and low CE, and (iv) high DK and high CE. Table 5.26 presents the summary results.

For the group of participants that had low DK, irrespective of their level of CE, cognitive style showed no impact on their navigation. It was observed that both FD and FI participants in these groups seemed to navigate effectively through the HLS to meet their learning goals. However, cognitive style showed a significant impact on participants' use of the visual instructional aids for navigational purposes in the tutorial. It was observed that FD participants with one of these two experience profiles tended to depend more on the visual instructional aids to navigate through the HLS to reach the information that they needed than did the FI participants with the same experience profile. For instance, the FD participants in these experience profile groups made much use of the map, graphical overview diagram and history-based mechanism to navigate through the HLS to complete the tutorial. It is argued that this may be because the 'map' visual instructional aid assisted the FD participants in these groups in understanding the relationship between the information that was presented in relation to the XHTML learning content, and in reaching the information that they needed in relation to their learning goals. The history-based mechanism may have directed them to the latest pages that they had visited.

Table 5.26: Participants' interaction behaviour in terms of navigation

Experience Profiles	**Navigation**			
	In the Tutorial		**In the Practical Task**	
	Navigate-effectively	**Navigate less effectively**	**Navigate effectively**	**Navigate less effectively**
(i) Low DK and low CE	FD and FI		FD and FI	
(ii) Low DK and high CE	FD and FI		FD and FI	
(iii) High DK and low CE	FD and FI		The observation data related to navigation were not gathered since both FD and FI users had little interaction with the HLS	
(iv) High DK and high CE	FD and FI		The observation data related to navigation were not gathered since both FD and FI users had little interaction with the HLS	

In contrast, FI participants with one of these experience profiles seemed successfully to be setting their own learning paths to reach the information that they needed in the tutorial to achieve their learning goals. For instance, it was observed that the FI participants in these groups seldom used the history-based mechanism to navigate through the tutorial in the HLS. This form of visual cue may have directed the FI participants in these groups to the information that they needed easily and quickly. One of the reasons for the FI participants in these groups being less dependent on the visual instructional aids may be because, as reflected in their characteristics in Table 2.1, they prefer to provide structure when it is not inherent in the presented information, and tend to set their own learning paths in the HLS as they often depend on internal references and adopt an active approach to learning. Similar findings for these groups were identified in the practical task.

For the group of participants that possessed high DK and low CE, cognitive style showed no significant impact on their navigation when completing the tutorial. It was observed that both FD and FI participants with this experience profile enhanced their navigation efficacy in the tutorial. However, cognitive style seemed to have an impact on participants' use of the visual instructional aids for navigation purposes in the tutorial. It was observed that FD participants with this experience profile seemed to depend more on the visual instructional aids to navigate through the HLS to complete the tutorial than did FI participants with the same experience profile. With respect to the practical task, the data related to navigation was not identified since both FD and FI participants in this group interacted less with the HLS to complete the exercises.

Finally, for the group of participants that had high DK and high CE, the observation results mostly showed that cognitive style did not influence their navigation in the HLS when completing the tutorial. Both FD and FI participants with this experience profile were observed navigating effectively through the HLS to complete the tutorial. In addition to this finding, it was observed that both FD and FI participants in this group did not use any of the visual instructional aids to navigate through the HLS to complete the tutorial. However, the observational data related to navigation were not identified in the practical task because their prior knowledge of the XHTML learning content allowed both FD and FI participants in this group to complete the exercises without having to interact with the HLS.

This section now presents and considers the observation results in relation to levels of disorientation by FI and FD with the four experience profile groups. Table 5.27 gives the relevant summary results.

For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, the findings from the observations mostly showed that cognitive style seemed to have no significant impact on their levels of disorientation in the HLS when completing the tutorial. It was observed that FD users with one of these experience profiles seemed to experience no disorientation in the HLS when completing the tutorial; the same was true of FI users with the same experience profile. Both FD and FI participants with one of these experience profiles seemed to reach the information that they needed in relation to their learning goals in the tutorial effectively and efficiently.

However, cognitive style showed an impact on the use of the visual instructional aids to reduce their levels of disorientation in the HLS. It was observed that the FD participants with one of these experience profiles seemed to depend much more on the visual instructional aids to reduce their levels of disorientation than did the FI participants with the same experience profile. For instance, the FD users with one of these experience profiles tended to interact a lot with the visual instructional aids – map, graphical overview diagram and history-based mechanism – when completing the tutorial.

In contrast, the FI users with one of these experience profiles only tended to use the visual instructional aid of history-based mechanism'. Similar findings were identified in the practical task for the group of participants that had either low DK and low CE, or low DK and high CE. However, with regards to the group of participants that had high DK and low CE, this study did not have the opportunity to gather the observational data related to levels of disorientation in the practical task since both FD and FI participants in this group tended not to interact with the HLS when completing the exercises.

Table 5.27: Participants' interaction behaviour in terms of their levels of disorientation

Experience Profiles	**Levels of Disorientation**					
	In the Tutorial			**In the Practical Task**		
	Low-level	**High-level**	**None**	**Low-level**	**High-level**	**None**
(i) Low DK and low CE			FD and FI			FD and FI
(ii) Low DK and high CE			FD and FI			FD and FI
(iii) High DK and low CE			FD and FI	Observation data on disorientation was not gathered since both FD and FI barely interacted with the HLS.		
(iv) High DK and high CE			FD and FI	Observation data on disorientation was not gathered since both FD and FI barely interacted with the HLS.		

Finally, with regards to those users with high DK and high CE, cognitive style showed no significant impact on their levels of disorientation in the HLS when completing the tutorial. The FD and FI participants in this group seemed to experience no disorientation when navigating through the tutorial to achieve their learning goals. It was also observed that the FD and FI participants in this group did not use the visual instructional aids for navigation and orientation purposes in the HLS. However, their levels of disorientation were not identified in the practical task since both FD and FI participants with this experience profile seemed to use their prior knowledge of XHTML to perform the exercises rather than using the HLS.

Having considered navigation strategies and disorientation, this section now reports the observation results in relation to time efficacy and cognitive style for the four experience profile groups. Table 5.28 summarises the observation results.

Table 5.28: Observation data in relation to time efficacy

Experience Profiles	Time efficacy	
	In the Tutorial	**In the Practical Task**
(i) Low DK and low CE	FD spent the same amount of time as FI	FD spent more time than FI
(ii) Low DK and high CE	FD spent the same amount of time as FI	FD spent more time than FI
(iii) High DK and low CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI
(iv) High DK and high CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI

For the group of participants that had either low DK and low CE, or low DK and high CE, the observation results mostly showed that cognitive style seemed to have no significant impact on time efficacy when completing the tutorial. FD participants with one of these experience profiles were observed to take the same amount of time to complete the tutorial as did FI participants with the same experience profile. As reported earlier in this section, the fact that no disorientation was experienced by FD participants with one of these two experience profiles could explain why the same amount of time was taken by the FD and FI participants with this experience profile to complete the tutorial. Additionally, it was observed that both FD and FI participants with the same experience profile tended to view all of the lessons, including all their sections, when they were performing the tutorial. In the practical task, the observation results showed that cognitive style had a significant impact on time efficacy, with FD learners with one of these experience profiles taking more time to complete the exercises than FI learners with the same experience profile.

For the group of participants that had either high DK and low CE, or high DK and high CE, cognitive style had no impact on the time efficacy when using the HLS to complete the tutorial and the exercises in the practical task: both FD and FI users with the same experience profile spent the same amount of time to complete the tutorial and the exercises in the practical task. However, the observation data revealed that both FD and FI learners with the same experience profile did not visit all the lessons, or all the sections of a lesson, in the tutorial.

The section will now report the findings from the observation study related to the number of exercises that were completed in the practical task for different cognitive style types with the four experience profile groups. Table 5.29 presents the summary results.

Table 5.29: Observation results related to completion of exercises in the practical task

Experience Profiles	**Number of exercises completed in the practical task**	
	some of the exercises	**all of the exercises**
(i) Low DK and low CE		FD and FI
(ii) Low DK and high CE		FD and FI
(iii) High DK and low CE		FD and FI
(iv) High DK and high CE		FD and FI

For all four experience profiles ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), cognitive style did not seem to have a significant impact, with both FD and FI learners with the same experience profile completing all of the exercises in the practical task. However, it was observed that, for the group of participants that had either low DK and low CE, or low DK and high CE, both FD and FI learners within the same experience profile depended a lot on the HLS to complete the exercises, whereas for the group of participants that had high DK, irrespective of their level of CE, both FD and FI learners with the same experience profile interacted much less with the HLS to answer the exercises.

The next section draws out and presents the high levels of findings in relation to experiment 1, distilled from the preceding discussion in this chapter.

5.9 Discussion

The aim of Experiment 1 was to examine the effects of and between cognitive style, domain knowledge and computer experience on participants' learning performance, levels of disorientation and attitudes when using the two versions of the HLS. Section 5.9.1 summarises the findings in relation to the version of the HLS that provided no instructional aids and section 5.9.2 summarises the findings in relation to the version that incorporated visual instructional aids.

5.9.1 HLS that provided No Instructional aids

Analysis of the quantitative and qualitative data mostly showed that, when considering cognitive style, domain knowledge and computer experience together, they seemed to influence participants' learning performance, levels of disorientation and overall attitudes towards the version of the HLS that provided no instructional aids. Table 5.30 summarises the results. With regards to learning performance, the analysis of achievement tests/practical tasks and observation data mostly showed that cognitive style had a significant impact for the group of participants that had either low DK and low CE, or low DK and high CE. FD participants with one of these experience profiles performed less well in the post-test and in the practical task, completed only some of the exercises in the practical task, achieved lower gain scores, and took more time to complete the tutorial and the practical task than FI participants with the same experience profile. The results from the observation data revealed that both FD and FI users with the same experience profile depended a lot on the HLS to complete the exercises in the practical task, and tended to view all of the seven lessons, and all of their pages, in the tutorial.

However, for the group of participants that had either high DK and low CE, or high DK and high CE, cognitive style showed no significant impact, with FD and FI participants with the same experience profile performing equally well in the post-test and in the practical task, completing all of the exercises in the practical task and taking the same amount of time to complete the tutorial and the practical task. Additionally, their prior knowledge of XHTML led both FD and FI participants in these groups to achieve lower gain scores. However, though both FD and FI users with the same experience profile performed equally well in the practical task and in the post-test, the observations confirmed that these users did not interact with the HLS to perform the practical task, neither did they visit all of the lessons, or all of the pages of a lesson, in the tutorial.

With respect to disorientation, the results from the disorientation questionnaire study suggest that cognitive style seemed to influence levels of disorientation in the tutorial for the groups of participants that had low DK and low CE, low DK and high CE, or high DK and low CE. FD participants with one of these experience profiles seemed to experience higher levels of disorientation in the HLS than did FI participants with the same experience profile. However, for the group of participants that had high DK and high CE, cognitive style had no significant impact; FD and FI users in this group seemed to experience little, if any, disorientation in the HLS. This finding is in line with that gained from analysis of the semi-structured interviews, open-ended and closed questionnaires, and observations.

Finally, with regards to overall attitudes, the results from the closed questionnaires suggest that, for the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had an impact on their attitudes towards the HLS. FD participants with one of these experience profiles showed more negative attitudes towards the HLS in terms of structure, navigation and overall satisfaction than did FI participants with the same experience profile. This finding is also reflected in the data from the semi-structured interviews and open-ended questionnaires, where FD participants in these experience profile groups: reported that the high levels of flexibility that was offered from the HLS structure made it difficult for them to navigate effectively through the learning system; experienced high levels of disorientation; and, in turn, prohibited them from learning effectively, which consequently led them to lose interest learning in this version of HLS. In contrast, the FI participants with the same experience profile reported that the structure in the HLS allowed them to make use of the flexibility in the tutorial, and enabled them to set their own learning paths to reach the information that they needed in relation to their learning goals. These findings (that were gathered from the open-ended and closed questionnaires, and semi-structured interviews) support the results from the observation study, which showed that FD participants with one of these experience profiles (low DK and low CE, low DK and high CE, or high DK and low CE) tended to experience higher levels of disorientation in the non-linear structure when they were exploring the tutorial than did the FI participants with the same experience profile.

However, for the group of participants that had high DK and high CE, cognitive style had no significant impact, with both FD and FI participants in this group showing a positive attitude towards the HLS structure, navigation and overall satisfaction. This reflects the findings from the analysis of the semi-structured interviews and open-ended questionnaires, where both FD and FI participants in this group explained that the non-linearity features that were offered by the HLS allowed them to enjoy high levels of freedom of navigation in the learning system, and to have more control over the tutorial. The findings from the closed questionnaires, open-ended questionnaires and semi-structured interviews seemed also to be consistent with the observation data.

Table 5.30: High level findings in relation to the version of the HLS that provided no instructional aids

Learning performance		Low DK & low CE	Low DK & high CE	High DK & low CE	High DK & high CE
Post-test/practical task scores		FD performed worse than FI.	FD performed worse than FI.	FD performed as well as FI.	FD performed as well as FI.
Test-gain		FD achieved lower gain scores than FI.	FD achieved lower gain scores than FI.	FD and FI users achieved low gain scores.	FD and FI achieved lower gain scores.
Time-efficacy	Tutorial	FD spent more time than FI.	FD spent more time than FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
	Practical Task	FD spent more time than FI.	FD spent more time than FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
Observation					
Navigation	Tutorial	FD had more difficulties navigating through the tutorial than FI.	FD had more difficulties navigating through the tutorial than FI.	FD had more difficulties navigating through the tutorial than FI.	FD and FI navigated effectively through the HLS
	Practical task	Similar findings (to those gathered in the tutorial) were identified.	Similar findings (to those gathered in the tutorial) were identified.	Observation data on navigation was not gathered since both FD and FI had little interaction with the HLS.	Observation data on navigation was not gathered since both FD and FI had little interaction with the HLS.
Disorientation	tutorial	FD suffered more disorientation than FI.	FD suffered more disorientation than FI.	FD suffered more disorientation than FI.	FD and FI did not experience disorientation
	Practical task	FD suffered more disorientation than FI.	FD suffered more disorientation than FI.	FD and FI used less of the HLS, so observation data on disorientation was not gathered.	FD and FI used less of the HLS, so observation data on disorientation was not gathered.
Time efficacy	tutorial	FD spent more time than FI.	FD spent more time than FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
	Practical task	FD spent more time than FI.	FD spent more time than FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
No. of exercises completed		FI completed all exercises than FD.	FI completed all exercises than FD.	FD and FI completed all exercises.	FD and FI completed all exercises.
Attitudes/opinions of the HLS gathered from questionnaires and semi-structured interviews		FD showed negative attitudes towards the HLS: said they had difficulties navigating through the non-linear structure, experienced disorientation, and in turn, failed to meet their learning goals. In contrast, FI favoured the HLS: said they were enabled to make use of the flexibility in the tutorial; were allowed to set their own navigation paths in the tutorial; and experienced little disorientation.	FD appeared to show similar attitude and opinions to those of FD with low DK and low CE. FI appeared to show similar attitude and opinions to those of FI with low DK and low CE.	FD showed a negative attitude towards the HLS: despite their prior knowledge of the XHTML, they said they had difficulties navigating through the non-linear structure to explore it; their low CE made it difficult for them to map a mental representation of the document structure in the HLS, leading to greater disorientation. In contrast, FI gave the same opinions as to those given by FI participants with low DK and low CE, and low DK and high CE.	Both FD and FI favoured the HLS: they said that they enjoyed learning in the non-linear structure, which increased cognitive flexibility; they asserted that they enabled to enjoy high levels of freedom of navigation in the tutorial; and they reported that they experienced low levels of disorientation since they successfully navigated effectively and efficiently to reach the information they needed in the tutorial.

5.9.2 HLS that Incorporated Visual Instructional Aids

Analysis of the quantitative and qualitative data mostly showed that the participants performed well in most of the learning tasks, experienced little or no disorientation and had a positive attitude towards the version of the HLS that incorporated visual instructional aids. However, some interesting findings were revealed between cognitive style, domain knowledge and computer experience, which are now discussed. Table 5.31 summarises these results. With regards to learning performance, the analysis of the achievement tests/practical tasks and observation data mostly suggested that cognitive style had no significant impact. For the group of participants that had either high DK and low CE, or high DK and high CE, cognitive style had no significant effect, with FD and FI participants with the same experience profile performing equally well in the post-test and in the practical task, achieving low gain scores, and spending the same amount of time to complete the tutorial and the practical task. However, the observation study confirmed that these users had little interaction with the HLS when completing the practical task, and did not visit all of the lessons when they were exploring the tutorial.

For the group of participants that had low DK and low CE, or low DK and high CE, cognitive style had no significant impact: both FD and FI users with the same experience profile performed well in the post-test and in the practical task, achieved high gain scores, completed all of the exercises in the practical task, and took the same amount of time to complete the tutorial except with respect to time efficacy in the practical task. FD participants with one of these experience profiles spent more time in completing the practical task than did FI participants with the same experience profile. The results from the observation study, however, confirmed that both FD and FI with the same experience profile (low DK and low CE; or low DK and high CE) depended a lot on the HLS to achieve their learning goals.

With respect to disorientation, the disorientation questionnaire data showed that, for all four experience profile groups, cognitive style showed no significant impact, with both FD and FI participants with the same experience profile experiencing little or no disorientation in the HLS. However, the results from the semi-structured interviews and questionnaires suggested that cognitive style seemed to have a significant impact on the use of the visual instructional aids to reduce disorientation in the HLS. For the group of participants that had low DK and low CE, low DK and CE, or high DK and low CE, cognitive style had a significant impact: FD participants with one of these experience profiles reported greater dependence on the visual instructional aids to reduce their levels of disorientation than did FI participants with the same experience profile. For the group of participants that had high DK and high CE, cognitive style did not show any significant impact, with both FD and FI users reporting that, since they experienced little or no disorientation, they did not depend on the visual instructional aids. This finding supports the results from the observations in relation to the completion of the tutorial. The finding also supports the results from the observation data related to practical task, but only for the groups of participants that had low DK and low CE, or low DK and high CE.

With regards to attitudes, the analysis of the data collected from the closed questionnaires revealed that the participants displayed a positive attitude towards the system structure and navigation, and enjoyed learning in the HLS. However, the results from the semi-structured interviews and open-ended questionnaires mostly identified that, for the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style seemed to influence their reasons for showing positive attitudes towards the HLS. The FD participants with one of these experience profiles reported that, irrespective of the non-linearity that was available in the HLS, the visual instructional aids assisted them in reducing their levels of disorientation and in navigating effectively through the tutorial which, in turn, allowed them to learn effectively. In contrast, the FI participants with the same experience profile explained that, though they seldom used some of the visual instructional aids for navigation and orientation purposes, they favoured the HLS mostly because of its non-linearity, which permitted them to make use of the flexibility offered in the tutorial and allowed them to set their own learning paths to perform their learning. These findings are in line with those gained from the observation study.

However, for the group of participants that had high DK and high CE, cognitive style did not influence their reasons for favouring the HLS. Both FD and FI participants in this group reported, irrespective of the visual instructional aids, that the non-linearity that was available allowed them to have more control over the tutorial and to enjoy high levels of freedom of navigation. They also asserted that, because they were not distracted by the visual instructional aids they did not lose interest when learning in this version of the HLS.

Table 5.31: High level findings in relation to the version of the HLS that incorporated visual instructional aids

Learning performance		**Low DK & low CE**	**Low DK & high CE**	**High DK & low CE**	**High DK & high CE**
Post-test/practical task		FD performed as well as FI.	FD performed as well as FI.	FD performed as well as FI.	FD performed as well as FI.
Test-gain		FD and FI achieved higher gain scores.	FD and FI achieved higher gain scores.	FD and FI achieved lower gain scores.	FD and FI achieved lower gain scores.
Time efficacy (tutorial/exercise)		FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
Observation					
Navigation	Tutorial	FD and FI navigated through the tutorial effectively. FD used more of the visual instructional aids for navigation than FI.	Similar findings (to those gathered for the group of participants that had low DK and low CE in the tutorial) were identified.	Similar findings (to those gathered for the group of participants that had low DK and low CE in the tutorial) were identified.	FD and FI navigated effectively though the tutorial. FD and FI did not use the visual instructional aids for navigation.
Navigation	Practical task	Similar findings (to those gathered in the tutorial) were identified.	Similar findings (to those gathered in the tutorial) were identified.	Observation data on navigation was not gathered since both FD and FI had little interaction with the HLS.	Observation data on navigation was not gathered since both FD and FI had little interaction with the HLS.
Disorientation	Tutorial	FD and FI experienced little or no disorientation. However, FD used more of the visual instructional aids to reduce their disorientation than FI.	Similar findings (to those gathered for the group of participants that had low DK and low CE in the tutorial) were identified.	Similar findings (to those gathered for the group of participants that had low DK and low CE in the tutorial) were identified.	FD and FI experienced little or no disorientation. Additionally, both FD and FI did not use the visual instructional aids to reduce disorientation.
Disorientation	Practical task	Similar findings (to those gathered in the tutorial) were identified.	Similar findings (to those gathered in the tutorial) were identified.	Observation data on disorientation was not gathered since both FD and FI had little interaction with the HLS.	Observation data on disorientation was not gathered since both FD and FI had little interaction with the HLS.
Time efficacy	Tutorial	FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
Time efficacy	Practical task	FD spent more time than FI.	FD spent more time than FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
No. of exercises completed		FD and FI completed all exercises.	FD and FI completed all exercises.	FD and FI completed all exercises.	FD and FI completed all exercises.
Attitudes/opinions of the HLS gathered from questionnaires and semi-structured interviews.		For the experience profile low DK and low CE, low DK and high CE, and high DK and low CE, the following views were gathered. FD favoured the HLS structure and navigation, and was satisfied with the HLS mainly because the visual instructional aids assisted them in navigating through the HLS and in reducing their levels of disorientation, which in turn enhanced their learning performance. FI had positive attitudes towards the structure and navigation, and were satisfied with the HLS because: they had some flexibility in the non-linear structure; were allowed to set their own navigation paths and enabled to learn effectively; were able to use the visual instructional aids when they, on a rare occasion, experienced high levels of disorientation; and did not get distracted by the visual instructional aids.			FD and FI favoured the HLS mainly because the non-linear structure allowed them to have more flexibility in and to enjoy high levels of freedom of navigation; they were not distracted by the visual instructional aids.

5.10 Summary

This part of the study (experiment 1) aimed to examine the effects of and between cognitive style, domain knowledge and computer experience on learners' learning performance, levels of disorientation and attitudes when using a HLS that provided no instructional aids and when using a HLS that incorporated visual instructional aids. Significant results were found in experiment 1. The findings from experiment 1 are further discussed in Chapter 7, where they will be analysed to provide answers to each of the relevant research questions and frame design guidelines.

In Experiment 2, the effects of and between cognitive style, domain knowledge and computer experience on learners' learning performance, levels of disorientation and attitudes when using a HLS that provided no instructional aids and when using a HLS that provided audio instructional aids were examined. The results from experiment two are reported in Chapter 6.

Chapter Six: Experiment 2

6.1 Introduction

This chapter presents and considers the findings that were gathered from experiment 2, the aim of which was to address the three research questions re-stated in Table 6.1. As discussed in Chapter 4, the main aim of experiment 2 was to examine the effects of and between cognitive style, domain knowledge and computer experience on participants' learning performance, disorientation and attitudes when using a HLS with no instructional aids and when using a HLS with audio instructional aids. Data gathered from the achievement tests/practical tasks and closed questionnaires were analysed to support this study in answering the research questions. This study also analysed the qualitative data that were gathered through the open-ended questionnaires, semi-structured interviews and observations to provide additional evidence in relation to the research questions.

Chapter 4 also made clear that, unlike the HLS that incorporated visual instructional aids (used in experiment 1) in which participants could, if they chose, navigate without having to use the visual instructional aids provided, in the version of the HLS that incorporated audio instructional aids participants had to use the audio instructional aids and related 'key presses' in order to navigate through the HLS to complete the XHTML tutorial. The version of the HLS that provided no instructional aids that was used in experiment 1 was also used in experiment 2.

Table 6.1: Research questions in relation to experiment 2

Research Question 2(a): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?
Research Question 2(b): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?
Research Question 2(c): What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?

Additionally, although the participants were different, the same distribution and characteristics of the sample from experiment 1 were replicated in experiment 2. This led experiment 2 to gather similar findings to those gather in experiment 1 related to learning performance, disorientation and attitudes with respect to the version of the HLS with no instructional aids. Therefore, the detailed findings will not be presented here to avoid duplication. Instead, this chapter will present only the high-level findings related to learning performance, disorientation and attitudes in the version of the HLS that provided no instructional aids.

For the version of the HLS that provided audio instructional aids, different participants, but ensuring the same sample distribution and characteristics took part in experiment 2.

The findings related to disorientation, learning performance and attitudes in relation to the HLS that provided audio instructional aids will be presented in detail, and a summary of the ANOVA results where applicable, will also be presented.

This structure of this chapter is as follows: section 6.2 describes relevant characteristics of the sample; sections 6.3-6.8 present and consider the findings from the quantitative and qualitative data sources in terms of learning performance, levels of disorientation and attitudes in the two versions of the HLS – one that provides no instructional aids and one that incorporates audio instructional aids; section 6.9 distils the high level findings from the detail reported in sections 6.3-6.8; and, finally, section 6.10 summarises the chapter.

6.2 Description of the Participants

Experiment 2 had a total of 192 participants, who were undergraduate and postgraduate students across UK universities. 96 of them used the version of the HLS that provided no instructional aids; the remainder used the version of the HLS that incorporated audio instructional aids. Table 6.2 presents the distribution of the participants according to their cognitive style (FD or FI), domain knowledge (DK) and computer experience (CE) in relation to their use of the two HLS (re-stated in section 4.3).

Table 6.2: Distribution of participants according to their cognitive style (FD or FI), DK and CE

HLS with no instructional aids				**HLS with audio instructional aids**			
	FI	FD	Total		FI	FD	Total
Low DK and low CE	12	12	24	Low DK and low CE	12	12	24
Low DK and high CE	12	12	24	Low DK and high CE	12	12	24
High DK and low CE	12	12	24	High DK and low CE	12	12	24
High DK and high CE	12	12	24	High DK and high CE	12	12	24
Total	48	48	96	Total	48	48	96

The next section reports the findings from the ANOVA in relation to the disorientation questionnaire.

6.3 Results From the Disorientation Questionnaire

One of the aims of this study was to address research question 2(a) (re-stated in section 6.1). As discussed in chapter 4 (and as carried out in experiment 1), in experiment 2 levels of the four types of disorientation (see Table 5.3) were measured through the use of a closed questionnaire. The analysis of the disorientation questionnaire in relation to the HLS that provided no instructional aids and the HLS that incorporated audio instructional aids are reported in section 6.3.1 and 6.3.2 respectively.

6.3.1 Disorientation Results in Relation to the HLS with No Instructional Aids

The results related to disorientation gathered in experiment 2 were similar to those gathered in experiment 1. The three-way ANOVA revealed a significant effect between cognitive style, domain knowledge and computer experience on participants' levels of the four types of disorientation in the HLS. The analysis of the Newman Keuls post-hoc tests revealed some significant differences between the groups too. The summary results of the ANOVA and post-hoc tests are presented in Appendices B.1a-B.1b.

For the group of participants that had either low DK and low CE, or low DK and high CE, cognitive style had a significant impact. FD participants with one of these experience profiles reported higher levels of the four types of disorientation ((i) I know my current location in the HLS; (ii) being on a current page, I know what I was reading previously in the HLS; (iii) being on a current page, I know where to go next; and (iv) I know how to reach my desired destination in the HLS) than did FI participants with the same experience profile.

For the group of participants that had high DK and low CE, cognitive style had a significant impact on three of the four types of disorientation: (i) I know my current location in the HLS; (ii) being on a current page, I know what I was reading previously in the HLS; and (iv) I know how to reach my desired location in the HLS. FD participants with this experience profile experienced higher levels of these three types of disorientation than did FI participants with the same experience profile.

However, for the group of participants that had high DK and high CE, cognitive style did not have a significant effect: neither FD nor FI users in this group experienced higher levels of any of the four types of disorientation in the HLS.

6.3.2 Disorientation Results in Relation to the HLS with Audio Instructional Aids

With regards to the HLS that incorporated audio instructional aids, the three-way ANOVA did not find any significant impact between cognitive style, domain knowledge and computer experience on the four types of disorientation. A summary of the ANOVA results is presented in Appendix C.4. For all four experience profiles ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), FD and FI participants with the same experience profile responded that they knew: their current location; where they had been previously; where to go next; and how to reach their desired location in the HLS.

The next section reports the learning performance results in relation to both versions of the HLS.

6.4 Results Related to Learning Performance

As discussed in chapter 4, in order to support this study in answering research question 2(b) (re-stated in section 6.1), learning performance data that were gathered from post-test score, gain score (the difference between pre-test and post-test scores), practical task score and time efficacy (time taken to complete the tutorial and the practical task) were analysed using three-way ANOVA. In section 6.4.1, the findings from the analysis of the learning performance data related to the version of the HLS that provided no instructional aids will be reported, and in section 6.4.2 the findings from the analysis of the learning performance data related to the version of the HLS that incorporated audio instructional aids will be reported.

6.4.1 Learning Performance Results in Relation to the HLS with No Instructional Aids

Unsurprisingly, the three-way ANOVA in experiment 2 returned similar findings to those gathered in experiment 1 in relation to the HLS that provided no instructional aids and participants' learning performance. As discussed in section 6.1, this study will only provide high level findings related to learning performance in this version of HLS (with no instructional aids) to avoid duplication. The results of the ANOVA revealed a significant effect between cognitive style, domain knowledge and computer experience on learning performance. Additionally, post-hoc tests revealed some significant differences between the groups. The summary results of the ANOVA and pots-hoc tests analysis are presented in Appendices B.2a-B.2b. For the group of participants that had either low DK and low, or low DK and high CE, cognitive style had a significant impact on learning performance: FD participants with one of these experience profiles performed worse in the post-test and practical task, achieved lower gain scores, and took more time to complete the tutorial and the practical task than did FI participants with the same experience profile.

However, for the group of participants that had either high DK and low CE, or high DK and high CE, cognitive style did not have a significant impact: FD and FI participants with the same experience profile performed equally well in the post-test and practical task; achieved lower gain scores; and took the same amount of time to complete the tutorial and the practical task.

The next section presents and considers the learning performance results in relation to the version of the HLS that incorporated audio instructional aids.

6.4.2 Learning Performance Results in Relation to the HLS with Audio Instructional aids

The results from the three-way ANOVA revealed no significant effects between cognitive style, domain knowledge and computer experience on post-test score, practical task score, and time efficacy. With respect to all four experience profiles ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), cognitive style showed no significant impact: both FD and FI participants with the same experience profile performed equally well in the post-test and practical task; and took almost the same amount of time in completing the tutorial and the practical task.

Additionally, the results from the three-way ANOVA revealed no significant effect between cognitive style, domain knowledge and computer experience on gain score. With respect to those users with either low DK and low CE, or low DK and high CE, cognitive style had no significant impact: FD and FI participants with the same experience profile achieved higher gain scores. In contrast, with respect to those users with either high DK and low CE, or high DK and high CE, cognitive style had no significant impact: both FD and FI with the same experience profile achieved lower gain scores. A summary of the ANOVA results is presented in Appendices C.5a-C.5b.

In the next section, the results from the closed questionnaires in relation to attitudes towards the two versions of the HLS are presented and considered.

6.5 Results From the Closed Questionnaires in Relation to Attitudes towards the HLS

With regards to research question 2(c) (re-stated in section 6.1), this study aimed to examine participants' attitudes towards the HLS in terms of their views of the structure, navigation, disorientation, preference of and distraction caused by the audio instructional aids, and overall satisfaction. As reported in chapter 4, to meet this aim a closed questionnaire was used. The results from the closed questionnaires in relation to the two versions of the HLS are discussed next.

6.5.1 Views of the HLS that provided No Instructional Aids

Similar findings to those from experiment 1 were identified by the three-way ANOVA in experiment 2 in terms of participants'' views of: structure; navigation; disorientation; and overall satisfaction.

The three-way ANOVA revealed a significant effect between cognitive style, domain knowledge and computer experience on attitudes towards the HLS in terms of views of structure, navigation, disorientation and overall satisfaction. The results from the analysis of the post-hoc tests also showed significant differences between the groups. Appendices B.3a-B.3c presents the summary results from the analysis of the ANOVA and post-hoc tests. For the participants with experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact. FD participants with one of these experience profiles showed: more negative attitudes towards the structure that was offered in the HLS; reported experiencing more difficulties navigating through the HLS; disagreed with the statement that they were happy with the levels of freedom of navigation offered in the HLS; reported experiencing high levels of disorientation; and showed greater dissatisfaction learning in this version of learning system.

In contrast, FI participants with the same experience profile: showed a positive attitude towards the HLS's structure; responded that they had no major difficulties navigating through the tutorial and were satisfied by the levels of freedom of navigation that were permitted in the HLS; disagreed with the statement that they experienced high levels of disorientation in the HLS; and, lastly, showed greater satisfaction learning in this version of learning system.

For the group of participants that had high DK and high CE, cognitive style did not show a significant impact: both FD and FI users in this group gave the same views, and they were given by in line with those of the FI participants that had experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE.

6.5.2 Views of the HLS that Incorporated Audio Instructional aids

This section presents and considers the findings related to participants' attitudes towards the HLS that provided audio instructional aids in terms of the views on following themes: structure; navigation; disorientation; preferences of and distraction by the audio instructional aids; and overall satisfaction.

With regards to structure, the three-way ANOVA revealed a significant effect between cognitive style, domain knowledge and computer experience on attitudes towards the HLS's structure. Additionally, the post-hoc tests results revealed that there were significant differences between the groups. Table 6.3 summarises the ANOVA and the post-hoc tests results.

For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style seemed to influence their attitudes towards the HLS's structure. FD participants with one of these experience profiles showed more positive attitudes towards the HLS's structure than did FI participants with the same experience profile.

However, for the group of participants that had high DK and high CE, cognitive style did not have a significant impact on their attitudes towards the HLS's structure: both FD and FI users in this group strongly disagreed when ask is they favoured the structure offered by the HLS.

Table 6.3: Results related to participants' attitudes towards the HLS structure

Question 1: "Overall, I like the structure that is offered in the HLS																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	5.000		1.750		5.167		1.583		4.667		1.083		.250		.250	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	0	0	2	17	0	0	3	25	0	0	5	42	9	75	10	83
Disagree	0	0	3	25	0	0	3	25	0	0	3	25	3	25	1	8
Slightly disagree	2	17	5	42	1	8	4	33	2	17	3	25	0	0	1	8
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	1	8	2	17	2	17	2	17	3	25	1	8	0	0	0	0
Agree	2	17	0	0	2	17	0	0	2	17	0	0	0	0	0	0
Strongly agree	7	58	0	0	7	58	0	0	5	42	0	0	0	0	0	0
Significance	$F(1,88) = 15.467$, $p = 0.027$															

This section reports the findings in relation to views of navigation – navigation efficacy and levels of freedom of navigation. In terms of views related to navigation efficacy, a three-way ANOVA revealed no significant effect between cognitive style, domain knowledge and computer experience. With regards to participants in all four experience profile groups ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), cognitive style had no significant impact on views of navigation efficacy in the HLS. FD participants with one of these experience profiles reported as high levels when asked about their navigation effectiveness in the HLS as did the FI participants with the same experience profile. Appendix C.6 summarises the ANOVA results.

With respect to views related to levels of freedom of navigation, using the ANOVA analysis, a significant effect was found between cognitive style, domain knowledge and computer experience. The post-hoc test results also showed significant differences between the groups. Table 6.4 presents the summary of the ANOVA and post-hoc tests results.

Table 6.4: Analysis of variance on views of levels of freedom of navigation

Question 3: "I am happy with the levels of freedom of navigation that is offered in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	5.250		1.667		5.417		2.000		4.333		1.250		.333		.304	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	0	0	2	17	0	0	1	8	0	0	4	33	8	67	9	75
Disagree	0	0	4	33	0	0	4	33	0	0	5	42	4	33	3	25
Slightly disagree	0	0	4	33	0	0	4	33	2	17	1	8	0	0	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	2	17	2	17	2	17	3	25	4	33	2	17	0	0	0	0
Agree	5	42	0	0	3	25	0	0	4	33	0	0	0	0	0	0
Strongly agree	5	42	0	0	7	58	0	0	2	17	0	0	0	0	0	0
Significance	$F(1,88)= 10.850$, $p= 0.001$															

For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact. FD participants in these experience profile groups reported that they were happy with the level of freedom of navigation that was offered in the HLS. In contrast, FI participants in these experience profile groups disagreed with the statement that they were happy with the levels of freedom of navigation that they were permitted in the HLS.

For those users with an experience profile of high DK and high CE, cognitive style had no significant impact on their views of the levels of freedom of navigation in the HLS. Both FD and FI users in this group were not satisfied with the levels of freedom of navigation that they were allowed in the HLS.

In addition to structure and navigation, participants' views were requested in relation to overall levels of disorientation in the HLS. The results from the three-way ANOVA revealed no significant effect between cognitive style, domain knowledge and computer experience (see Appendix C.6). For all four experience profiles ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), FD and FI users with the same experience profile disagreed with the statement that they experienced high levels of disorientation when performing their learning in the HLS.

Besides structure, navigation and disorientation, participants were asked for their preferences in relation to the audio instructional aids when learning in the HLS. In this respect, a three-way ANOVA revealed a significant effect between cognitive style, domain knowledge and computer experience. With regards to the post- hoc test analysis, significant differences were found between the groups. Table 6.5 presents the relevant summary data.

For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact on their preferences of the audio instructional aids to perform their learning in the HLS. FI participants with one of these experience profiles exhibited a lower preference to use the HLS in which they had to interact with the audio instructional aids to perform their learning than did FD participants with the same experience profile.

However, for the group of participants that had high DK and high CE, cognitive style had no significant effect on their preferences of the audio instructional aids. Both FD and FI participants in this group preferred not to use the audio instructional aids to perform their learning in the HLS.

Table 6.5: Analysis of variance on views related to preference of the audio instructional aids in the HLS

Question 5: "I prefer a HLS in which I have to interact with the audio instructional aids to perform my learning"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	5.000		1.417		5.583		1.250		4.083		1.750		1.167		.917	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	0	0	4	33	0	0	6	50	0	0	2	17	5	42	6	50
Disagree	0	0	4	33	0	0	1	8	1	8	5	42	4	33	3	25
Slightly disagree	1	8	2	17	0	0	3	25	2	17	2	17	1	8	2	17
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	1	8	1	8	1	8	2	17	3	25	3	25	2	17	1	8
Agree	6	50	1	8	3	25	0	0	4	33	0	0	0	0	0	0
Strongly agree	4	33	0	0	8	67	0	0	2	17	0	0	0	0	0	0
Significance	$F(1,88) = 6.314$, $p = 0.014$															

With respect to distraction, participants were asked to give their views of any distraction caused by the audio instructional aids when they were performing their learning in the HLS. As Table 6.6 shows, the results from the three-way ANOVA and the post-hoc test analysis identify a significant effect between cognitive style, domain knowledge and computer experience.

For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact on the reported distraction caused by the audio instructional aids. FD participants with one of these experience profiles responded that they were not distracted by the audio instructional aids. This was the opposite of the case for the FI participants with the same experience profile: they responded that they were distracted by the audio instructional aids when they were performing their learning in the HLS.

Table 6.6: Analysis of variance on views of distraction by the audio instructional aids

Question 6: "I am distracted by the audio instructional aids while performing my learning in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.000		3.833		1.250		4.333		2.167		4.583		4.667		4.500	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	7	58	0	0	3	25	1	8	2	17	0	0	1	8	0	0
Disagree	2	17	1	8	5	42	0	0	3	25	0	0	0	0	0	0
Slightly disagree	1	8	3	25	3	25	1	8	3	25	2	17	0	0	3	25
Neither	0	0	0	0	0	0	1	8	0	0	0	0	2	17	0	0
Slightly agree	2	17	3	25	1	8	2	17	3	25	3	25	1	8	2	17
Agree	0	0	3	25	0	0	3	25	1	8	3	25	2	17	2	17
Strongly agree	0	0	2	17	0	0	4	33	0	0	4	33	6	50	5	42
Significance	F (1,88) = 4.512, p = 0.036															

For the group of participants that had high DK and high CE, cognitive style showed no significant effect on the reported distraction caused by the audio instructional aids, with both FD and FI participants in this group reporting that they had been distracted by the audio instructional aids in the HLS.

Finally, participants' views of overall satisfaction with the HLS are presented and considered. Using a three-way ANOVA, a significant effect was found between cognitive style, domain knowledge and computer experience. The results from the analysis of the post-hoc tests also revealed some significant differences between the groups. Table 6.7 presents the relevant summary data.

For the group of participants that had experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact on reported satisfaction with the HLS. FD participants with one of these experience profiles were more satisfied learning with the HLS than were FI participants with the same experience profile.

Table 6.7: Analysis of variance on views related to overall satisfaction

Question 7: "Overall, I am satisfied learning in the HLS"																
	Experience Profiles															
	Low DK and low CE				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	5.583		1.250		4.917		1.000		4.333		1.250		1.583		1.500	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	0	0	5	42	0	0	4	33	0	0	5	42	2	17	4	33
Disagree	0	0	3	25	0	0	6	50	1	8	3	25	6	50	3	25
Slightly disagree	0	0	2	17	1	8	1	8	2	17	2	17	2	17	2	17
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	8
Slightly agree	0	0	2	17	2	17	1	8	2	17	2	17	1	8	2	17
Agree	5	42	0	0	5	42	0	0	3	25	0	0	1	8	0	0
Strongly agree	7	58	0	0	4	33	0	0	4	33	0	0	0	0	0	0
Significance	$F(1,88) = 5.342$, $p = 0.023$															

For the group of participants that had high DK and high CE, cognitive style did not have an impact on their overall satisfaction with the HLS, with both FD and FI users in this group reporting greater dissatisfaction with the HLS.

Having considered the analysis of the closed questionnaire data, the results from the open-ended questionnaires in relation to attitudes and opinions of the two versions of the HLS are presented and considered next.

6.6 Results From the Open-ended Questionnaires

Following the same approach as in experiment 1, open-ended questionnaires were used in experiment 2 to supplement the findings from the closed questionnaires in relation to research question 2(c). Sections 6.6.1 and 6.6.2 report the results that were gathered from the open-ended questionnaires in relation to, respectively, the version of the HLS that provided no instructional aids and the version of the HLS that incorporated audio instructional aids. As was the case for experiment 1, where statements related to the participants are cast in technical language associated with the HLS and its use, they are paraphrased versions of the original participant utterances.

6.6.1 Overall Views of the HLS that provided No Instructional Aids

The results from the open-ended questionnaires revealed significant findings in relation to the effect of cognitive style, domain knowledge and computer experience on participants' views of: structure; navigation; disorientation; and overall satisfaction. Similar findings to those from experiment 1 were identified in experiment 2 in terms of these participants' views. Appendix B.4 presents some of the participants' overall views of the HLS; the high-level findings will now be discussed.

For the participants with experience profiles of low DK and low CE, low DK and high CE, and high DK and low CE, cognitive style had a significant impact on their overall views of the HLS. FD participants with one of these experience profiles said that the structure in the HLS made it difficult for them to navigate effectively through the tutorial, in turn led them to experience high levels of disorientation in the learning system and, consequently, failed in supporting them to achieve their learning goals. In contrast, FI participants with the same experience profile asserted that the structure in the HLS permitted them to make use of the flexibility in the tutorial, and allowed them to set their own navigation paths in relation to their learning goals.

With regards to those users with an experience profile of high DK and high CE, cognitive style had no significant impact on their overall views of the HLS. The FD and FI participants with this experience profile showed a positive attitude towards the HLS: they said that the structure in the HLS permitted them to enjoy high levels of freedom of navigation and to have more control over the tutorial.

Participants' overall views of the HLS that incorporated audio instructional aids are presented and considered next.

6.6.2 Overall Views of the HLS that Incorporated Audio Instructional aids

Significant results were found between cognitive style, domain knowledge and computer experience in relation to participants' overall views of the HLS that incorporated audio instructional aids. Table 6.8 presents representative statements draw from the questionnaires to illustrate the overall findings.

For the group of participants that had experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style seemed to have an impact on overall views of the HLS. As quotes (1-6) illustrate, FD participants with one of these experience profiles showed more interest in learning in the HLS than did FI participants with the same experience profile. The FD participants with one of these experience profiles said that they were satisfied learning in the HLS because the audio instructional aids assisted them in navigating through the tutorial and in decreasing their levels of disorientation and, in turn, led them to learn effectively.

In contrast, the FI participants with the same experience profile said that they had less interest learning in the HLS for four reasons. Firstly, they argued that that they did not have the option of using any visual elements in the HLS (other than those tied to the audio instructional aids) to navigate through the tutorial. Secondly, they mentioned that the structure of the audio instructional aids did not offer them much flexibility in the tutorial. Thirdly, they reported that the freedom for setting their own navigation paths using the audio instructional aids in the HLS was very limited. Lastly, they stated that they were sometimes distracted by the audio instructional aids when they were performing their learning in the HLS.

For the group of participants that had high DK and high CE, cognitive style did not have a significant impact on their overall views of the HLS. Both FD and FI participants in this group disliked using the HLS to perform their learning. The FD and FI participants in this group gave the same reasons as those given by the FI users with one of the following experience profiles, low DK and low CE, low DK and high CE, or high and low CE, for showing a negative attitude towards this version of HLS. Quotes (7-12) illustrate these views.

Table 6.8: Representative participant views of the version of the HLS that incorporated audio instructional aids

Experience profiles: low DK and low CE; low DK and high CE; high DK and low CE			**Experience profile: high DK and high CE**	
FD	1.	"The audio instructional aids provided guided learning in the HLS." *(Low DK and low CE)*	7.	"I do not like the HLS because I cannot enjoy high levels of freedom of navigation."
	2.	"The audio instructional aids assisted me in navigating through the HLS and in reducing my high levels of disorientation." *(High DK and low CE)*	8.	"Low levels of flexibility in the tutorial and distraction by the audio instructional aids discourage me from learning in this HLS."
	3.	"With the audio I can impose a structure on the learning content." *(Low DK and high CE)*	9.	"There are no other options other than using audio to navigate the tutorial. I will not use this HLS."
FI	4.	"The option of setting my own navigation paths through the audio is limited." *(Low DK and high CE)*	10.	"The structure in the HLS prohibits me from gaining more control over the tutorial. I dislike the HLS."
	5.	"The structure in the audio does not provide high levels of flexibility in the tutorial." *(Low DK and low CE)*	11.	"I will not use this HLS due of low levels of flexibility and low levels of freedom of navigation available in the audio."
	6.	"I do not have other options other than the audio instructional aids to navigate through the HLS. I am bit distracted by the audio too." *(High DK and low CE)*	12.	"I do not like the HLS as I have to use the audio instructional aids to navigate the tutorial."

Alongside the open-ended questionnaire, semi-structure interviews were conducted to gather participants' views of the HLS. The results from the semi-structured interview are reported next.

6.7 Results From the Semi-structured Interviews

As in experiment 1, semi-structured interviews were used in experiment 2 to provide evidence in relation to research question 2(c) (re-stated in section 6.1) with respect to participants'' attitudes, opinions, feelings, experiences, preferences and suggestions of structure, navigation, disorientation, distraction and overall satisfaction with the HLS with which they interacted. Section 6.7.1 reports the findings from the analysis of the semi-structured interview data in relation to the HLS that provided no instructional aids. Section 6.7.2 reports the findings from the analysis of the semi-structured interview data in relation to the HLS that incorporated audio instructional aids. As was the case for experiment 1, statements from the semi-structured that contain technical language associated with the HLS and its use are paraphrased versions of the original participant utterances.

6.7.1 Views of the HLS that provided No Instructional aids

Similar findings to those gathered in experiment 1 in relation to participants' views of the same version of HLS – with no instructional aids in terms of structure, navigation, disorientation an overall satisfaction) – were identified in experiment 2. Appendices B.5a-B.5b present some of the participants' views of the HLS. As discussed in section 6.1, the high level findings related the views of this version of the HLS in terms of structure, navigation, disorientation and overall satisfaction will now be discussed.

The analysis of the semi-structured interviews revealed significant effects between cognitive style, domain knowledge and computer experience on participants' views of HLS in terms of structure, navigation, levels of disorientation and overall satisfaction. For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact. FD participants with one of these experience profiles: showed a negative attitude towards the HLS's structure and navigation; reported experiencing high levels of disorientation; and showed greater dissatisfaction learning in the HLS than did FI participants with the same experience profile. FD participants in these experience profile groups explained that the structure that was offered in the HLS was non-linear arrangement, provided too much flexibility, and made it difficult for them to navigate effectively through the learning system to explore the tutorial. They further added that a consequence of the navigation problems that were experienced by them in the HLS was high levels of disorientation and, in turn, this led them to show more negative attitudes towards this version of learning system. Lastly, they suggested that a HLS with linear structure or instructional aids could have provided guided learning.

In contrast, the FI participants in these experience profile groups reported that the structure in the HLS permitted them to make use of the flexibility in the tutorial, which increased their cognitive flexibility. These participants further asserted that they were allowed to set their own learning paths in the tutorial which they normally preferred to make use of. Lastly, they said they were able to navigate through the HLS to perform their learning without experiencing high levels of disorientation.

However, with regards to those users with high DK and high CE, cognitive style did not have a significant impact on their views of the structure, navigation, levels of disorientation and overall satisfaction in the HLS. Both FD and FI participants with this experience profile: showed a positive attitude towards the HLS's structure and navigation; reported experiencing no disorientation in the HLS; and were satisfied learning in the HLS. These participants explained to the interviewer that the non-linear structure in the HLS provided high levels of flexibility in the tutorial, and enabled them to access and sequence the information in accordance with the information that they needed in the tutorial. They also added that they were enabled to enjoy high levels of freedom of navigation, and that their prior knowledge in using computers and of the learning content of the XHTML prevented them from experiencing high levels of disorientation in the HLS. Having more control over the tutorial in the HLS was another reason that was given by these participants for showing greater satisfaction when learning using this version of the HLS.

The results from the semi-structured interviews in relation to the HLS that incorporated audio instructional aids are now presented and considered next.

6.7.2 Views of the HLS that Incorporated Audio Instructional Aids

The analysis of the semi-structured interviews mostly suggested that, when considered together, cognitive style, domain knowledge and computer experience seemed to influence participants' views of the this version of HLS in terms of structure, navigation, distraction by the audio instructional aids, preferences and overall satisfaction. For participants that had experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style seemed to influence their views of the HLS in terms of structure, navigation, levels of disorientation, distraction by the audio instructional aids, preferences and overall satisfaction. Table 6.9 summarises the results in relation to cognitive style for these three experience profile groups.

With regards to structure, as can be seen from quotes (1-6), FD participants with one of these experience profiles showed more positive attitudes towards than did FI participants with the same experience profile. The FD participants with one of these experience profiles reported that the audio instructional aids helped to create a linear structure for them, providing them with guided learning in the tutorial. They further explained that the structure that was offered in the audio instructional aids assisted them in navigating through the HLS to find the information that they needed or imposed a structure on the information that was presented in the HLS. In contrast, FI participants with the same experience profile argued that the structure that was offered as a result of the audio instructional aids did not allow them higher levels of flexibility in the tutorial.

In terms of navigation, FD participants with one of these experience profiles showed more positive attitudes towards navigation than did FI participants with the same experience profile. FD participants with one of these experience profiles reported that the audio instructional aids assisted them in navigating effectively and efficiently through the HLS to reach the information that they needed in the tutorial. For instance, they reported that the audio instructional aids prevented them from opening unnecessary nodes in meeting their learning goals in the HLS. Furthermore, they affirmed that the audio instructional aids assisted them in determining where best to go or how to go to their desired location in the tutorial in relation to their learning goals. Lastly, they added that, in general, they did not need to use that much effort when navigating through the HLS to meet their learning goals because the audio instructional aids directed them to their desired destination. Quotes (7-9) reflect these views.

In contrast, as can be seen from quotes (10-12), the FI participants with the same experience profiles said that the levels of freedom in terms of setting their own navigation paths when using the audio instructional aids in the tutorial were very low. They further argued that there should have been the option of visual elements (for example hyperlinks, backward and forward buttons, etc.) in the HLS to allow users to make use of navigational flexibility in the tutorial. Lastly, they affirmed that they preferred to learn in a single HLS that provided both non-linearity features and navigation instructional aids.

They explained that the former would provide flexible navigation whereas the latter would provide navigation guidance if needed.

With regards to disorientation, cognitive style did not influence participants' views, with both FD and FI participants in the three experience profile groups ((i) low DK and low CE; (ii) low DK and high CE; and (iii) high DK and low CE) reporting that they experienced little or no disorientation in the HLS. However, cognitive style seemed to have a significant impact on their use of the audio instructional aids to reduce their levels of disorientation. As quotes (13-18) demonstrate, FD participants with one of these experience profiles asserted that their levels of disorientation were reduced mainly because of the audio instructional aids compared to FI participants with the same experience profile. For instance, the FD participants with either low DK and low CE, or low DK and high CE reported that without the audio instructional aids they would have experienced high levels of disorientation in the HLS. They further reported that, in general, the audio instructional aids assisted them in the following: what they needed to know; what they needed to visit; and, where and how they needed to reach their destination in order to achieve their learning goals.

Additionally, the FD participants with high DK but low CE argued that, in general, they knew what information they needed to view in relation the learning content of the XHTML, but they reported that to navigate through the HLS to reach the information that they needed was very difficult and hence led to them experiencing high levels of disorientation in this version of the learning system. They further explained that the audio instructional aids helped them to reduce these issues. In contrast, FI participants in these experience profile groups argued that they experienced little or no disorientation not because of the audio instructional aids, but because they were able to navigate effectively to reach the information that they needed in the tutorial. They further argued that they may have been dependent on the audio instructional aids, but only on the rare occasions when they felt high levels of disorientation in the HLS.

Participants were also asked to give their views of any distraction caused by the audio instructional aids in the HLS. The results from the interviews mostly showed that FI participants with one of these experience profiles were more distracted by the audio instructional aids than were FD participants with the same experience profile. For instance, the FD participants with one of these experience profiles reported that they were not distracted by the audio instructional aids when they interacting with them to navigate through the tutorial to perform their learning. In contrast, FI participants with the same experience profile gave different views: they reported that they found it a bit distracting interacting with the audio instructional aids to navigate through the HLS to perform their learning. The FI participants with the same experience profile further asserted that although they could skip listening to the options that were being 'read' and presented using the audio, they were sometimes irritated by them.

Finally, with respect to overall satisfaction, FD participants with one of these experience profiles showed greater satisfaction learning in the HLS than did FI participants with the same experience profile. The FD participants with one of these experience profiles affirmed that the audio instructional aids supported them in navigating effectively and efficiently through the tutorial; and it also helped to reduce their high levels of disorientation, which in turn led them to complete what they needed in the tutorial to achieve their learning goals. They also said that they would prefer to learn in this type of HLS in the future.

The findings for FI participants with the same experience profile were the opposite. They said that they were displeased learning in the HLS for the following reasons. Firstly, they said that the structure in the audio instructional aids was too constrained, permitting them low levels of flexibility in terms of setting their own navigation path in the tutorial. Secondly, they reported that they were given no option other than to use the audio instructional aids to navigate through the tutorial. Thirdly, they argued that they were somewhat irritated or distracted by the audio instructional aids when they were interacting with them to perform their learning in the HLS. In addition to these reasons, they suggested that they would prefer to learn in a HLS that had the following two features: (i) non-linearity; and (ii) instructional aids. For instance, they explained that users who do not need assistance could switch to a non-linear 'mode' whereas those who need guided learning could switch to the instructional aids 'mode'. Quotes (19-24) present the views related to distraction by the audio instructional aids, preferences and satisfaction with the HLS.

Table 6.9: Participants' views of the HLS that provided audio instructional aids in relation to cognitive style for the three experience profile groups: (i) low DK and low CE; (ii) low DK and high CE; and (iii) high DK and low CE.

Structure			Navigation		Disorientation		Distraction/Preferences/Satisfaction	
FD	1.	"The structure in the audio instructional aids is in the form of linear arrangement, provides me guided learning." *(Low DK and low CE)*	7.	"The audio instructional aids prevent me from opening unnecessary nodes. Overall, I enhance my navigation efficacy." *(Low DK and high CE)*	13.	"The audio instructional aids assist me in finding my current location, finding and guiding me back to my previous visited pages and in guiding where best next to go in the tutorial." *(Low DK and high CE)*	19.	"I do not get distracted by the audio. I am satisfied and preferred learning in the HLS as the audio instructional aids assisted me in accomplishing my learning goals." *(Low DK and low CE)*
	2.	"The audio instructional aids assist me in mapping the physical arrangement of the HLS document." *(High DK and low CE)*	8.	"With the audio I can read the relationship between the information presented in the HLS, which assist me in reaching the information I need easily and quickly." *(Low DK and high CE)*	14.	"I am totally dependent on the audio instructional to reduce my levels of disorientation in the HLS." *(High DK and low CE)*	20.	"Overall, I am satisfied learning in the HLS because the audio supports me to reduce my levels of disorientation. I do not get distracted by the audio too."*(Low DK and high CE)*
	3.	"The structure in the audio aids provides less flexibility, directs me to the information I need in the tutorial." *(Low DK and high CE)*	9.	"The audio guides me of where and how to reach a desired location in the tutorial." *(High DK and low CE)*	15.	"Without the audio instructional aids I will end up experiencing high levels of disorientation." *(Low DK and low CE)*	21.	"I am satisfied with the HLS as the audio aids provide me guided learning." *(High DK and low CE)*
FI	4.	"The structure offers less flexibility, which prohibits me to learn at my own pace." *(Low DK and high CE)*	10.	"I have no major difficulties navigating through the HLS. However, I do not like to use the audio to navigate the tutorial because I there is not enough flexibility." *(Low DK and low CE)*	16.	"I experience little disorientation, not because of the audio instructional aids, but because I can navigate effectively through the HLS to reach the information I need." *(Low DK and high CE)*	22.	"I am less satisfied with the HLS as the structure in the audio instructional aids offers less flexibility in the tutorial. The audio is distractive too." *(High DK and low CE)*
	5.	"The structure in the audio aids is more of linear arrangement, leading to a lack of flexibility in the tutorial" *(Low DK and low CE)*	11.	"Using the audio, I have low levels of freedom of setting my own navigation paths to perform my learning in the HLS." *(Low DK and high CE)*	17.	"I depend little on the audio aids to reduce my levels of disorientation." *(Low DK and low CE)*	23.	"Not much freedom about setting my own navigation paths when using the audio. Not satisfied." *(Low DK and high CE)*
	6.	"The structure in the HLS is too constraint and I cannot learn in such environment." *(High DK and low CE)*	12.	"I will prefer to use a HLS which provides both flexible navigation and instructional aids for guided navigation." *(High DK and low CE)*	18.	"Irrespective of the audio instructional aids, I experience little disorientation in the HLS." *(High DK and low CE)*	24.	"A HLS with options of using the non-linear features and instructional aids will be better." *(Low DK and high CE)*

For the group of participants that had high DK and high CE, cognitive style did not have an impact on their views of the HLS in terms of structure, navigation, levels of disorientation, preferences of and distraction by the audio instructional aids and overall satisfaction. Table 6.10 summarises these participants’ views of the HLS. As can be seen from quotes (1-6), both FD and FI participants in this group showed a negative attitude towards the structure: they reported that the structure in the audio instructional aids provided low levels of flexibility, prohibiting them from having more control over the tutorial in the HLS.

As can be seen from quotes (7-12), both FD and FI participants with this experience profile showed a negative attitude towards navigation. Both FD and FI participants with this experience profile argued that using the audio instructional aids prevented them from enjoying high levels of freedom of navigation in the tutorial. Additionally, they asserted that they would have preferred to have been given visual elements – for example hyperlinks, forward and backward buttons, index or search tools, etc. – to help them to navigate through the tutorial.

In addition to structure and navigation, participants gave their views on disorientation in the HLS. Both FD and FI participants in this group reported that that they did not experience any levels of disorientation in the HLS. Additionally, they argued that, irrespective of the audio instructional aids, they knew the following in the tutorial: their current location; where they were coming from; how to revisit their previously visited pages; and where and how to go to their next location in relation to their learning goals. Quotes (13-18) illustrate these views.

Finally, as far as distraction by the audio instructional aids and overall satisfaction with the HLS is concerned, the following views were gathered. With respect to distraction, both FD and FI participants in this group reported that they were distracted by the audio instructional aids when they were using them to navigate through the HLS to perform their learning. They further reported the fact that they had no option other than to use the audio instructional aids to navigate through the tutorial, and that the distraction caused by the audio discouraged them from viewing all the sections of a lesson, or all of the lessons.

As noted above, with regards to satisfaction, both FD and FI participants in this group showed greater dissatisfaction learning in the HLS associated with being forced to use the audio instructional aids to navigate through the HLS to explore the tutorial. They further argued that, since they were enabled to navigate effectively to reach the information they needed in the tutorial and since they did not experience disorientation, they did not like to be given any instructional aids to perform their learning in HLS in the first instance.

Additionally, they asserted that the structure imposed by the audio instructional aids was in the form of linearity, prohibiting them from having control over the tutorial and restricting their freedom of navigation in the HLS. They further mentioned that the distraction caused by the audio instructional aids was another issue which led them to show greater dissatisfaction when learning in this version of learning system. Finally, they said that they would prefer to learn in the following versions of HLS: one that provided non-linear features without any instructional aids; or one that gave the option of using either the non-linear features or any instructional aids, but did not force the user to use them. Quotes (19-24) reflect the views related to distraction by the audio instructional aids, and overall satisfaction with the HLS.

Table 6.10: High DK and high CE participants' views of the HLS that incorporated audio instructional aids in relation to cognitive style

	Structure		Navigation		Disorientation		Satisfaction//distraction	
FD	1.	"I am not satisfied with the structure because it provides low levels of flexibility."	7.	"I do not enjoy the high levels of freedom of navigation in the HLS."	13.	"I do not experience any levels of disorientation in the HLS."	19.	"I am unsatisfied with the HLS because I cannot enjoy high levels of freedom of navigation in the tutorial."
	2.	"Although I can access and sequence the information I need in the tutorial I have to use the audio instructional aids (which is too constraint) to reach. I will not learn in this type of structure. "	8.	"I prefer not to use audio instructional aids to navigate through the HLS. I will prefer to use visual elements, for example, hyperlinks, backward and forward buttons, index tools and so on instead."	14.	"Irrespective of the audio instructional aids, I know my current location; what I was visiting before and how to go back to these visited pages and where next to go in the tutorial."	20.	"I do get distracted when using the audio instructional aids to navigate through the HLS. It is because of this I did not visit all the sections of a lesson."
	3.	"Since I have to use the structure that is offered in the HLS I find the structure too boredom to use because it is of linear arrangement."	9.	"The audio instructional aids provide less flexibility in terms of navigation in the HLS. I will not use this learning system in the future."	15.	"The audio instructional aids are for those who experience high levels of disorientation in the HLS."	21.	"I prefer a HLS with one of the following: with non-linear structure; with non-linear structure and instructional aids, but without been distracted by the instructional aids."
FI	4.	"The structure in the audio instructional aids provides low levels of flexibility, which prohibit me to enjoy high levels of freedom of navigation."	10.	"I can navigate effectively without the use of any instructional aids. Therefore, I do not want to use audio instructional aids for navigation purposes."	16.	"I can navigate and orientate effectively through the tutorial. I do not depend on the audio instructional aids to reduce disorientation."	22.	I am not satisfied with the HLS as the audio is distractive to use. I prefer to learn in a HLS with visual elements instead."
	5.	"The structure in the audio instructional aids prevents me to have control of the tutorial."	11.	"With the provision of the audio in the HLS I am not allowed to set my own navigation paths in the tutorial."	17.	"I do not experience disorientation not because of the audio instructional aids, but because of my prior knowledge in using computers and of the XHTML."	23.	"The audio instructional aids are for those who have difficulties learning in a HLS. Since I do not have difficulties learning in HLS, I prefer a HLS with non-linearity features instead."
	6.	"The structure in the audio instructional aids provides less flexibility."	12.	"Unlike a HLS with audio instructional aids for navigation, I will prefer to use a HLS which provided high levels of freedom of navigation."	18.	"Since I do not experience disorientation, I will prefer not to use the audio instructional aids."	24.	"The structure in the HLS does not provide enough flexibility, prevents me from taking control of the tutorial."

The results from the observation study in relation to navigation, levels of disorientation, learning performance and any unexpected findings from this study are considered next.

6.8 Results From the Observation Study

As discussed in chapter 4, observational techniques were used so as to support this study in gaining an improved understanding of participants' navigation, levels of disorientation, and learning performance and to highlight any unexpected observations in relation to these themes when they interacted with the HLS to perform the tutorial and the practical task. The analysis of the observational data in relation to the version of the HLS that provided no instructional aids and the version of the HLS that incorporated audio instructional aids are presented and considered in sections 6.81 and 6.8.2 respectively.

6.8.1 Observation Results in Relation to the HLS that provided No Instructional Aids

For the version of the HLS with no instructional aids, similar observation results to those from experiment 1 were identified in experiment 2. Therefore, as discussed in section 6.1, this section will present only the high level findings from the observation study in relation to this HLS version. Additional detail is presented in Appendices B.6a-B.6d.

The results from the observation study mostly showed that there was an effect between cognitive style, domain knowledge and computer experience on participants' navigation, levels of disorientation and learning performance when they interacted with this version of HLS to complete the tutorial and the practical task. It was observed that FD participants with one of the two experience profiles low DK and low CE, or low DK and high CE tended to have more difficulties navigating through the HLS to perform their learning, tended to experience higher levels of disorientation in the HLS, took more time in completing the tutorial and the practical task than did FI participants with the same experience profile. The FD participants with one of these experience profiles also failed to complete all of the exercises in the practical task, in contrast to the FI users with the same experience profile. However, it was observed that both FD and FI participants with experience profiles of low DK and low CE, or low DK and high CE seemed to be highly dependent on the HLS to achieve their learning goals, and tended to view all the lessons and all the pages while performing the tutorial.

For participants with an experience profile of high DK and low CE, it was observed that FD participants had more difficulties navigating through the HLS to explore the tutorial, and experienced higher levels of disorientation in the HLS than did FI participants with the same experience profile. Despite the fact that they had prior knowledge of the learning content of XHTML, the FD participants with this experience profile seemed to experience greater difficulty navigating through the HLS to reach the information that they needed in relation to their learning goals than the FI participants with the same experience profile. However, the observation study confirmed that cognitive style did not have an impact on learning performance (in terms of time efficacy in the tutorial), with both FD and FI participants with this experience profile (high DK and low CE) taking almost the same amount of time to complete the tutorial. It was also observed that both FD and FI participants in this group tended not to visit all of the sections of a lesson in the tutorial. In the practical task, this study did not have the opportunity to gather observation data related to navigation and disorientation because both FD and FI users in this group barely interacted with the HLS to complete the task, relying instead on their existing knowledge. However, it was observed that both the FD and FI participants with this experience profile completed all of the exercises in the practical task and within the same amount of time.

For users with an experience profile of high DK and high CE, cognitive style did not have any significant impact on participants' navigation, disorientation, time efficacy or number of exercises completed in the practical task. In the tutorial, the observation results mostly suggested that both FD and FI participants with this experience profile navigated effectively through the HLS, experienced little or no disorientation, and took the same amount of time to complete the tutorial. It was also observed that, although both FD and FI participants with this experience profile visited all of the lessons in the tutorial, they tended not to visit all of the sections of a lesson. Again, in the practical task the study did not have the opportunity to gather observational data related to navigation and disorientation, since both FD and FI participants in this group tended not to interact with the HLS. Additionally, both FD and FI users with this experience profile took the same amount of time to complete the exercises in the practical task, and completed all of the exercises in the practical task despite having less interaction with the HLS.

The results from the observation study in relation to the version of the HLS that incorporated audio instructional aids are now reported.

6.8.2 Observation Results in Relation to the HLS that Incorporated Audio Instructional Aids

As discussed in Chapter 4, participants had to navigate through the XHTML tutorial using the audio information and associated key presses to perform learning tasks in the version of the HLS that incorporated audio instructional aids. As they used the system to complete the tutorial and the practical task, observation data was gathered relating to participants' navigation, levels of disorientation, time efficacy, number of exercises completed in the practical task and any unexpected observations in relation to these themes.

The observations in relation to navigation and cognitive style for the four experience profile groups are now reported. Table 6.11 summarises the observation results. With respect to all four experience profiles ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), cognitive style had no significant impact on navigation when completing the tutorial in the HLS. FD and FI participants with the same experience profile were observed successfully navigating through the HLS to complete the tutorial. Similar findings for the group of participants that had either low DK and low CE, or low DK and high CE were identified in the practical task. For participants that had experience profiles of either high DK and low CE, or high DK and high CE, the observational data related to navigation were not gathered in the practical task since both FD and FI in these groups interacted much less with the HLS, drawing instead on their existing domain knowledge to complete the task.

Table 6.11: Participants' interaction behaviour in terms of navigation

Experience Profiles	Navigation			
	In the Tutorial		In the Practical Task	
	Navigate effectively	**Navigate less effectively**	**Navigate effectively**	**Navigate less effectively**
(i) Low DK and low CE	FD and FI		FD and FI	
(ii) Low DK and high CE	FD and FI		FD and FI	
(iii) High DK and low CE	FD and FI		The observation data related to navigation were not identified since both FD and FI users interacted less with the HLS	
(iv) High DK and high CE	FD and FI		The observation data related to navigation were not identified since both FD and FI users interacted less with the HLS	

The observation results related to disorientation and cognitive style for the four experience profile groups are now reported. The summary results are presented in Table 6.12.

With regards to all four experience profiles ((i) low DK and low CE; (ii) low DK and high DK; (iii) high DK and low CE; and (iv) high DK and high CE), cognitive style showed no significant impact on participants' disorientation in the tutorial. The findings from the observations confirmed that both FD and FI participants with the same experience profile experienced little or no disorientation in the HLS when completing the tutorial. Similar findings were identified in the practical task for participants with one of the two experience profiles low DK and low CE, and low DK and high CE. For participants with one of the two experience profiles high DK and low CE, or high DK and high CE, the study did not gather the observational data related to levels of disorientation in the practical task since both FD and FI participants with one of these experience profiles barely interacted with the HLS when completing the task.

Table 6.12: Participants' interaction behaviour in terms of their levels of disorientation

Experience Profiles	Levels of Disorientation					
	In the Tutorial			In the Practical Task		
	Low-level	High-level	None	Low-level	High-level	None
(i) Low DK and low CE			FD and FI			FD and FI
(ii) Low DK and high CE			FD and FI			FD and FI
(iii) High DK and low CE			FD and FI	The observation data related to disorientation were not gathered since both FD and FI users barely used the HLS		
(iv) High DK and high CE			FD and FI	The observation data related to disorientation were not gathered since both FD and FI users barely used the HLS		

However, cognitive style seemed to have an impact on the use of some of the optional audio instructional aids to reduce disorientation in the tutorial. For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had an impact, with FD participants with one of these experience profiles using more of the optional audio instructional aids to reduce their disorientation in the tutorial than did FI participants with the same experience profile. For example, it was observed that the FD participants with one of these experience profiles tended to use more of the optional audio control panels to 'play'/determine their current location, previously visited pages and how to revisit them, and where to go next in relation to their learning goals in the tutorial than did the FI participants with the same experience profile.

For the group of participants that had high DK and high CE, cognitive style had no significant impact on their use of the optional audio instructional aids to reduce disorientation in the HLS; it was observed that both FD and FI participants in this group did not interact with any of the optional audio control panels to reduce disorientation.

This section now reports the findings from the observations in relation to time efficacy and cognitive style for the four experience profile groups. Table 6.13 presents the summary results. With regards to all four experience profile groups ((i) low DK and low CE; (ii) low DK and high DK; (iii) high DK and low CE; and (iv) high DK and high CE), the results from the observations mostly showed that cognitive style had no significant impact on time efficacy when completing the tutorial and the practical task, with both FD and FI participants with the same experience profile spending almost the same amount of time completing the tutorial and the practical task. However, it was observed that for participants that had either low DK and low CE, or low DK and high CE, both FD and FI users with the same experience profile tended to view all of the lessons, including all of the pages, when they were completing the tutorial. In contrast, for those users with an experience profile of either high DK and low CE, or high DK and high CE, neither FD nor FI users within the same experience profile opened all of the lessons, or all of the sections of a lesson, while completing the tutorial.

Table 6.13: Observation data related to time efficacy

Experience Profiles	**Time efficacy**	
	In the Tutorial	**In the Practical Task**
(i) Low DK and low CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI
(ii) Low DK and high CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI
(iii) High DK and low CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI
(iv) High DK and high CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI

Finally, this section reports the observation results in relation to the number of exercises that were completed in the practical for the four experience profile groups. The summary results are presented in Table 6.14.

With regards to participants in the two experience profile groups low DK and low CE, and low DK and high CE, cognitive style had no significant impact on the number of exercises that were completed in the practical task. It was observed that both FD and FI participants with the same experience profile completed all of the exercises. However, the observation results revealed that, for participants with low DK, irrespective of the level of CE, both FD and FI users with the same experience profile depended a lot on the HLS to answer the exercises in the practical task; in contrast, for participants that had high DK, irrespective of the level of CE, both and FI users with the same experience profile interacted much less with the HLS to answer the exercises in the practical task.

Table 6.14: Observation results related to completion of exercises in the practical task

Experience Profiles	Number of exercises completed in the practical task	
	Completed some of the – exercises	**Completed all of the -exercises**
(i) Low DK and low CE		FD and FI
(ii) Low DK and high CE		FD and FI
(iii) High DK and low CE		FD and FI
(iv) High DK and high CE		FD and FI

Having reported the findings from the analysis of the quantitative and qualitative data, the next section draws out and presents the high level findings from experiment 2.

6.9 Discussion

Experiment 2 aimed to look into the effects of and between three individual differences (cognitive style, domain knowledge and computer experience) in relation to disorientation, learning performance and attitudes when using the two versions of the HLS. Section 6.9.1 summarises the findings in relation to the version of the HLS that provided no instructional aids and section 6.9.2 does the same in relation to the version that incorporated audio instructional aids.

6.9.1 HLS that provided No Instructional Aids

The analysis of the quantitative and qualitative data gathered from experiment 2 revealed significant results in relation to cognitive style, domain knowledge and computer experience in the version of the HLS that provided no instructional aids. A summary of the results is presented in Appendix B.7.

For participants that had experience profiles of either low DK and low CE, or low DK and high CE, cognitive style had a significant impact on learning performance, disorientation and attitudes in the HLS. The results from the achievement tests/practical tasks and observations confirmed that FD participants with one of these experience profiles performed worse in the post-test and in the practical task, took more time in completing the tutorial and the practical task, and achieved lower gain scores than FI did participants with the same experience profile. In relation to these findings, the observation data showed that both FD and FI learners with the same experience profile depended a lot on the HLS to achieve their learning goals.

Additionally, the analysis of the disorientation questionnaire data revealed that FD participants with one of these experience profiles had more difficulties navigating through the HLS and, overall, experienced higher levels of disorientation than did FI participants with the same experience profile. This finding is in line with that gained from analysis of the attitude questionnaires, semi-structured interviews and observations. Lastly, the results from the closed questionnaires showed that FD participants with one of these experience profiles had a negative attitude towards the HLS' structure and navigation, and showed greater dissatisfaction when learning in the HLS than was the case for FI participants with the same experience profile. These findings support the results from the analysis of the open-ended questionnaires and semi-structured interviews.

For participants that had an experience profile of high DK and low CE, cognitive style seemed to have a significant impact only on disorientation in, and attitudes to the HLS. The analysis of the disorientation questionnaires suggests that, in general, FD participants with this experience profile experienced higher levels of disorientation in the HLS than did FI participants with the same experience profile. This finding supports the results that were gathered in the semi-structured interviews, attitude questionnaires (in terms of open-ended and closed questions) and observation study. In terms of learning performance, cognitive style did not have a significant impact, with both FD and FI participants with high DK and low CE performing equally well in the post-test and practical task, achieving broadly equivalent (but lower) gain scores, and taking almost the same amount of time to complete the tutorial and the practical task. However, the observation results confirmed that these participants had limited interaction with the HLS when performing the practical task, neither did they visit all of the lessons, or all the sections of a lesson, in the tutorial, probably because of their high levels of existing domain knowledge.

With regards to those users with high DK and high CE, cognitive style did not have a significant impact on learning performance, disorientation or attitudes in the HLS. The analysis of the achievement tests/practical task data confirmed that both FD and FI participants with this experience profile performed equally well in the post-test and practical task, enhanced their time efficacy, and achieved lower gain scores compared participants with other experience profiles. However, the observation results confirm that these users visited only some of the lessons, or some of the sections of a lesson, and made less use of the HLS to complete the practical task. Additionally, the results from the disorientation questionnaires revealed that both FD and FI participants with this experience profile experienced little or no disorientation in the HLS. This finding seems to be consistent with the evidence from the semi-structured interviews, attitude questionnaires and observation study.

Finally, the analysis of the closed questionnaire data suggested that both FD and FI participants with this experience profile had a positive attitude towards the HLS' structure and navigation, and, overall, were satisfied when learning using this version of HLS. This finding is in line with that gained from analysis of the semi-structured interviews and open-ended questionnaires.

6.9.2 HLS that Incorporated Audio Instructional aids

The analysis of the quantitative and qualitative data related to learning performance, disorientation and attitudes in the version of the HLS that incorporated audio instructional aids showed some interesting findings. Table 6.15 presents the summary results. With regards to learning performance, the results from the achievement tests/practical tasks and observation study suggested that, for participants in all four experience profiles groups ((i) low DK and low CE; (ii) low DK and high DK; (iii) high DK and low CE; and

(iv) high DK and high CE), cognitive style had no significant impact. FD participants with one of the experience profiles took the same amount of time to complete the tutorial and the practical task, and performed equally well in the post-test and practical task when compared to FI participants with the same experience profile. However, the observation results confirmed that both FD and FI participants with either high DK and low CE, or high DK and high CE, barely interacted with the HLS to perform the practical task, and neither did they open all the lessons, or all the sections of a lesson, in the tutorial. In contrast, both FD and FI participants with either low DK and low CE, or low DK and high CE, used significant parts of the HLS to perform the practical task, and tended to complete all of the lessons, including all of the sections, to acquire knowledge of the learning content of 'XHTML.'

Another finding related to learning performance was that FD participants with either low DK and low CE, or low DK and high DK, achieved higher gain scores than FI participants with the same experience profile, whereas FD participants with either high and low CE, or high DK and high CE, achieved lower gained scores than FI participants with the same experience profile.

With respect to disorientation, the analysis of the disorientation questionnaire data revealed that, for all four experience profile groups ((i) low DK and low CE; (ii) low DK and high DK; (iii) high DK and low CE; and (iv) high DK and high CE), cognitive style showed no significant effect: both FD and FI participants with the same experience profile experienced little or no disorientation when navigating through the HLS to perform their learning. However, the analysis of the semi-structured interviews suggested that cognitive style had a significant impact on the use of the audio instructional aids to reduce levels of disorientation in the HLS. For instance, FD users with one of the three experience profiles (i) low DK and low CE, (ii) low DK and high CE, or (iii) high DK and low CE, suggested that they were highly dependent on the audio instructional aids to reduce their levels of disorientation in the HLS when compared to FI users with the same experience profile.

For the group of participants that had high DK and high CE, cognitive style did not influence their use of the audio instructional aids to reduce disorientation in the HLS: both FD and FI users in this group explained that since they did not experience disorientation in the HLS they did not depend on the audio instructional aids to reduce such issue.

Finally, in terms of attitudes, the following results were identified. The analysis of the data gathered from the closed questionnaires suggested that, for the group of participants that had experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact on attitudes towards the HLS. FD participants with one of these three experience profiles showed more positive attitudes towards the HLS's structure and navigation, preferred learning with the audio instructional aids, and showed greater satisfaction with using this version of learning system than did FI participants with the same experience profile. This reflects the findings from the analysis of the open-ended questionnaires and semi-structured interviews. For instance, the FD participants with one of these experience profiles affirmed that the structure that was offered through the audio instructional aids provided guided learning, enabled them to navigate effectively though the tutorial, assisted them in reducing their levels of disorientation and, in turn, led them to achieve their learning goals efficiently and effectively. The FD participants in these experience profile groups also said that it would have been difficult for them to learn effectively in the HLS without the audio instructional aids.

In contrast, the FI participants with the same experience profile reported that the structure in the audio instructional aids provided less flexibility in the tutorial, and prevented them from setting their own navigation paths in the HLS. These participants further explained that they did not depend on the audio instructional aids to reduce their levels of disorientation, but sometimes did get distracted by them. Additionally, they said that they were given no option other than to use the audio instructional aids to navigate through the HLS to perform their learning. Finally, they suggested that they preferred to learn in a HLS that provided both non-linearity features and instructional aids.

For the group of participants that had high DK and high CE, cognitive style did not influence attitudes towards the HLS. Both FD and FI participants in this group showed a negative attitude towards the HLS's structure and navigation, and showed greater dissatisfaction of learning in this learning system. This finding also supports the results from the open-ended questionnaires and semi-structured interviews. For instance, the FD and FI participants in this group argued that they were not given any options (for example, visual elements such as hyperlinks, index tools, search tools, backward and forward buttons and so on) for navigation purposes. Additionally, they said that the structure in the audio instructional aids provided low levels of flexibility, preventing them from taking control over the tutorial and from enjoying high levels of freedom of navigation in the HLS. They also asserted that, in general, they did not need any instructional aids to perform their learning in HLS. They further reported being distracted by the audio instructional aids in the HLS. Having criticised the HLS that incorporated audio instructional aids, they suggested that they would prefer to learn in versions of HLS that provided only non-linear features, or that provided both non-linear features and any instructional aids, but where they were not disturbed by the instructional aids if they chose not to use them.

Table 6.15: High level findings in relation to the version of the HLS that incorporated audio instructional aids

Learning performance		**Low DK & low CE**	**Low DK & high CE**	**High DK & low CE**	**High DK & high CE**
Post-test/practical task		FD performed as well as FI.	FD performed as well as FI.	FD performed as well as FI.	FD performed as well as FI.
Test-gain		FD and FI achieved higher gain scores.	FD and FI achieved higher gain scores.	FD and FI achieved lower gain scores.	FD and FI achieved lower gain scores.
Time efficacy (tutorial/exercise)		FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
Observation					
Navigation	Tutorial	FD and FI navigated through the tutorial effectively.	FD and FI navigated through the tutorial effectively.	FD and FI navigated through the tutorial effectively.	FD and FI navigated effectively though the tutorial.
	Practical task	Similar findings (to those gathered in the tutorial) were identified.	Similar findings (to those gathered in the tutorial) were identified.	Observation data on navigation was not gathered since both FD and FI had little interaction with the HLS.	Observation data on navigation was not gathered since both FD and FI had little interaction with the HLS.
Disorientation	Tutorial	FD and FI experienced little or no disorientation. However, FD used more of the optional audio control panels to reduce their disorientation than FI.	Similar findings (to those gathered for the group of participants that had low DK and low CE in the tutorial) were identified.	Similar findings (to those gathered for the group of participants that had low DK and low CE in the tutorial) were identified.	FD and FI experienced little or no disorientation. Additionally, both FD and FI did not use any of the optional audio control panels to reduce disorientation.
	Practical task	Similar findings (to those gathered in the tutorial) were identified.	Similar findings (to those gathered in the tutorial) were identified.	Observation data on disorientation was not gathered since both FD and FI barely interacted with the HLS.	Observation data on disorientation was not gathered since both FD and FI interacted less with the HLS.
Time efficacy	Tutorial	FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
	Practical task	FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
Number of exercises completed		FD and FI completed all of the exercises.	FD and FI completed all of the exercises.	FD and FI completed all of the exercises.	FD and FI completed all of the exercises.
Attitudes/opinions of the HLS gathered from questionnaires and semi-structured interviews.		For those users with experience profile of low DK and low CE, low DK and high CE, and high DK and low CE, the following views were gathered. FD had a positive attitude towards the HLS structure and navigation, and was satisfied with the HLS because the audio instructional aids which they depended on provided guide learning; assisted them in navigating through the HLS and in reducing their disorientation, in turn, enhanced their learning performance. In contrast, FI showed a negative attitude towards the structure and navigation and were not satisfied with the HLS because: they did not have much flexibility in the tutorial; were not allowed to set their own navigation paths; had no other options other than using the audio instructional aids; and were sometimes distracted by the audio. They reported that a HLS that offers both non-linear features and visual instructional aids would be better.			FD and FI did not like the HLS because its structure was less flexible, prevented them from enjoying high levels of freedom of navigation in the tutorial; they were distracted by the audio instructional aids; and had no other options other than using the audio to navigate the HLS.

6.10 Summary

Having reported the findings from experiment 1 and experiment 2 in Chapters 5 and 6 respectively, Chapter 7 will present a general discussion of the findings from the two experiments. Based on this discussion, a set of guidelines for the design and development of HLS will be presented and justified.

Chapter Seven: General Discussion

7.1 Introduction

Chapters 5 and 6 reported two experimental studies which gathered data relevant to the thesis' research aims and objectives. The purpose of experiment 1 was to address research questions 1(a-c), related to the effects of and between cognitive style, domain knowledge and computer experience, and visual instructional aids on learners' disorientation, learning performance and attitudes in HLS. The purpose of experiment 2 was to address research questions 2(a-c), related to the effects of and between cognitive style, domain knowledge and computer experience, and audio instructional aids on learners' disorientation, learning performance and attitudes in HLS.

Chapter 7 builds on the experimental work to provide a general discussion of the findings, positing 'answers' to each of the research questions, and to develop guidelines for the design of HLS with the aim of reducing disorientation, improving learning performance and increasing learner satisfaction in the use of the HLS.

The structure of this chapter is as follows: section 7.2 provides a general discussion of the findings from Experiment 1 in relation to research questions 1(a-c) and identifies areas within this where guidelines might be developed; section 7.3 does the same for the findings from Experiment 2 in relation to research questions 2(a-c); section 7.4 draws out the issues from the preceding sections to frame and justify specific design guidelines for HLS; and, finally, section 7.5 provides a summary of the chapter.

7.2 General Discussion of the Findings in Relation to Experiment 1

This section will present and consider the high level findings in relation to each of the research questions addressed in experiment 1.

Research question 1(a)

> What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?

With regards to the HLS that provided no instructional aids, the analysis of the disorientation questionnaires mostly suggested that there was a significant effect between cognitive style, domain knowledge and computer experience in relation to learners' disorientation. Cognitive style had a significant impact on learners' disorientation for the groups of participants that had low DK and low CE, low DK and high CE, or high DK and low CE: FD users with one of these experience profiles experienced higher levels of disorientation in the HLS than did FI users with the same experience profile. This finding is in line with the analysis of the open-ended questionnaires, semi-structured interviews and observation study, which suggested that FD users with one of these experience profiles had greater difficulties imposing a structure on the learning content that was presented in the HLS, mapping a mental representation of the information that was presented in the HLS, and navigating through the HLS environment than did FI users with the same experience profile. As such, this is an important area to consider in the design of HLS, so will be considered in the guidance developed in section 7.4.

However, the analysis of the disorientation questionnaires, open-ended questionnaires, semi-structured interviews and observation study suggested that cognitive style showed no significant effects for those users with an experience profile of high DK and high CE, with neither FD nor FI users in this group experiencing any disorientation in the HLS. This may be owing to the fact that their prior knowledge of the learning content (XHTML) and their expertise in using computers supported them in navigating effectively through the HLS. This finding seems not to be consistent with the results of previous research (for example, Dufresne and Turcotte, 1997; Chen and Macredie, 2004; and others – see section 2.4.1), which found that cognitive style influenced disorientation in HLS, with FD learners experiencing higher disorientation levels than FI learners. One possible reason for this contradictory finding is that the researchers who conducted these studies may not have considered other individual differences that may have influenced the findings, such as domain knowledge and computer experience, leading them to attribute the findings around disorientation purely to cognitive style. This study has shown that when considering the three individual differences (cognitive style, domain knowledge and computer experience) together, cognitive style does not always influence disorientation. This insight can assist designers in gaining an improved understanding about cognitive style's impact on disorientation in HLS use. This is an issue that will be picked up in section 7.4, where this thesis will frame and justify specific guidelines relevant to the design of the HLS.

In the version of the HLS that provided visual instructional aids – a map and a set of visual cues – the analysis of the disorientation questionnaires revealed no significant effects between cognitive style, domain knowledge and computer experience in relation to disorientation. For all four experience profile groups ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and high CE), cognitive style showed no significant impact on disorientation in the HLS, with neither FD nor FI users with the same experience profile agreeing with the statement that they experienced high levels of disorientation in the HLS.

However, the analysis of the attitudes questionnaires and the observation study showed that cognitive style had a significant effect on the use of the visual instructional aids to reduce levels of disorientation in the HLS. For the groups of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact: FD users with one of these experience profiles depended more on the visual instructional aids to reduce disorientation in the HLS than did FI users with the same experience profile. This is in line with the analysis of the open-ended questionnaires and semi-structured interviews. For instance, the FD users with an experience profile of either low DK and low CE, or low DK and high CE asserted that the maps assisted them in the following ways: the maps helped them in gaining a representation of the relationships between the information presented in the HLS; the conceptual structure of the information presented by the maps in the HLS assisted them in navigating through the HLS to reach the information that they needed to achieve their learning goals; and, finally, the disabled and different colour node in the graphical overview map informed them about their current location within the information that was presented in the HLS.

The FD users in these experience profile groups further said that the visual cues – for example the breadcrumbs, highlighting context, link annotation, pagination, page labels, graphical overview diagram, history based mechanism and different link colours – assisted them in reducing the following types of disorientation: “where are they”; “where have they been”; “where can they go next”; and “how can they reach a particular information to achieve their learning goals”. In contrast, FI users with the same experience profile said that they were not totally dependent on the visual instructional aids to reduce disorientation, but did use the history-based mechanism on the rare occasion that they experienced high levels of disorientation in the HLS. The study’s results suggest that while FD users with one of these experience profiles are totally dependent on the visual instructional aids, this opposite case is true for FI users with the same experience profile – that is, they are not totally dependent on these visual instructional aids, but have a preference for the use of some of them to reduce disorientation problems in HLS. This is an important area to consider in HLS design, and will be returned to in the development of guidance in section 7.4.

For the group of participants that had high DK and high CE, cognitive style did not have a significant impact on the use of the visual instructional aids to reduce disorientation problems in the HLS, with neither FD nor FI users in this group being dependent on them. As mentioned earlier, the fact that both FD and FI users in this experience profile group did not experience high levels of disorientation in the version of the HLS that provided no instructional aids means that it is not a surprise that they did not experience disorientation in the version that incorporated visual instructional aids and, as such, did not depend on these visual instructional aids to reduce disorientation. This study has shown that when considering cognitive style, domain knowledge and computer experience together, it is not always the case that cognitive style will influence the use of the visual instructional aids to reduce disorientation problems, making it an important area to consider in the HLS design that will be considered in section 7.4.

Research question 1(b)

> What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?

With respect to the version of the HLS that provided no instructional aids, the analysis of the achievement tests/practical tasks suggested that there was a significant effect between cognitive style, domain knowledge and computer experience in relation to learning performance. For participants with experience profiles of either low DK and low CE, or low DK and high CE, cognitive style had a significant impact, with FD users with one of these experience profiles performing less well in the post-test and in the practical task, achieving lower gain scores, and taking more time to complete the tutorial and the practical task than FI users with the same experience profile. The study's results suggest that FD users with one of these two experience profiles seemed to have difficulties imposing a structure on the learning content of 'XHTML' and/or imposing a mental representation about the physical arrangement of the document specified by the hypermedia nodes. This, in turn, prevented the FD users from completing the 'XHTML' tutorial, and consequently hindered their learning performance to an extent not experienced by FI users with the same experience profile. The results from the observation study suggested that both FD and FI users in these experience profile groups tended to view all of the lessons, including all of the sections, in the tutorial, and interacted a lot with the HLS to perform the exercises in the practical task. These findings raise a concern in relation to learning performance for the FD users in these experience profile groups, which is an important area to consider in HLS design, and which will be returned to in section 7.4 when design guidance is proposed.

With regards to those users with experience profiles of either high DK and low CE, or high DK and high CE, cognitive style revealed no significant effects, with both FD and FI users with the same experience profile performing equally well in learning tasks. Additionally, the results from the observation study suggested that both FD and FI users in these experience profile groups had limited interaction with the HLS when completing the practical task, and did not view all the lessons or all the sections of a lesson when they were exploring the tutorial. As noted in Chapter 5, this may be explained by their high domain knowledge prior to use of the tutorial, as reflected in their higher pre-test scores. This finding is not consistent with the results of most existing studies in the area (for example, Graff, 2003; Umar and Maswan, 2007 and others – see section 2.4.1), which found that cognitive style influenced learning performance in HLS, with FD learners performing less well than FI learners in learning tasks. One possible reason for this significant result is that these studies may have ignored individual differences other than cognitive style, including domain knowledge, which may have influenced their findings.

This study has shown that when domain knowledge is high, irrespective of cognitive style, computer experience and the mode of learning system used, learning performance will not be hindered. This insight may help designers to gain an improved understanding of when and why cognitive style will and will not influence learning performance in HLS. This issue will be returned to in section 7.4, where this thesis will frame and justify specific guidelines relevant to the design of the HLS.

In terms of the HLS that incorporated visual instructional aids, the analysis of the achievement tests/practical tasks mostly revealed no significant effects between cognitive style, domain knowledge and computer experience in relation to learning performance.

For the group of participants that had low DK and low CE, or low DK and high CE, cognitive style mostly showed no significant effects on learning performance, with FD users with one of these two experience profiles performing equally well as FI users with the same experience profile. The study's results suggest that, in general, the visual instructional aids (maps and a set of visual cues) seemed to have supported the FD users with one of these two experience profiles (low DK and low CE; low DK and high CE), reducing their higher levels of disorientation. This, in turn, led them to learn as effectively as the FI users with the same experience profile, in contrast to in the findings for the same experience profile groups using the version of the HLS that provided no instructional aids. This reflects the findings from the open-ended questionnaires and semi-structured interviews where, unlike FI users with one of these two experience profiles, the FD users reported that it would have been difficult for them to learn effectively in the HLS had the visual instructional aids not been provided. These results suggest that the relationship between HLS, visual instructional aids, individual differences and learning performance needs carefully considered, making it an important HLS design area which will be returned to in section 7.4.

Finally, for the participants that had either high DK or low CE, or high DK and high CE, similar findings were identified in both HLS modes (i.e., with and without instructional aids) in relation to cognitive style (as discussed earlier in this section). The study's results suggest that when considering cognitive style, domain knowledge and computer experience together, it is not always the case that cognitive style will influence the use of the visual instructional aids to enhance a user's learning performance in the HLS. This makes it an important HLS design area, which will be returned to in section 7.4.

Research question 1(c)

> What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates visual instructional aids – a map and a set of visual orientational cues?

In the version of the HLS that provided no instructional aids, the analysis of the closed questionnaires suggested a significant effect between cognitive style, domain knowledge and computer experience in relation to attitudes. For the groups of participants that had either low DK and low CE, or low DK and high CE, cognitive style showed a significant impact on attitudes: FD participants with one of these experience profiles showed more negative attitudes towards the HLS in terms of their views of structure, navigation and overall satisfaction than did FI participants with the same experience profile. This finding is supported by the earlier discussion in relation to research questions 1a and 1b, which asserted that FD participants with one of these two experience profiles were less comfortable learning in the version of the HLS that provided no instructional aids than were FI participants with the same experience profile. The analysis of the open-ended questionnaires and semi-structured interviews suggest that while FD participants with one of these two experience profiles need guidance in the HLS, FI participants with the same experience profile prefer to be given some flexibility in the tutorial and to be allowed to set their own learning paths. These differences make this an important area to consider in HLS design, and will be returned to in section 7.4.

For participants with an experience profile of high DK and low CE, cognitive style also had a significant impact, with FD users in this group showing more negative attitudes towards the HLS than FI users in the same group. The findings from the closed questionnaires seemed also to be consistent with the open-ended questionnaires and semi-structured interviews data: unlike FI users, FD users in this group reported that although their domain knowledge was high, their low levels of computer experience made it difficult for them to understand the physical arrangement of the HLS document, which in turn, made it difficult for them to successfully navigate through the non-linear environment to achieve their learning goals. This raises a concern in relation to attitudes for FD users in this group, and is an issue that will be discussed in section 7.4 when seeking to develop guidance for HLS design.

With regards to those users with an experience profile of high DK and high CE, cognitive style did not have a significant impact on attitudes, with both FD and FI users in this group showing a positive attitude in terms of their views of the structure of, navigation in, and overall satisfaction with the HLS. It is argued that this could be because their prior knowledge of the learning content of 'XHTML' and of using computers permitted the users in this group, irrespective of their cognitive style, to be comfortable learning in a non-linear learning environment. In contrast to this finding, previous research (for example, Alomyan and Au, 2004; Altun and Cakan, 2006 and others – see section 2.4.1) has mostly suggested that cognitive style influences learners' attitudes towards HLS, with FD users tending to show a generally negative attitude towards HLS when compared to that shown by FI users. One possible explanation for the difference in this finding is that these studies may have ignored individual differences other than cognitive style, including domain knowledge and computer experience, which may in turn have influenced their findings. This study has shown that when considering cognitive style, domain knowledge and computer experience together, it is not always the case that cognitive style will influence attitudes in HLS, with FD and FI users with an experience profile of high DK and high CE showing the same preference for non-linearity features in the HLS. This issue will be returned to in section 7.4, where the specific guidelines relevant to the design of the HLS will be presented and considered.

With respect to the version of the HLS that incorporated visual instructional aids, the analysis of the closed questionnaires did not reveal any significant effects between cognitive style, domain knowledge and computer experience in relation to attitudes. For all four experience profiles ((i) low DK and low CE; (ii) low DK and high CE; (iii) high DK and low CE; and (iv) high DK and low CE) cognitive style did not show any significant effects, with FD users, overall, showing positive attitudes towards the HLS to the same degree as FI users with the same experience profile.

However, the analysis of the open-ended questionnaires and semi-structured interviews suggested that there was a significant impact between cognitive style, domain knowledge and computer experience on the cause for the positive attitudes towards this version of HLS. For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style showed a significant impact. FD users with one of these three experience profiles reported that they showed a positive attitude towards the HLS mainly because of the visual instructional aids, which assisted them in: (i) mapping a mental representation of the document structure; (ii) imposing a conceptual structure on the learning content; or (iii) successfully navigating through the HLS to locate the information that they needed in relation to their learning goals.

In contrast, FI users with the same experience profile said that they favoured the HLS mostly because of its non-linearity features, which gave them more flexibility in the tutorial and offered the ‘permission’ to set their own paths to accomplish their learning. Considering these individual differences (cognitive style, domain knowledge and computer experience) together may assist designers to gain an improved understanding of why cognitive style influences the use of visual instructional aids in the HLS, making it an issue in HLS design which will be considered further as part of the development of design guidance in section 7.4.

With regards to those users with an experience profile of high DK and high CE, cognitive style did not show a significant effect, with both FD and FI users in this group arguing that they showed a positive attitude towards the HLS not because of the visual instructional aids, but because of its non-linearity features which allowed them to have high levels of freedom of navigation and to have more control over the tutorial. It could be that their prior knowledge of the learning content of ‘XHTML’ and experience in using computers enabled the users in this group, irrespective of their cognitive style and the visual instructional aids provided, to show a strong preference towards a HLS that provides non-linearity features. When considering other individual differences, such as domain knowledge and computer experience, alongside cognitive style, it is not always the case that cognitive style will influence the use of visual instructional aids and lead to a positive attitude towards the HLS. This makes it an important area to consider in the design of the HLS, and will be returned to in section 7.4.

7.3 General Discussion of the Findings in Relation Experiment 2

This section will present and consider the high-level findings in relation to the three research questions addressed in experiment 2. As discussed in chapter 6, the same version of the HLS (that provided no instructional aids) was used for both experiment 1 and experiment 2. Since the findings in relation to this version of HLS have been considered in section 7.2, they will not be presented in detail here to avoid duplication.

Instead, the only high-level findings in relation to the version of the HLS that provided audio instructional aids will be presented and considered.

Research question 2(a)

> What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' levels of disorientation when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?

With regards to the HLS that provided no instructional aids, similar results to those gathered in experiment 1 (in relation research question 1a) were identified.

With regards to the HLS that incorporated audio instructional aids, the results from the disorientation questionnaire suggested that there were no significant effects between cognitive style, domain knowledge and computer experience in relation to disorientation, with all participants reporting that they did not experience higher levels of disorientation when navigating through the HLS to perform their learning. However, the analysis of the open-ended questionnaires and the semi-structured interviews mostly showed that there was a significant impact of cognitive style, domain knowledge and computer experience on the dependency on the audio instructional aids for navigation and orientation purposes in the HLS. For participants with experience profiles of low DK and low CE, low DK and high CE, and high DK and low CE, cognitive style had a significant impact on their dependency on the audio instructional aids to reduce disorientation in the HLS. FD participants with one of these experience profiles asserted that the main reasons for experiencing little or no disorientation in the HLS was because of the audio instructional aids, which assisted them in navigating effectively and in orientating themselves in the tutorial. In contrast, FI participants with the same experience profile said that they experienced little or no disorientation not because of the audio instructional aids, but because they were able to navigate effectively without help through the HLS in relation to their learning goals.

For participants with the experience profile of high DK and high CE, cognitive style had no significant impact, with both FD and FI users reporting that, since they did not experience high levels of disorientation in the HLS, they did not depend on the audio instructional aids to reduce disorientation.

As reported in section 3.3, little consideration has been given to the combined effects of the individual differences considered in this thesis on learners' disorientation in a HLS that incorporates audio instructional aids. The study's results in relation to disorientation have suggested that while audio instructional aids are essential for some learners, they may not necessarily be needed by others to increase their orientation in the HLS. This makes it an important area to consider in HLS design which will be returned to in section 7.4.

Research question 2(b)

> What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' learning performance when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?

With regards to the version of the HLS that provided no instructional aids, similar results to those gathered in experiment 1 (in relation to research question 1b) were identified.

In terms of the version of the HLS that incorporated audio instructional aids, the analysis of the achievement tests/practical tasks mostly revealed that there were no significant effects between cognitive style, domain knowledge and computer experience in relation to learning performance. For the group of participants that had either low DK and low CE, or low DK and low CE, cognitive style did not have a significant impact. Both FD and FI users with the same experience profile: performed well in the post-test and in the practical task; took almost the same amount of time to complete the tutorial and the practical task; and achieved higher gain scores. The audio instructional aids seemed to have helped the FD participants in these groups to reduce their higher levels of disorientation (as justified earlier in this section in relation to research question 2a) which, in turn, led them to complete all the learning materials needed to achieve their learning goals than was not the case for the version with no instructional aids.

For the group of participants that had either high DK and low CE, or high DK and high CE, cognitive style did not show a significant impact on learning performance either, with both FD and FI users with the same experience profile performing equally well in the learning tasks. However, the results from the observation study showed that both FD and FI users with one of these experience profiles interacted less with the HLS to complete the practical task. Another result gathered from the observation study was that neither FD nor FI users with one of these experience profiles visited all of the lessons, or all of the sections of a lesson, when they were completing the tutorial. This result reflects that from experiment 1 in relation to the HLS that provided visual instructional aids and learning performance, which suggested that both FD and FI users with the same experience profile (high DK and low CE; or high DK and high CE), irrespective of the visual instructional aids that were provided in the HLS, performed well in learning tasks. These results suggest that their prior knowledge of the learning content of the XHTML tutorial allowed the users with one of these experience profiles (high DK and low CE; high DK and high CE) to perform well in learning tasks irrespective of their cognitive style and the instructional aids provided in the HLS.

As mentioned in section 3.3, there is a lack of research into the combined effects of individual differences on learning performance in a HLS that incorporates audio instructional aids. The study's results in relation to this area have shown that while audio instructional aids are imperative for some users, they may not necessarily be needed by others to achieve their learning goals in the HLS. These results can assist designers in gaining an improved understanding about the link between audio instructional aids, individual differences and learning performance in HLS – an issue that will be presented and considered in detail in section 7.4.

Research question 2(c)

> What are the effects of and between individual differences (cognitive style – FD/FI, domain knowledge, computer experience) on learners' attitudes when using a HLS that provides no instructional aids and when using a HLS that incorporates instructional aids – in the form of audio elements?

With regards to the HLS that provided no instructional aids, the study identified similar results to those gathered in experiment 1 (in relation to research question 1c).

In the version of the HLS that incorporated audio instructional aids, the analysis of the questionnaires and the semi-structured interviews revealed a significant effect between cognitive style, domain knowledge and computer experience in relation to overall attitudes. For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style showed a significant impact on learners' overall attitudes towards the HLS that incorporated audio instructional aids. FD users with one of these experience profiles showed more positive attitudes towards the HLS than did FI users with the same experience profile. The FD users with one of these experience profiles reported a positive attitude towards the HLS because of the audio instructional aids, which assisted them in reducing their higher levels of disorientation and in increasing their navigation. This, in turn, enabled them to visit all the necessary learning content and, consequently, to improve their learning performance.

In contrast, FI users within the same experience profile groups provided reasons for their negative attitude towards the HLS: they were not given enough flexibility in the tutorial; they had no option other than to use the audio instructional aids to navigate through the HLS to perform their learning; and though they did not depend on the audio instructional aids to reduce disorientation in the HLS, they were sometimes distracted by them. The FI users within these experience profile groups further suggested that they preferred a HLS that provided both instructional aids and non-linearity features.

With regards to those users with an experience profile of high DK and high CE, cognitive style did not show a significant impact on attitudes, with both FD and FI users in this group showing a generally negative attitude towards the HLS. Both FD and FI users with this experience profile reported that the structure in the audio instructional aids did not allow them high levels of freedom of navigation and prevented them from taking control over the tutorial. They further argued that they were 'forced' to use the audio instructional aids to navigate through the HLS to perform the tutorial, and were sometimes distracted by the audio instructional aids. They, finally, reported that they preferred to learn in the versions of HLS that either provided only non-linear features, or that provided both non-linear features and instructional aids, but where they were not ‘disturbed’ by them if they chose not to use them.

As reported in section 3.3, the combined effects of cognitive style, domain knowledge and computer experience on learners’ attitudes when using a HLS that incorporates audio instructional aids have been afforded little attention in research related to HLS. The study’s results suggest that when considering cognitive style, domain knowledge and computer experience together, not all learners will show a positive attitude towards a HLS that incorporates audio instructional aids at the expense of high levels of flexibility, making it an important area to consider in HLS design - this is an issue that will be considered in section 7.4.

7.4 Specific Design Guidelines for HLS

This section will draw out the issues from the preceding sections to frame and justify specific design guidelines for HLS. Section 7.4.1 will do this in relation to the findings from experiment 1; section 7.4.2 will do the same in relation to the findings from experiment 2.

7.4.1 Design Guidelines for HLS in Relation to the Findings from Experiment 1

Based on the general discussions of the findings from experiment 1 in relation to research questions (1(a-c)) (see section 7.2 and Table 7.1), designers need to be aware that while some users (for example, FI users with low DK and low CE, low DK and high CE, or high DK and low CE; and FD/FI users with high DK and high CE) have no difficulties learning in HLS, others (for example, FD users with low DK and low CE, low DK and high CE, or high DK and low CE) struggle to learn effectively and, in turn, demonstrate negative attitudes towards this non-linear learning environment. The FD users with one of these experience profiles (low DK and low CE, low DK and high CE, high DK and low CE) are totally dependent upon learning guidance in the form of visual instructional aids to perform their learning in HLS. However, the results of experiment 1 suggest that including these visual instructional aids will not have detrimental effects for those users who are not totally dependent on them or who do not need them to perform their learning in HLS (for example, FI with low DK and low CE, low DK and high CE, or high DK and low CE; FD/FI with high DK and high CE).

The remainder of this section will suggest ways in which HLS may be designed to support FD users with one of the following experience profiles (low DK and low CE, low DK and high CE, or high DK and low CE) to learn effectively in HLS but, without disturbing the other users (FI with low DK and low CE, low DK and high CE, or high DK and low CE; FD/FI with high DK and high CE) who (the results of experiment 1 suggest) do not need especially require additional support in using HLS.

Table 7.1: High level findings in relation to the general discussion of the findings from Experiment 1

	RQ1a in relation to Disorientation		**RQ1b in relation to Learning Performance**		**RQ1c in relation to Attitudes**	
	HLS with no instructional aids	*HLS with visual instructional aids*	*HLS with no instructional aids*	*HLS with visual instructional aids*	*HLS with no instructional aids*	*HLS with visual instructional aids*
Low DK and low CE	FD had greater difficulties navigating through the HLS than FI. FD experienced higher levels of disorientation than FI.	Neither FD nor FI users experienced difficulties navigating through the HLS; and neither experienced high levels of disorientation. FD were totally dependent on the visual instructional aids to reduce disorientation. In contrast FI were not totally dependent on the visual instructional aids to reduce disorientation.	FD performed less well than FI.	FD and FI performed equally well. FD were totally dependent on the visual instructional aids to perform well. In contrast, FI were not totally dependent on the visual instructional aids to perform well.	FD showed more negative attitudes towards the HLS than FI.	FD showed positive attitudes towards the HLS mainly because of the visual instructional aids. FI showed positive attitudes towards the HLS mainly because of its non-linearity features.
Low DK and high CE	FD had greater difficulties navigating through the HLS than FI. FD experienced higher levels of disorientation than FI.	Neither FD nor FI experienced difficulties navigating through the HLS; and neither experienced high levels of disorientation. FD were totally dependent on the visual instructional aids to reduce disorientation. In contrast FI were not totally dependent on the visual instructional aids to reduce disorientation.	FD performed less well than FI.	FD and FI performed equally well. FD were totally dependent on the visual instructional aids to perform well. In contrast, FI were not totally dependent on the visual instructional aids to perform well.	FD showed more negative attitudes towards the HLS than FI.	FD showed positive attitudes towards the HLS mainly because of the visual instructional aids. FI showed positive attitudes towards the HLS mainly because of its non-linearity features.
High DK and low CE	FD had greater difficulties navigating through the HLS than FI. FD experienced higher levels of disorientation than FI.	Neither FD nor FI experienced difficulties navigating through the HLS; and neither experienced high levels of disorientation. FD were totally dependent on the visual instructional aids to reduce disorientation. In contrast, FI were not totally dependent on the visual instructional aids to reduce disorientation.	FD and FI performed equally well.	Irrespective of the visual instructional aids, FD and FI performed equally well.	FD showed more negative attitudes towards the HLS than FI.	FD showed positive attitudes towards the HLS mainly because of the visual instructional aids. FI showed positive attitudes towards the HLS mainly because of its non-linearity features.
High DK and high CE	Neither FD nor FI experienced difficulties navigating through the HLS. Neither FD nor FI experienced higher levels of disorientation.	Neither FD nor FI experienced difficulties navigating through the HLS; and neither experienced high levels of disorientation. Neither FD nor FI needed/used the visual instructional aids to reduce disorientation.	FD and FI performed equally well.	Irrespective of the visual instructional aids, FD and FI performed equally well.	Both FD and FI showed positive attitudes towards the HLS.	Both FD and FI showed positive attitudes towards the HLS, not because of the visual instructional aids, but mainly because of its non-linearity features.

Designers need to think about the ways for FD users with one of these experience profiles (low DK and low CE, low CE and high CE, or high CE and low CE) to reduce their higher levels of disorientation in HLS. The FD users in these experience profile groups experience higher levels of disorientation in HLS because they: have difficulty imposing a structure on the learning content that is presented in the HLS; have difficulty mapping a mental representation of the physical arrangement of the HLS document. In order to help FD users to reduce these problems in HLS designers need to provide visual instructional aids in the form of a graphical map on every page. The graphical map will support the learners in seeing a global overview of the information (in the form of nodes/links) that is represented in the HLS.

Additionally, it will assist the learners in gaining a representation of the relationships between the information presented in the HLS. The conceptual structure of the information presented by the graphical map can further assist them in navigating through the HLS to reach the information that they desire in relation to their learning goals. Furthermore, the map can assist users in mapping a mental representation of the physical arrangement of the HLS document structure.

Referring to the graphical map will make these FD users, especially those with low DK and low CE, or low DK and high CE, confident that they are successfully completing all of the learning materials in the HLS which are needed to achieve their learning goals. This, in turn, can help them, not only to complete all of the topics, but to integrate their knowledge so as to complete the tutorial effectively. The map can also support FD users with high DK and low CE to navigate the tutorial to access content in accordance with their information needs and navigation preferences, but without them being disorientated in the non-linear environment.

However, providing a map in the HLS can cause some problems. For FD learners with low CE, providing a complex graphical map may prevent them from successfully achieving their learning goals in the HLS. Providing a guide (in the form of audio/video presentation) page showing how to use the map effectively may reduce this problem. Care does need to be taken when presenting the graphical map on the same page where the learning content is presented as this can create two issues: firstly, the graphical map may take up a lot of space on the page, which may prevent the learning content from being clearly visible on the screen; and secondly, the graphical map may disturb other users who do not need it (for example –FI users with low DK and low CE, low DK and high CE, or high DK and low CE; FD/FI users with high DK and high CE). In order to reduce the impact of these two issues, zoom-in and zoom-out features can be added to the visual representation.

In addition to the graphical map, designers can provide a visual representation of the hierarchical structure of the learning content in the HLS. This visual representation normally shows the hierarchical relationships between the main sections (in the form of main links) and their sub-sections (in the form of sub-links) to represent the information contained in the HLS. Such a visual representation can, in turn, support FD users with one of the following three experience profiles – (i) low DK and low CE; (ii) low DK and high CE; and (iii) high DK and low CE) – to map a mental representation of the document structure in the HLS or to impose a structure on the learning content that is presented in the HLS. This visual representation can also help these learners to follow the appropriate paths to reach the information that they must acquire in order to achieve their learning goals. However, a hierarchical structure with a more complex and wide-ranging content, organised in multiple sections and sub-sections, is harder to present and takes up more space. A consequence of excess of space being taken up by the hierarchical structure is that it may obstruct the learning content from being clearly visible, which, in turn, can cause problems to all the users.

One (imperfect) solution to this problem is for designers to hide the sub-links of all of the main links that are presented in the hierarchical structure. Additionally, designers must allow all the sub-links of a main link to be visible only when users have opened the respective main link, or when they are currently in one of the sub-links of a respective main link. This implies that, unlike maps, not all sub-links in relation to all the main links will be displayed at the same time in the hierarchical structure. Whereas this may not cause issues for FD users with high DK and low CE, FD users with low DK and low CE, or low DK and high CE may not be able to develop a conceptual structure and integrate knowledge. To overcome the difficulties that have been noted with providing visual representations of the content's hierarchical structure, it is imperative that maps are provided in the HLS.

The hierarchical structure can be provided in the left hand corner of the page, and with a different background colour, which can help the FD learners to differentiate this visual representation from the learning content that is been displayed in the rest of the page. A title labelled as 'menu or content' above the hierarchical structure will make it clearer to these learners that a visual instructional aid is being provided in the HLS.

The section has highlighted that FD users with one of the following experience profiles (low DK and low CE; low DK and high CE; and high DK and low CE) users can impose a structure on the learning content in the HLS and can map a mental representation of the document structure in the HLS when given a graphical map or the hierarchical structure of the learning system's content, which, in turn, can facilitate navigation and increase comprehension. However, they may still encounter higher levels of disorientation if they do not know the following when they navigate through the HLS: (1) where are they; (2) where are they going; (3) what have they visited; (4) where have they been (including the repeatedly visited pages) and how can they go back to these visited pages; and (5) where to go next. These issues may be particularly acute when high levels of freedom of navigation have been provided, and when the tutorial consists of a large number of main sections, sub-sections and even sub-sub sections. The maps and the hierarchical representation of the content's structure which have been proposed may not reduce all of these five types of disorientation, making it an issue in relation to the design of the HLS. This section will therefore now present and consider the different methods that can be applied to reduce these five types of disorientation problems in the design of the HLS.

With respect to the first type of the disorientation ('where are they'), FD users with one of these experience profiles ((i) low DK and low CE, (ii) low DK and high CE, and (iii) high DK and low CE) sometimes have difficulties finding: (i) how far they have navigated in the HLS to their current location in the HLS; and (ii) their location within a specific section in the tutorial. In terms of the first issue, 'breadcrumbs' can be used as a visual cue to show these FD users how they got to their current location in the HLS. For this to be most effective, the link showing the current page must be disabled and in a different colour text. Placing the 'breadcrumbs' above the page title can clearly attract the attention of these FD users. Additionally, a different background colour can be used to differentiate the 'breadcrumb' visual cue from the learning content on the page.

With regards to the second issue (how users find their location within a specific section of the tutorial), one solution is to clearly identify the current position on the graphical map – for example by disabling and differently colouring the 'current' node and using a 'hand' icon with the accompanying text 'you are here' to point to the node on the graphical map. Alternatively, the context could be highlighted by using, for example, disabled and shaded links with the text used for the links being presented using different font sizes, styles and colours in the hierarchical structure.

Moving onto the second type of disorientation from which FD users in these experience profile groups tend to suffer ('where they are going in the HLS'), providing a traceable navigation path feature in the graphical map may be useful. This feature would help the FD users in these experience profile groups to see their movement through the graph as they navigate through the HLS pages. This, in turn, should prevent them from experiencing higher levels of disorientation in the HLS in cases where they have wrongly chosen particular paths and have navigated away from their current learning goals. The effective the navigation trail must be clearly visible be must not distract the user.

Another solution to reduce this second type of disorientation is to provide a content summary at the start of each lesson to provide a brief overview of the issues that will be covered and the total number of pages that are attached to the lesson. This, in turn, can help the FD users in these experience profile groups to find out where they are going, and to judge whether it is useful to them to follow a particular lesson, especially in cases where they are looking for a specific answer or piece of information (as was the case in relation to the practical task).

The third type of disorientation – 'what have they visited' – is mostly experienced by FD users with low DK and low CE, or low DK and high CE, who find it difficult to impose a structure on the learning content in the HLS. A consequence of this disorientation problem is that the FD users in these experience profile groups may open unnecessary nodes or fail to complete effectively all of the learning materials needed to achieve their overall learning goals. One remedy for this issue is to provide a check mark to indicate the pages that the user has visited in the HLS. Such a check mark (in the form of a 'tick' symbol, for example) can be displayed inside the nodes (which represent the information that is presented in the HLS) in the graphical map. Additionally, different colours could be used for the tick symbols to differentiate the latest page from the previous pages visited. The tick symbol should be of reasonable size, so that it is clearly visible inside the nodes in the graphical map. If this approach is adopted, designers need to tell users, especially those with low CE, what the tick symbol/colours refer to by, for example, annotating the symbols (activated when the mouse is over them).

Providing different link colours is another way of informing the FD users in these experience profile groups of the pages that they have already visited.

In addition to the three types of disorientation discussed so far, FD users with low DK and low CE, low DK and high CE, or high DK and low CE, suffer from a fourth type – 'where have they been and how can they go back to these destinations in the HLS'. FD users with one of these experience profiles have difficulties finding where they have recently been in the HLS (including the pages that they have opened more than once), especially on the rare occasions that they use a non-linear approach in relation to their learning goals. This makes it harder for them to going back to these previously visited pages if they need to. One way to reduce this problem is to provide a history-based mechanism. Through the use of this visual technique, the FD users in these experience profile groups will be able to view a list of the pages that they have visited in the HLS.

Additionally, links could be provided to the visited pages to help the FD users to access them directly should they need in order to accomplish their learning goals. Designer will need to be aware, however, that displaying all of the visited pages (including those that have been visited repeatedly) on one page may lead to space and scrolling problems. A compromise may be to display only the last 10 visited pages (as recommended by users in the semi-structured interview).

Even if this compromise approach is adopted, designers will need to be cautious about the history-based mechanism being displayed on the same page as the learning content. If the left-hand area of the screen is used for the hierarchical structure, using an additional space to represent the history-based mechanism visual instructional aid will mean even less space will be left to display the learning content and, this, in turn, may cause two issues. Firstly, the learning content may not be clearly visible, which may prevent some users from learning effectively. Secondly, it may irritate other users (for example: FD/FI users with high DK and high CE). In order to reduce these two issues, the history-based mechanism cue could be opened in a new pop-up window, or zoomed in and out on the same page where the learning content is displayed.

If the mechanism is 'hidden' in one of these two ways to manage space use, designers will need to find a way to inform these FD users its presence and to convey how to access it in the HLS. One approach would be to provide a link at the end of the learning content in the page which represents 'where have I been recently and how can I go back to these destinations'. By clicking the link, the FD users would be directed to the history-based mechanism easily and quickly. To ensure the link's visibility, it could be separated from the learning content using different colours from other links provided in the HLS.

Finally, the fifth type of disorientation –'where to go next in the HLS' – is a common problem that is faced in the HLS by some FD users, especially those with low DK and low CE, or low DK and high CE. One way to help FD users in these experience profile groups to reduce this type of disorientation is to provide page labels in the form of heading, pagination and sub-headings on a page. For example a heading of 'Lesson 4:

Lists', followed by a pagination marker: 'page 2 of 5', and a sub-heading: 'Creating Unordered Lists' at the top of the learning content in a page, can inform these FD users that they are currently on page 2 of 5 (creating an unordered list) of lesson 4 (lists). This is in turn, can help learners in these groups to see that in order to successfully complete their current learning goals, the best next path will be to navigate to page 3 of 5, then to page 4 of 5 and, finally, to page 5 of 5. Using different font sizes, styles and colours for the text that is used for the page labels will help these users to differentiate the learning content from the page label visual cues. Additionally, the font size that is used for the labels should not be too large otherwise the labels may take up too much space on the page, causing a disturbance to other users who do not use the labels.

Another approach to alleviating the fifth type of disorientation is to provide direct guidance. The pagination facility (which shows the current page) can be displayed at the bottom of the learning content along with two arrow links: the backward arrow link to its left, and the forward arrow link to its right. The backward arrow link will direct these FD users one page back from the current one, whereas the forward arrow link will direct users one page ahead the current one. Allowing though this mechanisms only navigation one page either 'side' of the current page makes sure that these users will be opening appropriate pages in relation to their current learning goals and should help alleviate disorientation.

Finally, providing a content summary at the start of each lesson – which indicates the total number of pages in the lesson and provides a brief overview of what is covered in it – can help FD users to decide whether to stay in that lesson or to move to another section of the tutorial. This is especially useful when they are searching for particular information, for example to answer a question related to a practical task.

The suggestion made in this section in relation to the design of the HLS are distilled in Tables 7.2(a-c), with the aim of supporting cognitive style users in the four experience profile groups ((i) low DK and low CE, (ii) low DK and high CE), (iii) high DK and low CE, and (iv) high DK and high CE) to learn effectively, to enhance their learning satisfaction, and to continue showing interest in learning using HLS.

Table 7.2 (a): Design guidelines for HLS in relation to the general discussions of the findings from experiment 1

Visual instructional aids	Purposes	Design consideration
Provide a graphical map	To help learners to impose a structure on the learning content that is presented in the tutorial within the HLS. To help learners to map a mental representation of the document structure in the HLS. To help learners to reach the information that they need in relation to their learning goals.	Use a zooming feature with the graphical map to save space or to prevent other users from being distracted by it. A labelled map icon should be provided to inform and to link learners to the graphical map. A guide should to be provided to tell users how to use the map.
Use disabled and different colour nodes and a 'hand' icon with accompanying text to show the user's current location in the HLS on the graphical map	To tell learners which section of information that they are currently exploring, preventing them from experiencing the first type of disorientation – 'Where are they?'	The hand icon used must be placed next to the disabled and different colour node to draw attention to the current location in the HLS. The hand icon must be visible and reasonable in size.
Use a check mark ('tick' symbol) within/alongside the nodes of the graphical map	To indicate to the learner which pages have been visited, preventing them from experiencing the second type of disorientation – 'What have they visited?'	The tick symbols which denote all previously visited pages should be in a common colour, whereas the one representing the latest visited page should be in different colour.
Provide a traceable navigation path feature to the graphical map	To support learners to view their movement in the HLS as they navigate through its pages, preventing them from choosing problematic paths through the tutorial. This will reduce the second type of disorientation – 'Where are they going?	The navigation trail must be visible. The navigation trail must not distract learners who do not need to make use of it.
Provide hierarchical structure	To support learners in viewing the main sections and their sub-sections presented in the HLS. To help learners to reach the information that they need in the HLS.	Display the hierarchical structure in the left hand corner of every page, with a title 'content or menu', and with a different background colour. Hide the sub-sections (represented by sub-links) of a main section (represented by main links) to save space. Allow the subs-sections of a main section to be visible only when a learner has opened the main section or when s/he is currently on one of the sub-sections of a respective main section.

Table 7.2 (b): Design guidelines for HLS in relation to the general discussions of the findings from experiment 1

Visual instructional aids	Purposes	Design consideration
Highlight the context in the hierarchical structure	To help the learner to reduce the first type of disorientation - 'where are they' in relation to the (sub-) section of information that s/he is currently viewing.	Use disabled and shaded links, and different font sizes, styles and colours for the text used for the link to highlight users' current location. Annotate the highlighted context as 'you are currently viewing this page' in case the learner does not understand the purpose of this visual representation.
Use different links colours in the hierarchical structure	To reduce the third type of disorientation – 'what have they visited?'	Use different colours to indicate to users their visited and unvisited pages in the tutorial
Provide 'breadcrumbs'	To show learners the paths that have led them to their current location, helping to reduce the first type of disorientation – 'where are they?'	Use disabled and different coloured text for the link showing the current page in the 'breadcrumbs'. Display the 'breadcrumbs' above the page title, and with a different background colour to help learners to differentiate it clearly from the learning content.
Provide a 'content summary page'	To support learners to reduce the second type of disorientation – 'where are they going?'; and the fifth type of disorientation – 'where can they go next?'	Provide a 'content summary page' at the start of every lesson in the HLS. The 'content summary page' should include a brief overview of the lesson and its total number of pages.
Provide a 'history-based mechanism'	To show learners a list of the pages that they have accessed (including the repeatedly visited ones), and to make it easy for them to revisit these pages. This should reduce the fourth type of disorientation – 'where have they been, and how can they go back to their visited pages?'	Show a list of the 10 most recently visited pages (including those repeatedly visited). Provide a link to the visited pages to help learners to access them again, easily and quickly. Use a new pop-in window page or zooming feature to open this visual representation so that it is not constantly taking up space on the page. Provide a link labelled 'where have I been and how can I go back to the pages I've visited to make learners aware of the history-based mechanism cue and its access.

Table 7.2 (c): Design guidelines for HLS in relation to the general discussions of the findings from experiment 1

Visual instructional aids	Purposes	Design consideration
Provide 'page labels' in the form of headings, page identifiers and sub-headings.	To help learners successfully to decide on suitable, coherent paths in relation to their learning goals. This will reduce the fifth type of disorientation – 'where to go next in the HLS.'	Provide the page labels above the learning content, in the middle of the page. The heading should be at the top, followed by the page identifiers on the second line, and lastly, the sub-headings on the third line. Use different font sizes, styles and colours for the text representing the page labels to help learners to differentiate this visual representation from the learning content.
Provide 'direct guidance'	To help learners successfully to decide on suitable, coherent paths in relation to their learning goals. This will reduce the fifth type of disorientation – 'where to go next in the HLS?'	Use a pagination facility to highlight the current page, with a left arrow link to its left, and a right arrow link to its right, below the learning content. The text used for the pagination facility (related to the current page) should be in bold for ease of identification. The right arrow link should direct users to the next page from the current page, whereas the left arrow link should direct users to the previous page from the current one. The right and left arrow links should be labelled accordingly. Other pages in relation to the topic must be kept hidden to avoid confusion and limit navigation options for learners who suffer from disorientation problems.

7.4.2 Design Guidelines for HLS in Relation to the Findings from Experiment 2

The findings from experiment 2 addressed research questions (2(a-c)) (see section 7.3 and Table 7.3) and suggested that not all users can successfully use the HLS that provided no instructional aids in support of their learning. For instance, FD users with experience profiles of low DK and low CE, low DK and high CE, or high DK and low CE experienced more difficulties when learning in this version of the HLS than did FI users with the same experience profile or FD/FI users with an experience profile of high DK and high CE. The findings also suggested that, with regards to the HLS that incorporated audio instructional aids, FD users (with low DK and low CE, low DK and high CE, or high DK and low CE) were totally dependent upon these audio instructional aids to reduce their disorientation problems, and to improve their learning performance. The exception with respect to learning performance was FD users with an experience profile of high DK and low CE who already had prior knowledge of the learning content of 'XHTML'). The FD users with low DK and low CE, low DK and high CE, or high DK and low CE also showed a positive attitude towards the HLS that provided audio instructional aids. In contrast, the FI users (whether they had low DK and low CE, low DK and high CE, or high DK and low CE) and the FD and FI users with high DK and high CE did not depend on or need instructional guidance in the HLS.

However, the results of experiment 2 suggest that 'forcing' all users to use the audio instructional aids to navigate through the HLS will cause a detrimental effects for those users who do not depend on the aids (all FI users) or who do not need them to perform their learning in HLS (FD and FI with high DK and high CE). Although their levels of disorientation are low and learning performance are enhanced when using the audio instructional aids, the FD and FI users in these experience profile groups do not gain enough flexibility in terms of navigation and do not have enough control over the tutorial. Further, they were distracted by the audio. These three issues lead these users to show a negative attitude towards this type of HLS, making it an important HLS design issue. A HLS which offers non-linearity features as well as audio instructional aids, but has mechanisms that ensures that the audio instructional aids do not disturb users who do not need them, may be useful to a range of users in relation to cognitive style, domain knowledge and computer experience. The remainder of this section will draw on the findings from experiment 2 to suggest approaches to HLS design, with the aim of helping both different cognitive style users, with differing levels of CE and DK to learn effectively and to enhance their learning performance and learning satisfaction in non-linear environments.

Table 7.3: High level findings in relation to the General Discussion of the Findings from Experiment 2

	RQ2a in relation to Disorientation		**RQ2b in relation to Learning Performance**		**RQ2c in relation to Attitudes**	
	HLS with no instructional aids	*HLS with audio instructional aids*	*HLS with no instructional aids*	*HLS with audio instructional aids*	*HLS with no instructional aids*	*HLS with audio instructional aids*
Low DK and low CE	FD had greater difficulties navigating through the HLS than FI. FD experienced higher levels of disorientation than FI.	Neither FD nor FI users experienced difficulties navigating through the HLS; and neither experienced high levels of disorientation. FD were totally dependent on the audio instructional aids to reduce disorientation. In contrast, FI were not totally dependent on the audio instructional aids to reduce disorientation.	FD performed less well than FI.	FD and FI performed equally well. FD were totally dependent on the audio instructional aids to perform well. In contrast, FI were not totally dependent on the audio instructional aids to perform well.	FD showed more negative attitudes towards the HLS than FI.	FD showed positive attitudes towards the HLS mainly because of the audio instructional aids. FI showed negative attitudes towards the HLS because they were not allowed to set their own navigation paths; had no other options than using the audio instructional aids for navigational purposes; and were sometimes distracted by the audio.
Low DK and high CE	FD had greater difficulties navigating through the HLS than FI. FD experienced higher levels of disorientation than FI.	Neither FD nor FI experienced difficulties navigating through the HLS; and neither experienced high levels of disorientation. FD were totally dependent on the audio instructional aids to reduce disorientation. In contrast, FI were not totally dependent on the audio instructional aids to reduce disorientation.	FD performed less well than FI.	FD and FI performed equally well. FD were totally dependent on the audio aids to perform well. In contrast, FI were not totally dependent on the audio instructional aids to perform well.	FD showed more negative attitudes towards the HLS than FI.	FD showed positive attitudes towards the HLS mainly because of the audio instructional aids. FI showed negative attitudes towards the HLS because they were not allowed to set their own navigation paths; had no other options than using the audio instructional aids for navigational purposes; and were sometimes distracted by the audio.
High DK and low CE	FD had greater difficulties navigating through the HLS than FI. FD experienced higher levels of disorientation than FI.	Neither FD nor FI experienced difficulties navigating through the HLS; and neither experienced high levels of disorientation. FD were totally dependent on the audio instructional aids to reduce disorientation. In contrast, FI were not totally dependent on the audio instructional aids to reduce disorientation.	FD and FI performed equally well.	Irrespective of the audio instructional aids, FD and FI performed equally well.	FD showed more negative attitudes towards the HLS than FI.	FD showed positive attitudes towards the HLS mainly because of the audio instructional aids. FI showed negative attitudes towards the HLS because they were not allowed to set their own navigation paths; had no other options than using the audio for navigational purposes; and were sometimes distracted by the audio.
High DK and high CE	Neither FD nor FI experienced difficulties navigating through the HLS. Neither FD nor FI experienced higher levels of disorientation in the HLS.	Neither FD nor FI experienced difficulties navigating through the HLS; and neither experienced high levels of disorientation. Neither FD nor FI were depended on the audio aids to reduce disorientation.	FD and FI performed equally well.	Irrespective of the audio instructional aids, FD and FI performed equally well.	Both FD and FI showed positive attitudes towards the HLS.	FD and FI showed negative attitudes towards the HLS because the HLS structure was less flexible; they were not given high levels of freedom of navigation; had no other options than using the audio aids to navigate through the HLS; and were distracted by the audio.

The FD users with experience profiles of (i) low DK and low CE, (ii) low DK and high CE, or (iii) high DK and low CE have difficulties navigating through the HLS to perform their learning because they cannot impose a structure on the learning content that is presented in the HLS, or have no knowledge about the physical arrangement of the document in the HLS. One of the solutions to these problems is to provide a menu audio control panel (with 'play', 'stop' and 'pause' features) that can 'play' (through audio clips) the hierarchical relationships between the main sections and their sub-sections (also known as sub-contents), if there are any, to represent the information that is presented in the HLS. The 'play', 'stop' and 'pause' features will allow the FD users in these experience profile groups to listen to the audio at their own pace.

Additionally, a non-speech sound can be provided after each main section or sub-content is played in the menu audio control panel. This approach can help the FD users in these experience profile groups to differentiate clearly between the main sections or the sub-contents which represent the information that is being presented in the HLS. However, 'playing' all the information that is presented in the HLS may be time consuming, cause irritation, or lead to cognitive overload for these FD users. In order to mitigate against these three issues, designers can design and develop the menu audio control panel in such a way that it will only play the main sections of the HLS should these users decide to use this instructional aid, and will only play the sub-contents (if any) of a main section should the user decide to enter the respective main section.

Even when users have elected to use the audio, the FD users in these experience profile groups may want to skip through the options that are played in the menu audio control panel, especially when they have familiarised themselves with this type of instructional aid. It is therefore recommended that these users are provided with a 'skip' facility in the menu audio control panel, for example in the form of 'pressing the forward arrow key' on the keyboard. Designers would need to inform the users about this facility on the guide page.

To direct the FD users in these experience profile groups to the information that they need, keyboard commands (via key presses) can be provided in the menu audio control panel. For instance, after a main section or a sub-content has been played, users need to be informed about the key that they need to press from the keyboard to open the respective section or sub-content. Allowing these FD users to use the keyboard commands after a section or sub-content has been played will permit them to reach a destination without having to listen to the rest of the information that is presented in the HLS. This will reduce the time spent by users as well as making it less difficult for users to interact with this audio instructional aid in the HLS to perform their learning.

The menu audio control panel should be placed above the page title and make use of a different background colour from the one representing the learning content in the page, in order to make it prominent for the FD users in these experience profile groups. Designers need to make sure that this audio control panel is of reasonable size but does not occupy too much space, otherwise it may prevent the learning content from being clearly visible on the page. The extra space taken by the menu audio control panel can also distract some users (for example, FI with low DK and low CE, low DK and high CE, or high DK and low CE; and FD/FI with high DK and high CE) who do not depend on or require instructional aids in the HLS, and this may lead them to show a negative attitude towards the HLS.

The section has argued that, when given a menu audio control panel, FD users in these experience profile groups (low DK and low CE, low DK and high CE, or high DK and low CE) can impose a structure on the learning content that is presented in the HLS, or can map a mental representation of the document structure, which in turn, can help them to navigate through the HLS to perform their learning. However, this form of audio instructional aid may not be enough to ensure that these FD users do not experience higher levels of the following five types of disorientation in the HLS: (1) where are they; (2) where are they going; (3) what have they visited; (4) where have they been (including the repeatedly visited pages) and how can they go back to these visited pages; and finally (5) where to go next. As discussed in section 7.4.1, these issues may be particular acute when high levels of flexibility are offered in the HLS, or when the HLS consists of a large number of pages, organised in multiple sections and sub-sections. The menu audio control panel on its own cannot fully address these five types of disorientation problems in the HLS. For this reason, this section will now present and consider other forms of audio instructional aids that may be useful.

With regards to the first type of disorientation – 'where are they?'– as discussed in section 7.4.1, FD users with one of these experience profiles (low DK and low CE; low DK and high CE; high DK and low CE) suffer two major problems. First, they do not know how far they have navigated in the HLS to reach their current location. Second, they have difficulties finding their current location within a specific section in the HLS. One of the ways to help FD users in these experience profile groups to reduce these two issues is to provide a 'breadcrumb' audio control panel (with 'play', 'pause' and 'stop' features) that gives audio to provide: (i) the user's current location in the HLS, and (ii) the paths that have led the user to reach the current location. An example script for the audio in relation to this type of disorientation is shown in Box 7.1.

> '*You are currently on page 3* [non-speech sound] *setting a list appearance, of lesson 4* [non-speech sound] *lists*. *The path that has led you to the current page* is *home* [non-speech sound], *lesson index* [non-speech sound], *and lesson 4*. *End of message*.'

Box 7.1: Example of 'breadcrumbs' audio clip

The non-speech sound referred to in Box 7.4 will help these FD users to distinguish the page number from the page title, the lesson number from the lesson title, and to distinguish between the elements in the navigation path in the HLS. This audio control panel can be provided in the same area of the page where the menu audio control panel is located. This form of audio instructional aid should not take too much space in the page, otherwise it may obstruct the learning content from being clearly visible on the screen and/or may cause irritation to some users (for example, FI with low DK and low CE, low DK and high CE, or high DK and low CE; FD/FI with high DK and high CE) who do not need this audio support.

The second type of disorientation – 'where are they going' – tends to be severe for the FD users in these experience profile groups (low DK and low CE; low DK and high CE; high DK and low CE) when the HLS consists of a large number of main content and sub-contents sections, or offers high levels of flexibility in terms of navigation and control over the tutorial (learning content). Moving away from their current learning goals may, in turn, prevent these FD learners from learning effectively or may further increase their level of disorientation. One approach to addressing this issue would be to provide a 'traceable navigation path' audio control panel that can track and play back learners' navigation paths, including their current location, as they navigate through the HLS. One of the ways that the 'traceable navigation path' audio control panel could operate is presented in Box 7.2.

> *'You are currently on page 3 of lesson 6.'*
>
> [non-speech sound]
>
> *'You moved from page 2 to this page.'*
>
> [non-speech sound]
>
> *'Before that, you moved from page 1 to page 2 of lesson 6.'*
>
> [non-speech sound]
>
> *'Previously, you moved from the resources page to page 1 of lesson 6.'*
>
> [non-speech sound]
>
> *End of message.'*

Box 7.2: Example of a 'traceable navigation path' audio clip

The non-speech sound should help these FD users to differentiate between the different elements of the navigation path that are been played in the audio. The 'traceable navigation path' audio control panel should be provided in the same area where the other audio instructional aids are located, with the caveat about its size and that has already been noted.

As discussed in section 7.4.1, because they find it difficult to impose a structure on the material that is presented in the HLS, FD users either low DK and low CE, or low DK and high CE suffer from a third type of disorientation – ‘what have they visited?’ A consequence of this disorientation problem is that the FD users with one of these two experience profiles may repeatedly open the same nodes that they have previously visited and, as a result, may fail to open and cover other parts of the tutorial which are imperative in order to achieve their overall learning goals. This, in turn, can hinder their learning performance. One of the solutions for this type of disorientation problem is to provide a ‘checkmark’ audio control panel that plays a list of the visited pages (starting from the most recently visited page, playing each visited page only once). This approach may prevent the FD users in these experience profile groups from repeatedly opening the same pages, which may ‘create’ time for them to visit the rest of the tutorial or the chance to open the correct nodes in the tutorial to achieve their learning goals. This audio control panel with ‘play’, ‘stop’ and ‘pause’ features should be provided next to the other audio control panels, and should be of reasonable size.

The fourth type of disorientation – ‘where have they been and how can they go back to these destinations in the HLS?’ – is experienced by FD with low DK and low CE, low DK and high CE, or high DK and low CE. The FD users in these experience profile groups find it difficult to backtrack their visited pages, including those that they have visited more than once. To address this issue, the ‘history-based’ audio control panel (with ‘play’, ‘pause’ and ‘stop’ buttons) can be provided. This form of audio instructional aid will, starting with the most recent, backtrack and ‘play’ learners’ previously visited pages (including those that have been opened more than once). Similar to the history based mechanism visual cue that was discussed in section 7.4.1, this ‘history-based’ audio control panel should play a defined number of recently visited pages, say the last 10.

FD users with these experience profiles also encounter difficulties in being redirected to the pages that they have visited. To address this, and support these FD users in being redirected to their previously visited pages, keyboard commands (via key presses) can be provided in the ‘history-based’ audio control panel itself. For instance, having played a visited page in the history based audio, these FD users need to be provided with a key mapping that will take them directly to the page in question. This approach will also allow these users to open a previously visited page without having to listen to all of the other visited pages presented in the 'history-based' audio control panel, hence saving their time. To allow the FD users in these experience profile groups to get access to this 'history-based' audio control panel, it should be provided alongside the other audio control panels that have been discussed.

Finally, the fifth type of disorientation – 'where to go next?' – is mostly experienced by FD users with low DK and low CE, or low DK and high CE. Because they cannot impose a structure on the learning content, these FD users find it difficult to decide where to go next in the HLS in order to navigate their tutorial effectively. One of the ways to reduce this type of disorientation problem is to provide a 'direct guidance' audio control panel that will guide these users where to go next in the HLS in relation to their current learning goals. For instance, the audio can first play their current page, and then play the next page. This, in turn, will not only make sure that these users are completing all of the sections of a particular topic, but that they are completing them effectively in line with a user's current learning goals. The risk of opening unnecessary nodes should also be low if this approach is followed. However, these FD users may need to refer to the previous page if they have forgotten what they covered earlier in the topic. Therefore, the previous page will also need to be played as a second option in the 'direct guidance' audio control panel. Giving these two options will also make sure that the users are not moving away from their current learning goals. This form of guidance should be useful when these users are exploring the lessons for the first time in the tutorial.

Designers should, however, find a way to alert these FD learners to what steps they will need to take should they decide not to follow the recommended pages, especially in cases where they are looking for particular information to answer a question in relation to a practical task. One approach is to remind the user about the audio menu or the 'history-based' audio control panel which they can use should they decide to choose other paths to access information in the HLS.

Having given these FD users the option of where to go next in the HLS, designers need to find a way to direct them to the recommended pages. One solution is to provide keyboard commands (via key presses) in the 'direct guidance' audio control panel itself. Having played a recommended page, these FD users need to be provided with the key that they need to press on the keyboard to go directly to a recommended page. An example of 'direct guidance' audio is given in Box 7.3. As before, this audio control panel should offer 'play', 'stop' and 'pause' features and should be placed with the other audio control panels, should be of reasonable size, and should not distract other users who do not need the instructional aids.

> *'You are currently on page 3 of 5* [Non-speech sound] *floating images, of lesson 5* [Non-speech sound] *Images. It is recommended that you go to the next page, page 4 of 5* [Non-speech sound] *adding space around an image in relation to this lesson.* [Non-speech sound] *To go to the next page press n.'*
>
> [Non-speech sound]
> *'To go the previous page in relation to this lesson, select p.'*
>
> [Non-speech sound]
> *'Alternatively, for other information in the HLS, use the main menu.'*
> *'End of message.'*

Box 7.3: Example of 'direct guidance' audio clip

Another approach to reducing the fifth type of disorientation is to play a brief overview of a lesson or a topic, via the audio menu, in the lesson's homepage. This approach may help these FD users to decide whether to continue with or to exit the page. This should be especially useful when the user is searching for particular information, for example to answer a question in the practical task, or is comparing one topic with another.

There are two further issues of which designers need to be aware in relation to the audio instructional aids that have been suggested for FD users with low DK and low CE, low DK and high CE, and high DK and low CE: (i) the speed of the speech that is used in the audio; and (ii) the type of speech output in used in the HLS. Some FD users in these experience profile groups may not be comfortable with the speed and the type of the speech output that are used in a HLS. A consequence of this is that these users may not be able to complete their learning effectively. In order to reduce the problem related to the speed, it is suggested that an ‘audio speed rate’ command is made available in the HLS to allow these FD users to adjust the speed of the audio to one that is suitable for them. Providing a ‘reset’ button can reinstate the default speed should the user wish. As before ‘audio speed rate’ command should not occupy a lot of space, otherwise it may obstruct the learning content from being visible in the page or cause detrimental effects to some users (for example, FI with low DK and low CE, low DK and high CE, or high DK and low CE; FD/FI with high DK and high CE) who do not depend on or require instructional aids in HLS. This command should be provided in the same area where the other audio instructional aids are located. Finally, a guide should be provided to tell users how to operate this command.

In terms of the type of speech output, a ‘change voice command’ could be provided to allow these FD users to change the default voice to their preferred one from a list of other voices. The list of voices can be drawn from those used in real text to speech applications. A guide about how this command operates should be provided to users. Again, a reset button should be provided to make it easy to reinstate the default voice. Finally, this command should be provided among the other audio instructional aids, following the same caveat on size.

The section has suggested specific guidelines in the design of the HLS which can provide guided learning using audio instructional aids to FD users with one of the following experience profiles: (i) low DK and high CE; (ii) low DK and high CE; and (iii) high DK and low CE. It has also sought to explain how to include these audio instructional aids so that they will not have detrimental effects for those users who are not dependent on them or who do not need them in the HLS (for example, FD and FI users with high DK and high CE; FI with low DK and low CE, low DK and high CE; and high DK and low CE). These design guidelines are distilled in Tables 7.4 (a-c).

Table 7.4 (a): Design guidelines for HLS in relation to the general discussions of the findings from experiment 2

Audio instructional aids	Purposes	Design consideration
Provide a menu audio control panel	To support learners to impose a structure on the learning content that is presented in the HLS. To support learners to map a mental representation of the document structure in the HLS. To direct learners to the information that they need in the HLS in relation to their learning goals.	The menu audio control panel should allow users to skip through the information that is being played. By default, the menu audio control panel should only play the main sections in relation to the information that is presented in the HLS. The sub-sections of a section can only be played should the users decide to refer to the corresponding section. The menu audio control panel should make clear the keys that can be pressed from the keyboard to help users to access the information that is presented in the HLS. The menu audio control panel should be placed above the page title, and use of background colour that makes it visible; it should not cause any disturbance to users who will not be using it. A guide should be provided to tell users how the menu audio control panel operates, and how to use it to perform their learning in the HLS.
Provide a 'breadcrumb' audio control panel	To give audio information on users' current location in the HLS. To give audio information to users about how far they have navigated in the HLS to reach their current location.	The 'breadcrumb' audio control panel should be placed in the same area where the menu audio control panel is located, and should not cause any disturbance to users who will not be using it.
Provide a 'traceable navigation paths' audio control panel.	To track and give audio information on users' navigation paths, including their current location in the HLS, preventing them from choosing problematic paths through the tutorial. This in turn, will help them to reduce the second type of disorientation – 'where are they going?'	The 'traceable navigation paths' audio control panel should be placed in the same area where all other audio instructional aids are located, and should not cause any disturbance to users who will not be using it.
Provide a 'checkmark' audio control panel	To give audio information to users on their visited pages, preventing them from experiencing the third type of disorientation – 'what have I visited?'	Provide audio information on the visited pages in the 'checkmark' audio control panel, starting from the most recently visited and only including each visited page once. The 'checkmark' audio control panel should be provided with the other audio instructional aids and should not cause any disturbance to users who will not be using it.

Table7.4 (b): Design guidelines for HLS in relation to the general discussions of the findings from experiment 2

Audio instructional aids	Purposes	Design consideration
Provide a 'history-based' audio control panel	To 'play' learners a list of the pages that they have accessed, including those repeatedly visited, and to direct them to these visited pages. This should reduce the fourth type of disorientation – 'where have they been and how can they go back to these destinations in the HLS?'	'Play' a list of the 10 most recently visited pages (including those repeatedly visited) in the 'history-based' audio control panel. This 'history-based' audio control panel should provide audio information to make clear the keys that can be pressed from the keyboard to help users to access these pages easily and quickly. The 'history-based' audio control panel should be provided with the other audio control panels, and should not cause any detrimental effects to users who will not be using it.
Provide a 'direct guidance' audio control panel	To help users successfully to decide on suitable coherent paths in relation to their learning goals; and to direct them to the recommended page(s) in relation to the tutorial in the HLS. This should reduce the fifth type of disorientation – 'where can they go next?'	The 'direct guidance' audio control panel should first 'play' the current page to remind users of their location in the HLS. Then it should recommend the next page that needs to be visited in relation to their learning goals. Third, it should provide audio information on the page before the current one in case the user wants to visit that previous page again. Finally, it should alert the user about the audio menu in case the user wants to navigate to an alternative page in the HLS. The 'direct guidance' audio control panel should provide audio information to make clear the keys that can be pressed from the keyboard to help users to access these pages easily and quickly. The 'direct guidance' audio control panel should be provided in the same area as the other audio instructional aids and should not cause any disturbance to users who will not be using it.

Table 7.4 (c): Design guidelines for HLS in relation to the general discussions of the findings from experiment 2

Audio instructional aids	Purposes	Design consideration
Playing a brief overview of a lesson or topic in its home page in the audio menu	To support users to decide on suitable coherent paths in relation to their learning goals, especially when they are performing the practical task. This can reduce the fifth type of disorientation – 'where can they go next?'	Provide audio information on a brief overview of a lesson or a topic including its number of pages in its home page in the audio menu.
Provide a 'audio speed rate' command	To allow users to adjust with their preference speed of the audio.	A guide should be provided to tell users how this command works and how to use it. A reset button should be provided in this command to return users to the default speed. The command should be placed in the same area where all other audio instructional aids are located, and should not cause any disturbance to users who will not be using it.
Provide a 'change voice command'	To allow users to change the voice that is been used by default in the audio to others that are provided in the HLS.	A list of voices that are normally used in text to speech applications should be given in the 'change voice command' A guide should be provided to tell users how this command works; and how to use it. A reset button should be provided in this command to return users to the default voice. The audio command should be of reasonable size and should not occupy too much space on the page. It should be placed in the same area as the other audio instructional aids, and should not cause any disturbance to users who will not be using it.
Provide non-speech sound	To help users to differentiate between the information that is been played in the HLS.	The same non-speech sound should be played (if required) in the audio, and should not be long.

7.5 Summary

Chapter 7 has presented a general discussion of the findings from experiment 1 and experiment 2. As a result, the chapter has framed and justified specific design guidelines for the HLS, with the aim of supporting cognitive style (FD/FI) users with different levels of DK and CE to reduce their higher levels of disorientation, to learn effectively, and to enhance their learning satisfaction in non-linear learning environments. The following chapter summarises the work reported in this thesis, presents overall findings, discusses the contributions that have been made by the research, presents limitations identified in the work; and, finally, suggests directions for future research.

Chapter Eight: Conclusion

8.1 Introduction

This thesis has argued the increasing importance of HLS to education, as they characteristically offer learning content in a non-linear structure and allow users to access learning material in accordance with the information that they require and through navigation approaches that they prefer. However, some users have been shown to have difficulties navigating through HLS to perform their learning, leading them to experience higher levels of disorientation, preventing them from learning effectively, and showing negative attitudes towards HLS.

It is suggested that individual difference factors, such as cognitive style, domain knowledge and computer experience, tend to influence learners' disorientation, learning performance and attitudes when using HLS. Along with other studies, this thesis has argued that providing instructional aids in the form of visual elements (a map and a set of visual orientation cues) or audio elements can support individual differences to reduce learners' disorientation which, in turn, can increase learning performance in, and positive attitude towards, these non-linear environments. However, this thesis has contended that there are gaps in the research related to individual differences, HLS, visual instructional aids and audio instructional aids. Firstly, no studies have examined the effects of and between individual differences on learners' disorientation, learning performance and attitudes when using a single HLS that incorporates a map and a set of visual orientation cues. Secondly, the effects of and between individual differences and audio instructional aids on learners' disorientation, learning performance in, and attitude towards HLS have not been examined. Seeking to address these two gaps framed the objectives for the studies that have been reported in this thesis.

This chapter concludes the thesis. It begins with a brief review of each of the chapters, before reporting the findings in relation to the six research questions and 12 research hypotheses associated with experiments 1 and 2. The contributions made by the research are then presented, with reflections on the limitations of the research effort and recommendations for future research concluding the chapter.

8.2 Summary of the Chapters

Chapter One introduced the area of HLS and introduced the thesis' main aim and objectives related to HLS, individual differences, instructional aids (visual and audio), disorientation, learning performance and attitudes. The most appropriate research methodology to support this study was also outlined.

Chapter Two looked at how individual differences (cognitive style, domain knowledge, computer experience and gender) influence learners' disorientation, learning performance and attitudes in HLS. The use of visual and audio instructional aids to support individual differences with the aim of reducing disorientation, and increasing learning performance and positive attitudes in HLS were then investigated.

Chapter Three examined the gaps that exist in research related to HLS, individual differences, visual instructional aids/audio instructional aids, disorientation, learning performance and attitudes. Firstly, no studies had considered the impact of cognitive style, domain knowledge and computer experience in a HLS that incorporates visual instructional aids – in the form of a map and a set of visual orientation cues. Secondly, the effects of cognitive style, domain knowledge and computer experience on disorientation, learning performance and attitudes in a HLS that incorporates audio instructional aids had not been examined in a single study. Having articulated these gaps, the chapter developed the research questions and research hypotheses that would be explored in this study in an attempt to address the gaps.

Chapter Four framed the research methodology that allowed the study to address the six research questions and the twelve research hypotheses. The research design and methods used within it, including the sample, data collection instruments and procedures, and data analysis techniques, were presented.

Chapter Five reported the findings gathered from experiment 1 in relation to research questions 1(a-c) and research hypotheses (1-6). The high-level outcomes from the detail reported were then distilled in this chapter.

Chapter Six reported the findings from experiment 2, the aim of which was to answer research questions 2(a-c) and research hypotheses (7-12), before presenting the high-level outcomes.

Chapter Seven provided a general discussion of the findings in relation to each of the research questions. The issues within these findings, which were argued to be important in the design of HLS, were then identified. Finally, the chapter used these findings to frame and justify a set of design guidelines for HLS to address issues identified through the findings.

The next section recaps the findings from the two experiments in relation to the six research questions and 12 research hypotheses.

8.3 Research Questions, Research Hypotheses and Findings

The aim of experiment 1 was to address three research questions and to test six research hypotheses in relation to HLS and visual instructional aids. The aim of experiment 2 was to address three research questions and to test six research hypotheses in relation to the audio instructional aids. Section 8.3.1 summarises the findings in relation to research questions 1(a-c) and section 8.3.2 summarises the findings in relation to research questions 2(a-c).

8.3.1 Research Questions, Research Hypotheses and Findings from Experiment 1

Three research questions (RQ 1(a-c)) were addressed in experiment 1, and for each research question two research hypotheses were formulated. Table 8.1 summarises the findings in relation to these research questions and research hypotheses.

With regards to research question 1(a) and research hypotheses (1-2), the following findings were identified. With respect to the HLS that provided no instructional aids, significant effects were observed between cognitive style, domain knowledge and computer experience on learners' disorientation. For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style influenced learners' disorientation: FD users with one of these experience profiles experienced higher levels of disorientation than FI users with the same experience profile. Compared to FI users with one of these experience profiles, FD users in the equivalent experience profile groups asserted that they had difficulties navigating through the HLS because they could not map a mental representation of the document structure or could not impose a structure on the learning content that was presented in the HLS, which caused them to experience higher levels of disorientation.

However, for those users who had an experience profile of high DK and high CE, cognitive style did not influence levels of disorientation in the HLS, with neither FD FI users with this experience profile experiencing this problem. Based on these findings, Hypothesis 1 was partially supported.

In terms of the version of the HLS that incorporated visual instructional aids, no significant effects between the three individual difference factors were revealed, with all users experiencing little or no disorientation in the HLS. However, a significant effect was found between cognitive style, domain knowledge and computer experience on the use of the visual instructional aids to reduce disorientation in the HLS. FD users with one of the following three experience profiles – low DK and low CE, low DK and high

CE, or high DK and low CE – depended more heavily on the visual instructional aids to successfully navigate through the HLS, and to reduce their disorientation problems, than did FI users with the same experience profile. However, for those participants with an experience profile of high DK and high CE, cognitive style did not have a significant impact: neither FD nor FI users with this experience profile used the visual instructional cues to reduce disorientation in the HLS. Based on these findings, Hypothesis 2 was fully supported.

The section will now present the findings to research question 1(b) and research hypotheses (3-4). With regards to the HLS that provided no instructional aids, there was a significant effect between cognitive style, domain knowledge and computer experience in relation to learning performance. Cognitive style influenced learners' learning performance when DK was low and CE was low, or when DK was low and CE was high. FD users with one these experience profiles performed less well in the post-test and in the practical task, achieved lower gain scores, and took more time to complete the tutorial and the practical task than did FI users with the same experience profile. However, both FD and FI users in these experience profile groups interacted a lot with the HLS to complete the exercises in the practical task, and tended to view all the lessons, and all of their sections in the tutorial.

Cognitive style showed no significant impact for those users with an experience profile of either high DK and low CE, or high DK and high CE, with both FD and FI users with these experience profiles performed equally well in the post-test and in the practical task, spending almost the same amount of time to complete the tutorial and the practical task; and achieving lower gain scores. Additionally, FD and FI users in these experience profile groups interacted less with the HLS to complete the practical task, and did not visit all of the lessons or all of the sections of a lesson in the tutorial. These findings led research Hypothesis 3 to be partially supported.

In the version of the HLS that provided visual instructional aids, no significant effects between cognitive style, domain knowledge and computer experience were found. For the group of the participants that had low DK and low CE, or low DK and high CE, cognitive style had no significant impact on learning performance, with both FD and FI users within the same experience profile performing equally well in the post-test and in the practical task, spending the same amount of time to complete the tutorial, and achieving higher gain scores. Additionally, both FD and FI users in these experience profile groups interacted a lot with the HLS to complete the exercises in the practical task, and visited all the sections of all the lessons that were included in the tutorial. However, FD users with one of these experience profiles took more time to complete the practical task than the FI users with the same experience profile. For the group of participants that had high DK and low CE, or high DK and high CE, similar findings to those gathered for the HLS that provided no instruction aids were identified. These findings mean that Hypothesis 4 was partially supported.

Finally, in terms of the third research question (RQ (1c)) and research hypotheses (5-6), for the HLS that provided no instructional aids, a significant effect was revealed between cognitive style, domain knowledge and computer experience in relation to attitudes. Cognitive style had a significant impact for those users with an experience profile of low DK and low CE, low DK and high CE, or high DK and low CE: FD users with one of these experience profiles showed negative attitudes towards the HLS, asserting that they were given too much flexibility as a result of the HLS structure, which led them to feel high levels of disorientation. In contrast, FI users with the same experience profile showed more positive attitudes towards the HLS, reporting that the non-linearity features that were offered by the HLS enabled them to make use of the flexibility in the tutorial, and to set their own learning paths in relation to their learning goals. For those learners with an experience profile of high DK and high CE, cognitive style did not have a significant effect, with both FD and FI learners showing a positive attitude towards the HLS mainly because of its non-linearity features. Hypothesis 5 was therefore partially supported.

In terms of the HLS that incorporated visual instructional aids, no significant effects were found between cognitive style, domain knowledge and computer experience, with all users showing a positive attitude towards the learning system. However, a significant effect was found between cognitive style, domain knowledge and computer experience with respect to the reasons for learners showing positive attitudes towards the HLS. For the group of participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant effect: unlike FI users with one of these experience profiles who showed a positive attitude towards the HLS mainly because of its non-linearity features, FD learners with the same experience profile asserted that they were satisfied with the HLS mainly because of the visual instructional aids. For the group of participants that had high DK and high CE, cognitive style did not show any significant impact, with both FD and FI learners, irrespective of the visual instructional aids, being satisfied learning in this type of HLS mainly because of its non-linearity features. These findings fully supported hypothesis 6.

Table 8.1: Summary of the findings in relation to the research questions and hypotheses for experiment 1

Research Questions	Results	Research Hypotheses	Results
Research Question 1(a) What are the effects between cognitive style (CS) – FD/FI, domain knowledge (DK) and computer experience (CE) on learners' levels of disorientation when using a HLS that includes a map and the visual orientational cues and when using a HLS without any instructional aids?	A significant effect was revealed between CS, DK and CE on disorientation in the HLS that provided no instructional aids. No significant effects were revealed between CS, DK and CE on disorientation in the HLS that provided visual instructional aids. However, significant effects were revealed between CS, DK and CE on the use of visual instructional aids to reduce disorientation in HLS.	**Research Hypothesis 1** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will experience higher levels of disorientation in the HLS that provides no instructional aids than FI users with the same experience profile.	Partially supported
		Research Hypothesis 2 Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will not experience higher levels of disorientation in the HLS that incorporates visual instructional aids.	Supported
Research Question 1(b) What are the effects between CS – FD/FI, DK and CE on learners' learning performance when using a HLS that includes a map and the visual orientational cues and when using a HLS without any instructional aids?	A significant effect was revealed between CS, DK and CE on learning performance in the HLS that provided no instructional aids. No significant effects were revealed between CS, DK and CE on learning performance in the HLS that provided visual instructional aids.	**Research Hypothesis 3** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform less well in the HLS that provides no instructional aids than FI users with the same experience profile.	Partially supported
		Research Hypothesis 4 Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform equally well in the HLS that incorporates visual instructional aids.	Supported
Research Question 1(c) What are the effects between CS – FD/FI, DK and CE) on learners' attitudes when using a HLS that includes a map and the visual orientational cues and when using a HLS without any instructional aids?	A significant effect was revealed between CS, DK and CE on attitudes in the HLS that provided no instructional aids. No significant effects were revealed between CS, DK and CE on attitudes in the HLS that provided visual instructional aids. However significant effects were revealed between CS, DK and CE on the cause for showing positive attitudes towards the HLS that provided visual instructional aids.	**Research Hypothesis 5** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show more negative attitudes towards the HLS that provides no instructional aids than FI users with the same experience profile.	Partially supported
		Research Hypothesis 6 Both FD and FI users with the same experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show positive attitudes towards the HLS that incorporates visual instructional	Supported

The next section summarises the findings in relation to the research questions and research hypotheses examined through experiment 2.

8.3.2 Research Questions, Research Hypotheses and Findings from Experiment 2

Three research questions (RQ 2(a-c)) and six research hypotheses (7-12) were addressed in experiment 2. The findings in relation to the research questions and hypotheses are presented in Table 8.2. The section now presents the findings relevant to research question 2(a) and to research hypotheses (7-8). With respect to the version of the HLS that provided no instructional aids, the results related to disorientation were similar to those gathered in experiment 1 that used the same version of the HLS (i.e., without instructional aids). To avoid duplication, the results will not be discussed here (instead, refer to the findings to research question 1(a) and research hypothesis 1 in section 8.3.1).

With regards to the HLS that incorporated audio instructional aids, no significant effects were revealed between cognitive style, domain knowledge and computer experience, with all users experiencing little, or no disorientation in the HLS. However, significant effects were found between cognitive style, domain knowledge and computer experience in relation to the use of the audio instructional aids to reduce disorientation in the HLS. For the group of participants with one of the following three experience profiles (low DK and low CK; low DK and high CK; or high DK and low CE), cognitive style had a significant impact: FD users with one of these experience profiles depended more heavily on the audio instructional aids to reduce disorientation than did FI users with the same experience profile. Conversely, for those users with an experience profile of high DK and high CE, cognitive style had no significant impact, with neither FD nor FI users with this experience profile depending on, or needing, audio instructional aids to reduce disorientation, as they did not experience this problem. These findings suggest that hypothesis 8 was fully supported.

Moving onto research question 2(b) and research hypotheses (9-10), for the HLS that provided no instructional aids, the findings related to learning performance were similar to those from experiment 1 in relation to the same version of HLS (i.e, without instructional aids) (see findings for research question 1(b) and research hypothesis 3 in section 8.3.1).

In the version of the HLS that incorporated audio instructional aids, no significant effects were found between cognitive style, domain knowledge and computer experience on learning performance in terms of post-test scores, practical task scores and time efficacy: FD and FI users within the same experience performed equally well in the post-test and in the practical task; and spent the same amount of time to complete the tutorial and the practical task. Additionally, no significant effects were found on learning performance in terms of gain scores: FD and FI users with one of the following two experience profiles, low DK and low CE, or low DK and high CE, achieved higher gain scores; and FD and FI users with one of the following two experience profiles, high DK and low CE, or high DK and low CE, achieved lower gain scores. However, similar to the findings gathered in experiment 1, compared to FD and FI users with the same experience profile (i.e., low DK and low CE, or low DK and high CE), FD and FI users with one of the following two experience profiles, high DK and low CE, or high DK and high CE, interacted less with the HLS to perform the practical task, and did not complete all of the sections of a lesson or all of the lessons in the tutorial. These findings, led hypothesis 10 to be fully supported.

Finally, with regards to research question 2(c) and research hypotheses (11-12), the following findings were indentified. In the version of the HLS that provided no instructional aids, the findings related to attitudes were similar to those gathered in experiment 1 with respect to the same version of the HLS (i.e., without instructional aids) (see the findings to research question 1(c) and research hypothesis 5 in section 8.3.1).

For the version of the HLS that provided audio instructional aids, significant effects were found between cognitive style, domain knowledge and computer experience in relation to attitudes. For the group of participants that had one of the following three experience profiles – low DK and low CE; low DK and high CE; or high DK and low CE – cognitive style had a significant impact. FD users with one of these experience profiles showed more positive attitudes towards the HLS: they reported that the audio instructional aids provided them with guided learning which, in turn, led them to learn effectively. In contrast, FI users with the same experience profile showed more negative attitudes towards the HLS: they argued that they were given no option other than to use the audio instructional aids for navigational purposes in the HLS; the structure in audio instructional aids were seen as too constraining, preventing them from setting their own navigation paths in the tutorial; and they said that they were sometimes distracted by the audio instructional aids while using them to perform their learning.

For the group of participants with an experience profile of high DK and high CE, cognitive style did not show a significant effect in relation to attitudes. Both FD and FI users with this experience profile showed negative attitudes towards the HLS for the following reasons: they were forced to use the audio instructional aids to perform their learning; the structure in the audio instructional aids prevented them from having high levels of control over the tutorial and high levels of freedom of navigation; and, finally, they were distracted or irritated when using the audio to navigate through the HLS. Hypothesis 12 was therefore partially supported.

Table 8.2: Summary of the findings in relation to the research questions and hypotheses for experiment 2

Research Questions	Results	Research Hypotheses	Results
Research Question 2(a) What are the effects between individual differences (cognitive style (CS) – FD/FI, domain knowledge (DK) and computer experience (CE)) on learners' levels of disorientation when using a HLS that incorporates instructional aids (in the form of audio elements) and when using a HLS without any instructional aids?	A significant effect was revealed between CS, DK and CE on disorientation in the HLS that provided no instructional aids. No significant effects were revealed between CS, DK and CE on disorientation in the HLS that provided audio instructional aids. However significant effects were revealed between CS, DK and CE on the use of audio instructional aids to reduce disorientation in HLS.	**Research Hypothesis 7** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; high DK and high CE) will experience higher levels of disorientation in the HLS that provides no instructional aids than FI users with the same experience profile.	Partially supported
		Research Hypothesis 8 Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will not experience higher levels of disorientation in the HLS that incorporates instructional aids (in the form of audio elements).	Supported
Research Question 2(b) What are the effects between individual differences (CS – FD/FI, DK and CE) on learners' learning performance (in terms of time efficacy, gain score and practical task score) when using a HLS that incorporates instructional aids (in the form of audio elements) and when using a HLS without any instructional aids?	A significant effect was revealed between CS, DK and CE on learning performance in the HLS that provided no instructional aids. No significant effects were revealed between CS, DK and CE on learning performance in the HLS that provided audio instructional aids.	**Research Hypothesis 9** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; high DK and high CE) will perform less well in the HLS that provides no instructional aids than FI users with the same experience profile.	Partially supported
		Research Hypothesis 10 Both FD and FI users with the same experience profile (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will perform equally well in the HLS that incorporates instructional aids (in the form of audio elements).	Supported
Research Question 2(c) What are the effects between individual differences (CS – FD/FI, DK and CE) on learners' attitudes when using a HLS that incorporates instructional aids (in the form of audio elements) and when using a HLS without any instructional aids?	A significant effect was revealed between CS, DK and CE on attitudes in the HLS that provided no instructional aids. A significant effect was revealed between CS, DK and CE on attitudes in the HLS that provided audio instructional aids.	**Research Hypothesis 11** FD users with one of the four experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; high DK and high CE) will show more negative attitudes towards the HLS that provides no instructional aids than FI users with the same experience profile.	Partially supported
		Research Hypothesis 12 Both FD and FI users with the same experience profiles (low DK and low CE; low DK and high CE; high DK and low CE; or high DK and high CE) will show positive attitudes towards the HLS that incorporates instructional aids (in the form of audio elements).	Partially supported

8.4 Contributions

The section discusses the contributions made by this thesis, through both its literature and empirical work. Section 8.4.1 presents the contributions in relation to visual instructional aids and HLS, and section 8.4.2 presents the contributions in relation to audio instructional aids and HLS.

8.4.1 Contributions in Relation to the Visual Instructional Aids (Experiment 1)

This thesis has made three contributions to the field with respect to visual aids and HLS: (i) it has identified and sought to address what are argued to be major gaps in research related to HLS, individual differences, visual instructional aids, disorientation, learning performance and attitudes; (ii) it has generated original empirical data through the use of this HLS by learners in an experimental setting; and (iii) through the analysis and interpretation of these data, it has framed a set of guidelines to inform the design of the HLS. Each of these contributions will now be discussed in turn.

First, the thesis has contributed to the field through the identification of gaps in the existing research into visual instructional aids and HLS. Though there are a number of empirical studies that have looked at the effects of the map (as a visual instructional aid) on disorientation, learning performance and attitudes in relation to individual differences (cognitive style, domain knowledge and computer experience), only one or two of these individual differences have been considered in any single study, rather than all three. Furthermore, though a number of studies have suggested that visual orientation cues – in form of breadcrumbs, graphic visualisation, history-based mechanism, highlighting context, page labels, pagination, different link colours and link annotation – can reduce disorientation for learners with different individual characteristics, such as cognitive style, domain knowledge and computer experience, the effects of and between these three characteristics with respect to disorientation, learning performance and attitudes have not been examined in a single HLS that incorporates all of these visual orientation cues.

To address these gaps, the research effort reported in this thesis designed, developed and implemented a single HLS which incorporated a map and set of visual orientation cues before empirically examining the effects of and between the three individual differences (cognitive style, domain knowledge and computer) in relation to learners' disorientation, learning performance and attitudes when using this version of HLS.

Second, by conducting a single study that addressed cognitive style, domain knowledge and computer experience in relation to the two versions of the HLS (without instructional aids and with visual instructional aids), and their impact on disorientation, learning performance and attitudes, a significant, original dataset has been generated, the analysis of which has led to new insights in the field. For the HLS that provided no instructional aids these insights include the following.

With regards to disorientation, for participants who had low DK and/or CE, cognitive style showed a significant effect, with FD users with one of these three experience profiles experiencing higher levels of disorientation in the HLS than FI users with the same experience profile. However, for participants with an experience profile of high DK and high CE, cognitive style did not have any significant effect, with neither FD nor FI users experienced disorientation in the HLS.

With respect to learning performance, for those participants that possessed low DK, irrespective of level of CE, cognitive style had a significant effect on learning performance, with FD users with one of these experience profiles performing less well than FI users with the same experience profile. Both FD and FI users with these experience profiles tended to interact a lot with the HLS in the tutorial and in the practical task. For those users with high DK, irrespective of level of CE, cognitive style did not have a significant effect on learning performance or level of interaction with the HLS: both FD and FI users with the same experience profile performed equally well, and interacted less with the HLS when using the tutorial and in undertaking the practical task.

In terms of attitudes, for participants with an experience profile of low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact, with FD users with one of these experience profiles showing more negative attitudes towards the HLS than FI users with the same experience profile. However, cognitive style did not have a significant impact for those participants that had high DK and CE:

both FD and FI users with this experience profile showed positive attitudes toward the non-linear environment.

For the HLS that incorporated visual instructional aids, the followings insights were gained. In terms of disorientation, for all four experience profile groups, cognitive style had no significant effects: both FD and FI users with the same experience profile experienced little or no disorientation in the HLS. However, for participants that had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant effect on the use of the visual instructional aids to reduce disorientation, with FD users with one of these experience profiles being more dependent on them to reduce disorientation than were FI users with the same experience profile. When DK and CE were high, cognitive style did not have a significant effect, with neither FD nor FI users with this experience profile being dependent on the visual instructional aids to reduce disorientation in the HLS.

With respect to attitudes, for all four experience profile groups, cognitive style did not have a significant effect, with both FD and FI users with the same experience profile showing positive attitudes towards the HLS. However, where users had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style seemed to influence their reasons for showing positive attitudes towards the HLS. For FD users with one of these experience profiles, it was because of the visual instructional aids, which assisted them in reducing their disorientation and which, in turn, improved their learning performance. In contrast, for FI users with the same experience profile positive attitudes were mainly related to the non-linearity features, which allowed users to set their own learning paths and to make use of the flexibility offered in the tutorial. For users who had high DK and high CE, cognitive style did not have a significant effect, with both FD and FI users with this experience profile favouring the HLS mainly because of its non-linearity features, which allowed them to enjoy high levels of freedom of navigation and to have more control over the tutorial.

In terms of level of interaction with the HLS and learning performance, where users had low DK, irrespective of the level of CE, cognitive style did not have significant effects.

Both FD and FI users with the same experience profile had high levels of interaction with the HLS to perform their learning, and performed equally well in learning tasks except with respect to time efficacy in the practical task – FD users with one of these experience profiles spent more time completing the practical task than did FI users with the same experience profile. Where users had high DK, irrespective of level of CE, cognitive style did not have a significant effect, with both FD and FI users with the same experience profile performing equally well in the learning tasks and interacting less with the HLS to complete the tutorial and the practical task.

Third, based on the findings from experiment 1, this study has made a contribution to the field through the development of specific guidelines for the design of the HLS. There are a number of existing studies that have suggested guidelines for the design of the HLS in relation to cognitive style, domain knowledge, computer experience, disorientation, learning performance and attitudes. However, these studies tend to consider one or two of these three individual differences, rather than all three. As discussed with respect to the previous contribution, the analysis of the data gathered from this empirical study has shown that when considering cognitive style, domain knowledge and computer experience together, cognitive style has a significant effect in only some cases on learners' disorientation, learning performance and attitudes in a HLS that provides no instructional aids, and on their use of the visual instructional aids to perform learning in HLS. For instance, this study has provided empirical evidence that when DK and CE are both high, both FD and FI learners have no difficulties learning in HLS, do not depend on or need visual instructional aids to perform their learning in HLS, and are not distracted by the visual instructional aids that are provided in the HLS. This makes it an important area to consider in the design of the HLS and one where design guidance should be helpful.

On the other hand, FD participants who have low DK and low DK, low DK and high CE, or high DK and low CE have more difficulties learning in the HLS and depend more on the visual instructional aids to perform their learning than do FI users with the same experience profile. Having design guidelines that frame these findings in an accessible way is important for the design and development of effective HLS.

Based on the findings, this study has framed a set of guidelines for the use of visual instructional aids in the design of the HLS that aim to support designers in building systems that reduce disorientation, support effective learning and enhance learning satisfaction, but do not cause detrimental effects to those users who do not depend on the additional support of visual aids in using HLS.

8.4.2 Contribution in Relation to the Audio Instructional Aids (Experiment 2)

This thesis has made three contributions to the field with respect to audio instructional aids and HLS: (i) it has identified and sought to address what have been argued to be major gaps in research related to HLS, individual differences, audio instructional aids, disorientation, learning performance and attitudes; (ii) it has gathered original empirical data through an experimental study in relation to a HLS developed with audio instructional aids; and (iii) through the analysis and interpretation of these data, the thesis has developed a set of guidelines support HLS design in relation to the set of individual differences considered in this work. Each of these contributions will now be discussed.

First, the thesis has identified gaps within the research literature related to HLS, individual differences (cognitive style, domain knowledge and computer experience) and audio instructional aids. Though a number of empirical studies have confirmed that instructional aids in the form of audio elements reduce disorientation, and increase learning performance in and positive attitudes towards, HLS, little, consideration has been given to individual differences, particularly to those considered in this thesis. This implies that the effects of and between cognitive style, domain knowledge and computer experience on learners' disorientation, learning performance and attitudes in a HLS that provides audio instructional aids have not been examined. This shortcoming has been addressed by the research reported in this thesis in two ways: (i) it has designed, developed and implemented a HLS which provided audio as instructional aids; and (ii) it has empirically examined the effects of and between cognitive style, domain knowledge and computer experience with respect to learners' disorientation, learning performance and attitudes when using a HLS that incorporates audio instructional aids.

Second, by conducting a single study that examined the effects of cognitive style, domain knowledge and computer experience when using the two versions of the HLS (one with no instructional aids; one with audio instructional aids) in relation to disorientation, learning performance and attitudes, a significant, original dataset has been generated, the analysis of which has led to new insights in the field. For the HLS that provided no instructional aids, the findings were similar to those gathered in experiment 1 (with respect to the same version of HLS – that provided no instructional aids). Therefore, to avoid duplication, the findings will not be discussed here (instead, refer to the second contribution in section 8.4.1).

For the HLS that incorporated audio instructional aids, the following insights were gathered. With regards to disorientation, for all four experience profile groups, cognitive style did not have a significant effect, with neither FD nor FI users experiencing higher levels of disorientation in the HLS. However, where learners had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had a significant impact on their use of the audio instructional aids to reduce disorientation: FD users with one of these experience profiles were more dependent on this form of instructional aid to reduce their disorientation issues compared to FI users with the same experience profile. Cognitive style did not have a significant effect for those users who had high DK and high CE, with neither FD nor FI users with this experience profile being dependent on the audio instructional aids to reduce disorientation in the HLS.

With respect to interaction with the HLS and learning performance, for participants who had low DK, irrespective of the level of CE, cognitive style did not have significant effects. Both FD and FI users with the same experience profile performed equally well in learning tasks and interacted a lot with the HLS to achieve their learning goals. Similarly, where users had high DK, irrespective of level of CE, cognitive style did not have a significant impact: Both FD and FI users with the same experience profile performed equally well in the learning tasks but had less interaction with the HLS to complete the tutorial and the practical task.

In terms of attitudes, for users who had low DK and low CE, low DK and high CE, or high DK and low CE, cognitive style had significant effects, with FD users with one of these three experience profiles showing more positive attitudes towards the HLS than did FI users with the same experience profile. FD users with one of these experience profiles asserted that the audio instructional aids assisted in reducing their higher levels of disorientation, which in turn allowed them to learn effectively. FI users showed negative attitudes towards this version of the HLS because they: had no option other than to use the audio to navigate through the HLS to perform their learning; were sometimes distracted by the audio; and were not given higher levels of flexibility in the tutorial. Where users had high DK and high CE, cognitive style did not have a significant effect either, with both FI and FD users with this experience profile showing negative attitudes towards this version of the HLS because they: were not offered high levels of freedom of navigation; had less control over the tutorial; were distracted by the audio; and were forced to use the audio instructional aids in the HLS to perform their learning.

Third, this study has made a contribution to the field through the development of HLS design guidelines in relation to the three individual differences (cognitive style, domain knowledge and computer experience). The analysis of the data gathered during experiment 2 suggests that the audio instructional aids supported FD users with low DK and low CE, low DK and high CE, and high DK and low CE in reducing the higher levels of disorientation that they experienced, which, in turn, led them to enhance their learning performance (with the exception of the FD participants with high DK and low CE who already had high prior knowledge of 'XHTML') and consequently, to show more interest learning in the HLS.

However, the analysis of the experiment 2 data suggests that not all users depend on, or need, audio aids to perform their learning in the HLS – for example, FI users with low DK irrespective of level of CE; FI users with high DK and low CE; and both FD and FI users with high DK and high CE. The analysis of the data further suggests that forcing all users to use audio instructional aids to navigate through the HLS causes detrimental effects to those users who do not depend on, or need them and leads to them showing less interest in learning in the HLS.

To reflect the findings in a form that can help designers, this study framed a set of guidelines related to the use of audio instructional aids in the design of the HLS. It is suggested that the effective use of the guidelines should lead to HLS which assist users in reducing their disorientation and enhancing their learning performance and learning satisfaction, while not disturbing those users who do not depend on the additional support provided by the audio instructional aids, ensuring that they continue to learn effectively and to show an interest in learning in the HLS.

8.5 Limitations of the Study

In attempting to answer the six research questions and the 12 research hypotheses, some issues may have limited the generalisability of this study. Limitations in relations to the two experiments in this research are now discussed. A first limitation relates to the sample of this study, which was made up of university students. University students were considered to be a suitable sample because this research relates to HLS and Higher Education and because most existing studies related to HLS have used university students as their subjects (as discussed in chapter 2). It is important to note that university students may be more educated than the general population, so the findings related to the use of the three versions of the HLS ((i) without instructional aids; (ii) with visual instructional aids; and (iii) with audio instructional aids) may have been different had the sample been drawn from the general population.

A second limitation is that (as discussed in chapter 4), with regards to experiment 2 learners were given no other option than using the audio instructional aids to navigate through the HLS to perform their learning. Chapter 4 argued that, since no studies had examined the effects between individual differences and audio instructional aids on learners' learning in HLS, this approach was useful to evaluate in isolation, with respect to individual differences, the effects of audio elements on learners' disorientation, learning performance and attitudes in HLS. This approach caused some users (for example, FD/FI with high DK and high CE; and FI with low DK and low CE, low DK and high CE, or high DK and low CE) to be distracted or irritated by the audio, to have low levels of control over the tutorial, or to have less flexibility in terms of navigation which, in turn, led them to show negative attitudes towards the HLS. Had a HLS which provided audio instructional aids as well as non-linearity features been designed and developed (similar to the case in experiment 1, where a HLS provided visual instructional aids as well as non-linearity features), the findings may well have been different. For example, it may be that learners: would not have been distracted or irritated; would have had higher levels of control over the tutorial; and would have had higher levels flexibility in terms of navigation which, in turn, would have led them to show more positive attitudes towards the HLS.

A third limitation of this research is that, in both experiments, the learning content of the 'XHTML' was presented and explained using text and images. Some of the participants in this study were registered as having dyslexia, and their understanding of the learning content presented as text and images may have limited these participants' reading abilities and, in turn, may have hindered their learning performance and may have caused them to show less interest in the HLS. The findings related to learning performance and attitudes may have been different had an appropriate approach to overcome the dyslexia issue (for example, the use of audio to explain the learning content) been employed.

It may be argued that a final limitation of this research is that, with regards to experiment 1, a search tool was not provided in either version of the HLS. As a result, some participants (especially those who had prior knowledge of the learning content) may have had to browse or use the index tool whenever they needed to find specific information in relation their learning goals in the tutorial or when looking for information to answer the exercises in the practical task. However, the analysis of the data gathered from the open-ended questionnaires and semi-structured interviews overall, showed that, participants did not mention the lack of a search tool as an issue, possibly because of the availability of the index tool and/or the high levels of freedom of navigation offered to them in the HLS. The lack of a search tool may have run counter to the normal expectations of users of such systems, but not having one allowed behaviour in relation to the navigational aids that were being studied to be appraised.

Having discussed the limitations of the study, the next section presents recommendations for the future research emerging from this study.

8.6 Future Research

The findings and the identified limitations are useful in identifying areas for future research, which are now presented and considered.

With regards to the first limitation discussed in section 8.5, and with regards to the same set of individual differences considered in this thesis, this study could be replicated to examine the effects of instructional aids (visual and audio) on learners' disorientation, learning performance and attitudes, with a sample drawn from the general population. Using a sample drawn from the general population may encourage researchers to consider the effects of an even wider range of individual differences alongside cognitive style, domain knowledge and computer experience. Other factors such as age, educational level, ability to use computers and their applications may prove worthwhile to study. The results may guide designers in the design and development of HLS, with the aim of supporting the general population to learn more effectively and to show more positive attitudes towards HLS.

In terms of the second limitation, a HLS that provides non-linearity features as well as audio instructional aids could be designed and developed. The effects between and of individual differences (cognitive style, domain knowledge and computer experience) on learners' disorientation, learning performance and attitudes when using this version of the HLS could then be explored. The results would help to identify whether, when using this version of the HLS, learners learn effectively and enhance their learning satisfaction, or whether it still causes detrimental effects to some of the users, especially those who do not seem to need instructional aids in the HLS. This, in turn, should further help to frame specific guidelines of value in the design of the HLS.

With respect to the third limitation, further studies could be designed to examine the effects of audio (in terms of explaining the learning content) on disorientation, learning performance and attitudes and in relation to the same set of individual differences considered in this study, but with a sample of learners who have dyslexia. The results may help to identify whether this approach to using audio supports these learners in overcoming the issues associated with their dyslexia or whether problems still persist.

This, in turn, may help frame guidance for designers of HLS in relation to learners with dyslexia, having taken into consideration their cognitive style, domain knowledge and computer experience, with the aim of increasing learning performance and learning satisfaction in HLS.

In terms of the findings that were gathered in this study, the section now considers two other areas where further research could be undertaken in relation to the design of the HLS. Firstly, as justified in Chapter 3, this study used three individual difference factors – cognitive style, domain knowledge and computer experience – but chose not to consider gender, to examine their combined impact on disorientation, learning performance and attitudes when using a HLS that incorporated instructional aids (visual or audio). Future research could incorporate gender as a variable, to investigate the effects between domain knowledge and computer experience on learners' disorientation, learning performance and attitudes in HLS that incorporate visual or audio instructional aids. The results may help to identify any needs, support, preferences and opinions associated with males and females with different levels of domain knowledge and computer experience when using a HLS with and without instructional aids. The results from such study might help designers to better design HLS for male and female learners with different levels of domain knowledge and computer experience such that they learn more effectively and show more interest in learning in this type of learning environment. Further studies could also be conducted to examine the effects of gender and cognitive style (FD/FI) on disorientation, learning performance and attitudes in relation to two versions of HLS (visual or audio).

Secondly, this study has examined the effects between individual differences (cognitive style, domain knowledge and computer experience) on learners' disorientation, learning performance and attitudes when using a HLS that provided no instructional aids and when using a HLS that provided visual instructional aids. The results have shown that those users who did not depend or did not need the visual instructional aids in the HLS (for example, FD/FI users with high DK and high CE; and FI users with low DK and low CE, low DK and high CE, or high DK and low CE) performed well in learning tasks, experienced little or no disorientation, and, overall, showed a positive attitude towards this version of HLS. It was argued that this was because the users in these groups were not disturbed by these visual instructional aids, and still enjoyed the non-linearity which they normally prefer in HLS. It is yet to be ascertained, however, how the users in these groups will perform, what attitudes they will show, and whether they will experience higher levels of disorientation when they have no option other than to use the visual instructional aids to navigate through the HLS to perform their learning. Further studies could be conducted to examine the effects between individual differences (cognitive style, domain knowledge and computer experience) on disorientation, learning performance and attitudes when learners are forced to use the visual instructional aids in the HLS to perform their learning. The results may help to identify issues that could inform further guidelines for the design of HLS in relation to FD and FI users with different levels of domain knowledge and computer experience.

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APPENDIX A: EXPLORATORY PHASE

A.1 Experimental Protocol

Thank you for taking your time participating in this experimental study. There are a total of nine phases in this experiment, and you will be given a short break in between these phases. The phases are as follows:

1. Cognitive Style Assessment: You will use a program to identify your cognitive style. Time taken will be around 10-15 minutes.
2. Survey: You will be first asked to provide information on your demographic information, such as gender, age and so on. Additionally your levels of computer experience, levels of prior knowledge of ‘XHTML’ and other programming languages are essential to be recorded to support this study, and all of your information will be kept confidential.
3. Pre-Test: This test will support this study to determine your levels of prior knowledge of the learning content of ‘XHTML.’ Your score will be strictly kept confidential. A maximum time to complete this test is 15 minutes.
4. HLS and interaction: You will be given a Hypermedia learning system to learn XHTML. There are a total of seven lessons in this tutorial.
5. Practical task: Once you have completed the tutorial, you will be required to perform five exercises – in the form of designing web pages – as part of a practical task. You can interact with the HLS to complete the exercises.
6. Post-test: This test will assess your learning outcomes having used the HLS to learn ‘XHTML.’ Maximum time to complete this test is 15 minutes.
7. Attitude Questionnaire: This questionnaire will enable you to provide us your attitudes towards the HLS which you were given to complete learning tasks. Time taken to complete this questionnaire will be 10 minutes.
8. Semi-structured interview: In this phase, we will ask your opinions, beliefs, experiences, suggestions about the HLS that you used to perform learning tasks. Your responses will be strictly kept confidential.
9. End of the study: Once more, we will thank you for participating in the experiment along with the provision of agreed incentive.

Any questions before we start?

A.2 Demographic Information

Participant No.: ________________

Your information will be strictly kept confidential. Please tick one box for each question.

Q1. Gender Male ☐ Female ☐

Q2. Your age 18-23 ☐ 24 - 29 ☐ 30-35 ☐ 36 above ☐

Q3. Currently you are:

Undergraduate ☐ Postgraduate (Masters) ☐

Postgraduate (PhD) ☐

Other (please specify :____)

Q4. Course area:

Arts ☐ Health Science ☐

Business ☐ Law ☐

Computing and Maths ☐ Sports and Education ☐

Engineering and Design ☐ Social Science ☐

Other (please specify :____)

Q5. Do you consider yourself to have a specific disability or learning difficulty that you have declared to the University? Yes ☐ No ☐

Please state the nature of your disability *(Optional)* _____________________

A.3 Computer Experience/Domain Knowledge

Participant No.: ___________________

Instructions:

1. *The following items pertain to your experience with computer applications and programming languages.*
2. *There are no right or wrong answers.*
3. *Please state your opinions as accurately as possible*
4. *Please tick the position that best describes your expertise with computers.*

Key:

(1) Novice
(2) Intermediate
(3) Expert

<u>Question 1</u>
How would you rate yourself in relation to the following computer applications?

		1 = Novice	**2 = Intermediate**	**3 = Expert**
(i)	Word processing			
(ii)	Spreadsheet			
(iii)	Access			
(iv)	PowerPoint			
(v)	Internet			
(vi)	Web based learning systems			
(vii)	*Overall, how would you rate yourself in terms of your levels of computer experience?*			

<u>Question 2</u>
How would you rate yourself in relation to the following Web Page applications?

		1 = Novice	**2 = Intermediate**	**3 = Expert**
(ii)	HTML (Hypertext Mark-up Language)			
(ii)	XHTML (Extensible Hypertext Mark-up Language)			
(iii)	*Overall, how would you rate yourself in terms of your levels of knowledge of designing web pages?*			

<u>Question 3</u>
How would you rate yourself in relation to the following programming languages?

		1 = Novice	**2 = Intermediate**	**3 = Expert**
(i)	Java			
(ii)	Visual Basic			
(iii)	C++			
(iv)	*Overall, how would you rate yourself in terms of your levels of knowledge of programming languages?*			

A.4 (a) Disorientation Questionnaire in Relation to Both Experiments before the Pilot Study

Participant No: ________

Instruction:

- *Please circle the most appropriate number for each question in relation to levels of disorientation in the Hypermedia Learning System*

Question 1
I know my current location in the HLS.

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 2
Being on a current page, I know what I was reading previously in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 3
Being on a current page, I know where to go next in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 4
I know how to reach my desired location in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

A.4 (b) Disorientation Questionnaire in Relation to Both Experiments after the Pilot Study

Participant No: _______

Instruction:

- *Please circle the most appropriate number for each question in relation to levels of disorientation in the Hypermedia learning system*

Key:

(0) Strongly disagree
(1) Disagree
(2) Slightly disagree
(3) Neither
(4) Slightly agree
(5) Agree
(6) Strongly agree

<u>Question 1</u>
I know my current location in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>Question 2</u>
Being on a current page, I know what I was reading previously in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>Question 3</u>
Being on a current page, I know where to go next in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 4

I know how to reach my desired location in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

A.5 (a) Attitudes Scale Questionnaire in Relation to the HLS with NO instructional Aids before the Pilot Study

Participant No: _______

SECTION A:

Instruction:

- *Please circle the response that best indicates your attitudes towards the HLS that you were given for the following questions*

Question 1
Overall, I like the structure that is offered in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 2
I experience difficulties navigating through the HLS to perform my learning

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 3
I enjoy high levels of freedom of navigation in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 4
Overall, I experience high levels of disorientation in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 5
Overall, I am satisfied learning in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

SECTION B

Please take the time to reply briefly in your own words to the following question

Question
Overall, are you satisfied learning in this Hypermedia learning system? Give reasons to justify your answer.

A.5 (b) Attitudes Scale Questionnaire in Relation to the HLS with No instructional aids after the Pilot Study

Participant No: _______

SECTION A

Instruction:

- *Please circle the response that best indicates your attitudes towards the HLS that you were given for the following questions*

Key:

(0) Strongly disagree
(1) Disagree
(2) Slightly disagree
(3) Neither
(4) Slightly agree
(5) Agree
(6) Strongly agree

Question 1
Overall, I like the structure that is offered in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 2
I experience difficulties navigating through the HLS to perform my learning

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 3
I enjoy high levels of freedom of navigation in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 4
Overall, I experience high levels of disorientation in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 5
Overall, I am satisfied learning in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

SECTION B

Please take the time to reply briefly in your own words to the following question

Question
Overall, are you satisfied learning in this Hypermedia learning system? Give reasons to justify your answer.

A.6 (a) Attitudes Scale Questionnaire in Relation to the HLS with Visual Instructional Aids before the Pilot Study

Participant No: _______

<u>SECTION A</u>

Instruction:

- *Please circle the response that best indicates your attitudes towards the HLS that you were given for the following questions*

<u>Question 1</u>
Overall, I like the structure that is offered in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>Question 2</u>
I experience difficulties navigating through the HLS to perform my learning”

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>Question 3</u>
I enjoy the levels of freedom of navigation that are offered in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 4
Overall, I experience high levels of disorientation in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 5
I am totally dependent on the visual instructional aids to reduce my levels of disorientation in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 6
I am distracted by the visual instructional aids when learning in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 7
Overall, I am satisfied learning in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

SECTION B
Please take the time to reply briefly in your own words to the following question

Question
Overall, are you satisfied learning in this Hypermedia learning system? Give reasons to justify your answer.

A.6 (b) Attitudes Scale Questionnaire in Relation to the HLS with Visual Instructional Aids after the Pilot Study

Participant No: _______

SECTION A

Instruction:

- *Please circle the response that best indicates your attitudes towards the HLS that you were given for the following questions*

Key:

(0) Strongly disagree
(1) Disagree
(2) Slightly disagree
(3) Neither
(4) Slightly agree
(5) Agree
(6) Strongly agree

Question 1
Overall, I like the structure that is offered in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 2
I experience difficulties navigating through the HLS to perform my learning

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>Question 3</u>
I enjoy the levels of freedom of navigation that are offered in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>Question 4</u>
Overall, I experience high levels of disorientation in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>Question 5</u>
I am totally dependent on the visual instructional aids to reduce my levels of disorientation in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>Question 6</u>
I am distracted by the visual instructional aids when learning in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>Question 7</u>
Overall, I am satisfied learning in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

<u>SECTION B</u>
Please take the time to reply briefly in your own words to the following question

Overall, are you satisfied learning in this Hypermedia learning system? Give reasons to justify your answer.

A.7 (a) Attitudes Scale Questionnaire in Relation to the HLS with Audio Instructional Aids before the Pilot Study

Participant No: _______

SECTION A

Instruction:

- *Please circle the response that best indicates your attitudes towards the HLS that you were given for the following questions*

Question 1
Overall, I like the structure that is offered in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 2
I experience difficulties navigating through the HLS to perform my learning

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 3
I am happy with the levels of freedom of navigation that is offered in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 4
Overall, I experience high levels of disorientation in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 5
I prefer a HLS in which I have to interact with the audio instructional aids to perform my learning

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 6
I am distracted by the audio instructional aids while performing my learning in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 7
Overall, I am satisfied learning in the HLS

Strongly disagree			Neither			Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

SECTION B
Please take the time to reply briefly in your own words to the following question

Question
Overall, are you satisfied learning in this Hypermedia learning system? Give reasons to justify your answer.

A.7 (b) Attitudes Scale Questionnaire in Relation to the HLS with Audio Instructional Aids after the Pilot Study

Participant No: _______

SECTION A

Instruction:

- *Please circle the response that best indicates your attitudes towards the HLS that you were given for the following questions*

Key:

(0) Strongly disagree
(1) Disagree
(2) Slightly disagree
(3) Neither
(4) Slightly agree
(5) Agree
(6) Strongly agree

Question 1
Overall, I like the structure that is offered in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 2
I can navigate effectively through the HLS to perform my learning

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 3
I am happy with the levels of freedom of navigation that is offered in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 4
Overall, I experience high levels of disorientation in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 5
I prefer a HLS in which I have to interact with the audio instructional aids to perform my learning

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 6
I am distracted by the audio instructional aids while performing my learning in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

Question 7
Overall, I am satisfied learning in the HLS

Strongly disagree	disagree	Slightly disagree	Neither	Slightly agree	agree	Strongly agree
0	**1**	**2**	**3**	**4**	**5**	**6**

SECTION B
Open-ended question

Please take the time to reply briefly in your own words to the following question

Question

Overall, are you satisfied learning in this Hypermedia learning system? Give reasons to justify your answer.

A.8 Structural Knowledge – Pre-test Questions

Participant number: _______

Purpose of the test:

- *The purpose of this test is to measure your learning outcomes having used the HLS to learn* ***Extensible Hypertext Mark-up Language*** *(XHTML).*

- *There are 20 questions in total, and there is* ***only one correct answer*** *for each question.*

- *Each mark is worth 1 mark*

- *Please select the best answer for the following questions.*

---

1. **What is the term XHTML stand for?**
   A. Extra Hyperlinks and Text Mark-up Language
   B. Extensible HyperText Marking Language
   C. Extensible HyperText Mark-up Language
   D. Extreme HyperText Mark-up Language
   E. I do not Know

2. **Which of the following will be replaced by XHTML?**
   A. VB
   B. XML
   C. PHP
   D. JAVA
   E. I do not know

3. **Which of the following is correct in XHTML?**
   A. The code is generally used in Uppercase
   B. All tags have a start and end tag <> </>
   C. All XHTML tags and attributes must be in lower case
   D. All elements in XHTML must be open
   E. I do not know

4. **What elements are mandatory in XHTML documents?**
   A. html,_head, and body
   B. doctype, html, body
   C. doctype, html, head, body, and title
   D. html, body, title, and head
   E. I do not know

5. What are the different DTDs in XHTML?

A. Strict, Transitional, Loose
B. Strict, Transitional, Loose, Frameset
C. Strict, Transitional and Frameset
D. Strict, Loose and Frameset
E. I do not know

6. What is the most common XHTML DTD?

A. Normal
B. Transitional
C. Loose
D. Frameset
E. I do not know

7. What XHTML code will make the text bold in an XHTML document?

A. This is bold
B. </strongThis is bold
C. <STRONG>This is bold
D. This is bold
E. I do not know

8. What is the correct XHTML tag for a line break?

A.
B.
C. <break>
D. </br>
E. I do not know

9. Which of the following is correct for heading tags in an XHTML doc?

A. Heading tag 8 <h8></h8> is the smallest heading tag
B. Heading tag 8 <h8></h8> is the highest heading tag
C. Heading tag 6 <h6></h6> is the smallest heading tag
D. Heading tag 6 <h6>/h6> is the highest heading tag
E. I do not know

10. Which of the following show the correct use of ordered list?

A. <ul start = “2” type="I">
This is item 1
This is item 2

B. <ol start="2" type="I">
This is item 1
This is item 2

C. <ol start="2" type="I">
<list>This is item 1</list>

<list>This is item 2</list>

D. <ol start="2" type="I">
This is item 1
This is item 2
</l>

E. I do not know

11. Which is the correct declaration for an italic text inside a paragraph?
A. <p> here is an emphasized.<em>paragraph</p> .
B. </i><p>here is an emphasized.<i>paragraph</i>.</p>
C. <p>here is an emphasized.<i>paragraph</i>.</p>
D. <p> here is an emphasized.<i>paragraph</p>.</i></p>
E. I do not know

12. Which of the following is not used for list?
A. < li>
B.
C.
D. <em>
E. I do not know

13. Which of the following is used to create list?
A. <./li\>
B. <lo>
C. <ul//>
D. <em>
E. I do not know

14. What is the correct XHML tag to add rows to tables?
A. < td> and </td>
B. <cr> and </cr>
C. <tr> and </tr>
D. All of the above
E. I do not know

15. colspan = ‘x’ can be added to what tag?
A. <tr>
B. <td>
C. <table>
D. <tr> and <td>
E. I do not know

16. What is the function of cellpadding?
A. It increases the space between cells
B. It increases the distance between cells and content
C. It increases the width and height between content

D. It stretches the rows and columns
E. I do not know

17. What does “a href” mean?
A. “a” means the beginning, “href” means the end
B. “a” means the start of a hyperlink, “href” means the destination
C. “a” means the destination, “href” means the start of a hyperlink
D. None of the above
E. I do not know

18. An image called **"button.jpg"** is located in the folder **"pics"**, what XHTML code would insert the image into a web page if the page was in a folder one level above the folder **"pics"**?
A.
B.
C.
D.
E. I do not know

19. Using Hspace **will add which of the following to your image?**
A. height to all sides
B. space to left and bottom
C. space to left and right
D. space between contents
E. I do not know

20. What XHTML tag is used to start a link?
A. </>
B. <start here>
C. <a>
D. <l>
E. I do not know

A.9 Structural Knowledge – Post-test Questions

Participant number: _______

Purpose of the test:

- *The purpose of this test is to measure your learning outcomes having used the HLS to learn **Extensible Hypertext Mark-up Language** (XHTML).*

- *There are 20 questions in total, and there is **only one correct answer** for each question.*

- *Each mark is worth 1 mark*

- *Please select the best answer for the following questions.*

---

1. **Which of the following will be replaced by XHTML?**
   A. VB
   B. XML
   C. PHP
   D. JAVA
   E. I do not know

2. **What is DTD?**
   A. A method tied to an object
   B. A Detrimental Transitional Development
   C. A Document Type Declaration
   D. A Definitive Type Declaration
   E. I do not know

3. **What is the most common XHTML DTD?**
   A. Loose
   B. Normal
   C. Transitional
   D. Frameset
   E. I do not know

4. **Which XHTML code will make the text bold in an XHTML document?**
   A. **</** strong>This is bold
   B. </strongThis is bold <strong
   C. <STRONG>This is bold
   D. This is bold
   E. I do not know

5. What is the most common XHTML DTD?

A. Normal
B. Loose
C. Transitional
D. Frameset
E. I do not know

6. What does XHTML stand for?

A. Extra Hyperlinks and Text Mark-up Language
B. Extreme Hypertext Mark-up Language
C. Extensible Hypertext Marking Language
D. Extensible HypertText Mark-up Language
E. I do not know

7. To add rows to tables, which XHTML tag do we use?

A. <tr> and </tr>
B. <cr> and </cr>
C. <td and </td>
D. All of the above
E. I do not know

8. What XHTML tag is used to create list?

A.
B. <em//>
C. <//ul>
D. <//li\\>
E. I do not know

9. What XHTML tag is used to start a link?

A. <start here>
B. **</>**
C. <l>
D. <a>
E. I do not know

10. An image called **"tree.jpg"** is located in the folder **"picture"**, what XHTML code would insert the image into a web page if the page was in a folder one level above the folder **"picture"**?

A.
B.
C.
D.
E. I do not know

11. What elements are mandatory in XHTML documents?

A. html**,** head, and body
B. doctype, html, body
C. doctype, html, head, body, and title
D. html, body, title, and head
E. I do not know

12. What is the correct XHTML tag for a line break?

A.
B. </br>
C. <break>
D.
E. I do not know

13. Which of the following is used for linking?

A. hreftag
B. Anchor tag
C. Relative Pathnames
D. Absolute Pathnames
E. I do not know

14. What is the function of cellpadding?

A. It increases the space between cells
B. It increases the distance between cells and content
C. It increases the width and height between content
D. It stretches the rows and columns
E. I do not know

15. What are the different DTDs in XHTML?

A. Strict, Loose and Frameset
B. Strict, Transitional, Loose
C. Strict, Transitional and Frameset
D. Strict, Transitional, Loose, Frameset
E. I do not know

16. Which of the following show the correct use of ordered list?

A. <ul start = “2” type="I">
This is item 1
This is item 2

B. <ol start="2" type="I">
This is item 1
This is item 2

C. <ol start="2" type="I">
<list>This is item 1</list>

<list>This is item 2</list>

D. <ol start="2" type="I">
This is item 1
This is item 2
</l>
E. I do not know

17. colspan = ‘x’ can be added to which of the following?
A. <tr>
B. <td>
C. <table>
D. <tr> and <td>
E. I do not know

18. Using Hspace will add which of the following to your image?
A. space to left and right
B. space to left and bottom
C. height to all sides
D. space between contents
E. I do not know

19. Which is the correct declaration for an italic text inside a paragraph?
A. <p> here is an emphasized.>strong>paragraph.</p>
B. <p> here is an emphasized.<em>paragraph</p>
C. <p> here is an emphasized.paragraph</p>.</p>
D. <p>here is an emphasized.paragraph.</p>
E. I do not know

20. Which of the following is used in XHTML?
A. The code is generally used in Uppercase
B. All tags have a start and end tag <> </>
C. All XHTML tags and attributes must be in lower case
D. All elements in XHTML must be open
E. I do not know

A.10 (a) Practical Task Questions before the Pilot Study

Participant number: _______

Instructions:

1. *In this phase of the study you are required to complete a practical task, which include a total of five exercises. The exercises are related to the learning content of XHTML that you referred to earlier in the tutorial.*
2. *You will need to use the notepad application to perform the exercises.*
3. *You can interact with the HLS to perform the exercises.*
4. *Before you start the exercises, create a folder on the desktop and name it as your participant number which you were given at the start of this experiment (for example, 0014). Pease ask the researcher your participant number in case you do not know.*

Learning outcomes:

Having completed these exercises you will be able to:

1. Create a basic web page
2. Format text
3. Create different type of lists
4. Add images to your pages
5. Use links
6. Create and Insert tables to your pages

Exercise 1:

1. Create a page in a file named **`empty.html`**, with Transitional DOCTYPE and with no text in the body. Type **empty.html** between the **`title`** tags. Verify that this shows up on the top of your browser window when you load the page.

   Note: make sure you save your file in your folder.

2. Make a copy of **`empty.html`**, named it **`index.html`**, and perform the following:
   1) Change the title (between the title tags) as "Bank holidays UK!"
   2) Type the following text – Bank holidays in UK are holidays when banks and many other businesses are closed for the day. Public holidays are holidays which have been observed through custom and practice. – between heading<h4></h4> tags inside the body of your document.
   3) Save the '`index.html`' file in your folder.

Exercise 2:

Make a copy of **`empty.html`** and named is as **`exercise2.html`**. Use the Transitional as DOCTYPE and insert "**Exercise 2**" between the **`title`** tags. Use the exercise.html file to perform the following:

1. Copy and paste the content from the file named ex2 (which is available in the practical task folder on the desktop) inside the body tag.
2. By referring to **page 3** (with heading labelled 'Health Benefit of exercises') from your printed task sheet, make the adjustments that are required.
3. Save exercise 2 in your folder.

The following document accompanies Exercise 2

Apply as second level heading, left aligned, font specification as verdana and font style as bold.

Apply as first level heading, aligned centre, and with font style as bold.

Health Benefits of Exercise

Apply as second level heading, left aligned, font specification as verdana and font style as bold

Health Benefits of Exercise

Regular exercise can help protect you from heart disease and stroke, high blood pressure, noninsulin-dependent diabetes, obesity, back pain, osteoporosis, and can improve your mood and help you to better manage stress.

For the greatest overall health benefits, experts recommend that you do 20 to 30 minutes of aerobic activity three or more times a week and some type of muscle strengthening activity and stretching at least twice a week. However, if you are unable to do this level of activity, you can gain substantial health benefits by accumulating 30 minutes or more of moderate-intensity physical activity a day, at least five times a week.

If you have been inactive for a while, you may want to start with less strenuous activities such as walking or swimming at a comfortable pace. Beginning at a slow pace will allow you to become physically fit without straining your body. Once you are in better shape, you can gradually do more strenuous activity.

Apply as third level heading, left aligned, font specification as verdana, font style as bold and font colour as medium purple.

How Physical Activity Impacts Health

Regular physical activity that is performed on most days of the week reduces the risk of developing or dying from some of the leading causes of illness and death in the United States.

- Reduces the risk of dying prematurely.
- Reduces the risk of dying prematurely from heart disease.
- Reduces the risk of developing diabetes.
- Reduces the risk of developing high blood pressure.
- Helps reduce blood pressure in people who already have high blood pressure.
- Reduces the risk of developing colon cancer.
- Reduces feelings of depression and anxiety.
- Helps control weight.
- Helps build and maintain healthy bones, muscles, and joints.
- Helps older adults become stronger and better able to move about without falling.
- Promotes psychological well-being

Apply as third level heading, left aligned, font specification as verdana, font style as bold and font colour as medium purple.

Specific Health Benefits of Exercise

Heart Disease and Stroke. Daily physical activity can help prevent heart disease and stroke by strengthening your heart muscle, lowering your blood pressure, raising your high-density lipoprotein (HDL) levels (good cholesterol) and lowering low-density lipoprotein (LDL) levels (bad cholesterol), improving blood flow, and increasing your heart's working capacity.

High Blood Pressure. Regular physical activity can reduce blood pressure in those with high blood pressure levels. Physical activity also reduces body fatness, which is associated with high blood pressure.

Apply font style as bold and font size of 10.

Exercise 3:

Copy **`empty.html`** to a new page called **`exercise3.html`** and perform the following:

1. Create a level 1 heading titled "Cocktails", and aligned it left.
2. Below the title insert a horizontal bar.
3. Below the horizontal bar, insert the image 'image.jpg' with border = 0 **(the image is available in the practical task folder on the desktop)**
4. Create a line break and insert the following texts with paragraphs:-

   Paragraph 1: *Cocktail making can be appreciated by everyone from the beginner to the bar expert and with so many choices of cocktails on offer, you would be hard-pushed not to find satisfaction.*

   Paragraph 2: *We hope you benefit from the extensive database of new and classic cocktails, the hints and tips we have made available and of course the ingredients and equipment with which to make them.*

5. **From (4),** change the font style as italic, the font size to 11 and font specification to Arial.
6. Use hspace of value 80 and vspace of value 80 to align the above image to the left.
7. Save exercise 3 in your folder.

Exercise 4:

Copy **`empty.html`** to a page called **`exercise4.html`** and perform the following:

1. Create a heading (using **`<h2></h2> tags`**) and with title "My Web Site."
2. Below the heading create an unordered list containing links of the following three exercises that you have done so far:

   index.html – Index

   exercise2.html – Exercise 2

   exercise3.html – Exercise 3

   empty.htm – Empty

3. Create a new heading, of level 2, and of title 'My Favourite Sites.' Create an ordered list of two absolute links to your favourite websites, where the target must be blank.
4. Using the image named **home.gif (which is available in the practicaltask folder on the desktop)**, show how you are going to use it as a relative link to access to the file 'index.html.'
5. Save exercise 4 in your folder.

Exercise 5:

Copy **`empty.html`** to a new page called **`excercise5.html`** and perform the following:

1. Create a table with four rows and three columns, with border with of '1'.
2. From (i) change the border colour to blue. Insert the image called 'homepage.gif' **(which is available in the practical task folder on the desktop)** in the left column.
3. Insert the image called pussy.gif **(which is available in the practical task folder on the desktop)** in the right column.
4. Save exercise 5 in your folder.

Exercise 6:

Copy **`empty.html`** to a new page called **`excercise6.html`** and perform the following:

1. Create the link to the following search engines:
    a. Google
    b. Yahoo
    c. AltaVista
    d. Lycos

2. Create links to the any three of the exercises that you have done so far, which need to be opened in a new window.
3. Create a link at the top of your page, which will enable us to jump all the way to the bottom of the page. Additionally, create a link at the bottom of that page which will enable us to shift back to the top of the page.
4. Save exercise 6 in your folder.

Exercise 7:

Copy **`empty.html`** to a new page called **`excercise7.html`** and then, perform the following:

1. Type the following text: *'My family has a number of cars. Their names and the cars that they drive are presented in the Table below.'*
2. Create a table above the text to show the following information:

Name	Relation	Car
Paul	Brother	BMW
Jason	Brother	Porsche
Jane	Sister	Koenigsegg
Dona	Sister	Ferrari Enzo

3. Add a border of width = 1 to your table.

4. Add a caption ‘My family and cars’; and the following three headers – Name, Relation and Car to your table.
5. Save exercise 7 in your folder.

A.10 (b) Practical Task Questions after the Pilot Study

Participant number: ________

Instruction:

1. *In this phase of the study you are required to complete a practical task, which include a total of five exercises. The exercises are related to the learning content of XHTML that you referred to earlier in the tutorial.*
2. *You will need to use the notepad application to perform the exercises.*
3. *You can interact with the HLS to perform the exercises.*
4. *Before you start the exercises, create a folder on the desktop and name it as your participant number which you were given at the start of this experiment (for example, 0014). Pease ask the researcher your participant number in case you do not know.*

Learning outcomes:

Having completed these exercises you will be able to:

1. Create a basic web page
2. Format text
3. Create different type of lists
4. Add images to your pages
5. Use links
6. Create and Insert tables to your pages

Exercise 1:

1. Create a page in a file named **`empty.html`**, with Transitional DOCTYPE and with no text in the body. Type **empty.html** between the **`title`** tags. Verify that this shows up on the top of your browser window when you load the page.

   Note: make sure you save your file in your folder.

2. Make a copy of **`empty.html`**, named it **`index.html`**, and perform the following.
   1) Change the title (between the title tags) as "Bank holidays UK!"
   2) Type the following text – Bank holidays in UK are holidays when banks and many other businesses are closed for the day. Public holidays are holidays which have been observed through custom and practice. – between heading<h4></h4> tags inside the body of your document.
   3) Save the `'index.html'` file in your folder.

Exercise 2a:

Make a copy of empty.html and named is as **`exercise2.html`**. Use the Transitional as DOCTYPE and insert "**Exercise 2**" between the **`title`** tags. Use the **`exercise2.html`** file to perform the following:

1. Copy and paste the content from the file named ex2 (which is available in the practical task folder on the desktop) inside the body tag.
2. By referring to **page 3** (with heading labelled 'Health Benefit of exercises') from your printed task sheet, make the adjustments that are required.
3. Do not close your file yet.
4. Refer to exercise 2b.

The following document accompanies Exercise 2a/b

Apply as second level heading, left aligned, font specification as verdana and font style as bold.

Apply as first level heading, aligned centre, and with font style as bold.

Health Benefits of Exercise

Apply as second level heading, left aligned, font specification as verdana and font style as bold.

Health Benefits of Exercise

Regular exercise can help protect you from heart disease and stroke, high blood pressure, noninsulin-dependent diabetes, obesity, back pain, osteoporosis, and can improve your mood and help you to better manage stress.

For the greatest overall health benefits, experts recommend that you do 20 to 30 minutes of aerobic activity three or more times a week and some type of muscle strengthening activity and stretching at least twice a week. However, if you are unable to do this level of activity, you can gain substantial health benefits by accumulating 30 minutes or more of moderate-intensity physical activity a day, at least five times a week.

If you have been inactive for a while, you may want to start with less strenuous activities such as walking or swimming at a comfortable pace. Beginning at a slow pace will allow you to become physically fit without straining your body. Once you are in better shape, you can gradually do more strenuous activity.

Apply as third level heading, left aligned, font specification as verdana, font style as bold and font colour as medium purple.

How Physical Activity Impacts Health

Regular physical activity that is performed on most days of the week reduces the risk of developing or dying from some of the leading causes of illness and death in the United States.

- Reduces the risk of dying prematurely.
- Reduces the risk of dying prematurely from heart disease.
- Reduces the risk of developing diabetes.
- Reduces the risk of developing high blood pressure.
- Helps reduce blood pressure in people who already have high blood pressure.
- Reduces the risk of developing colon cancer.
- Reduces feelings of depression and anxiety.
- Helps control weight.
- Helps build and maintain healthy bones, muscles, and joints.
- Helps older adults become stronger and better able to move about without falling.
- Promotes psychological well-being

Apply as third level heading, left aligned, font specification as verdana, font style as bold and font colour as medium purple.

Specific Health Benefits of Exercise

Heart Disease and Stroke. Daily physical activity can help prevent heart disease and stroke by strengthening your heart muscle, lowering your blood pressure, raising your high-density lipoprotein (HDL) levels (good cholesterol) and lowering low-density lipoprotein (LDL) levels (bad cholesterol), improving blood flow, and increasing your heart's working capacity.

High Blood Pressure. Regular physical activity can reduce blood pressure in those with high blood pressure levels. Physical activity also reduces body fatness, which is associated with high blood pressure.

Apply font style as bold and italic, and font size of 10.

Exercise 2b:

Having completed 2a, please perform the following:

1. Create a link to the text ***Stroke (which can be found under the heading of* 'Specific Health Benefits of Exercise'**) to link the following address in a new window.

   Address: **http://en.wikipedia.org/wiki/Stroke**

2. Create a link at the top of the page, which will enable us to jump all the way to the bottom of the page.
3. Create a link at the bottom of the page, which will enable us to shift back to the top of the page.
4. Save exercise 2 in your folder.

Exercise 3:

Copy **`empty.html`** to a new page called **`exercise3.html`** and perform the following:

1. Create a level 1 heading, titled "Cocktails", and with left alignment.
   Below the title insert a horizontal bar.
2. Below the horizontal bar, insert the image 'image.jpg' with border = 0 **(the image is available in the practicaltask folder on the desktop)**
3. Create a line break and insert the following texts with paragraphs:-

   Paragraph 1: *Cocktail making can be appreciated by everyone from the beginner to the bar expert and with so many choices of cocktails on offer, you would be hard-pushed not to find satisfaction.*

   Paragraph 2: *We hope you benefit from the extensive database of new and classic cocktails, the hints and tips we have made available and of course the ingredients and equipment with which to make them.*

4. **From (4),** change the font style as italic, the font size to 11 and font specification to Arial.
5. Use hspace of value 80 and vspace of value 80 to align the above image to the left.
6. Save exercise 3 in your folder.

Exercise 4:

Copy **`empty.html`** to a page called **`exercise4.html`** and perform the following:

1. Create a heading (using **`<h2></h2> tags`**) and with title “My Web Site.”
2. Below the heading create an unordered list containing links of the following three exercises that you have done so far:

   index.html – Index

   exercise2.html – Exercise 2

   exercise3.html – Exercise 3

   empty.htm – Empty

3. Create a new heading, of level 2, and of title ‘My Favourite Sites.’ Create an ordered list of two absolute links to your favourite websites, where the target must be blank.
4. Using the image named **home.gif (which is available in the practical task folder on the desktop)**, show how you are going to use it as a relative link to access to the file ‘index.html.’
5. Save exercise 4 in your folder.

Exercise 5:

Copy empty.html to a new page called exercise5.html and then perform the following:

1. Type the following text: *‘My family has a number of cars. Their names and the cars that they drive are presented in the Table below.’*
2. Create a table below the text to show the following information:

Name	**Relation**	**Car**
Paul	Brother	BMW
Jason	Brother	Porsche
Jane	Sister	Koenigsegg
Dona	Sister	Ferrari Enzo

3. Add a border of width =1 to the table.
4. Add a caption ‘My family and cars’; and the following three headers – Name, Relation and Car to the table.
5. Save exercise 5 in your folder.

A.11 Interview Form/Questions in Relation to the HLS that provided NO Instructional Aids

Participant number: ________

Instruction:

- *In this session we will ask you a set of questions in relation to your attitudes towards the HLS that you used to perform your learning.*

- *You will be able to give your opinions, beliefs, preferences, experiences and suggestions.*

- *Your responses will be strictly kept confidential*

Question 1
Theme: structure

(i) Did you like the structure of the HLS?

If yes, can you explain why?

If no, can you explain why?

Question 2
Theme: navigation

(i) Did you experience any difficulties navigating through the HLS to perform your learning?

If yes, can you please explain why?

If no, can you please explain why?

(ii) Did you enjoy with the levels of freedom of navigation that were given in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

<u>Question 3</u>
Theme: disorientation

(i) Did you experience any higher levels of disorientation in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

<u>Question 4</u>
Theme: overall satisfaction

(i) Overall, are you satisfied with the HLS?

If yes, can you please explain why?

If no, can you please explain why?

(ii) Would you continue to learn in this type of HLS?

(iii) Have you got any suggestions and recommendations to improve this type of learning system?

If yes, can you please talk about them?

A.12 Interview Form/Questions in Relation to the HLS that provided Visual Instructional Aids

Participant number: ________

Instruction:

- *In this session we will ask you a set of questions in relation to your attitudes towards the HLS that you used to perform your learning.*
- *You will be able to give your opinions, beliefs, preferences, experiences suggestions.*
- *Your responses will be strictly kept confidential.*

<u>Question 1</u>
Theme: structure

(i) Did you like the structure of the HLS?

If yes, can you please explain why?

If no, can you please explain why?

<u>Question 2</u>
Theme: navigation

(i) Did you experience any difficulties navigating through the HLS to perform your learning?

If yes, can you please explain why?

If no, can you please explain why?

(ii) Did you enjoy with the levels of freedom of navigation that were given in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

Question 3
Theme: disorientation

(i) Did you experience any higher levels of disorientation in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

Question 4
Theme: distraction

(i) Were you distracted by the visual instructional aids while performing your learning in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

Question 5
Theme: dependency upon the visual instructional aids

(i) Were you depended upon the visual instructional aids to perform your learning in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

Question 6
Theme: overall satisfaction

(i) Overall, are you satisfied with the HLS?

If yes, can you please explain why?

If no, can you please explain why?

(ii) Would you continue to learn in this type of HLS?

(iii) Have you got any suggestions and recommendations to improve this type of learning system?

If yes, can you please talk about them?

A.13 Interview Form/Questions in Relation to the HLS that provided Audio Instructional Aids

Participant number: ________

Instruction:

- *In this session we will ask you a set of questions in relation to your attitudes towards the HLS that you used to perform your learning.*

- *You will be able to give your opinions, beliefs, preferences, experiences suggestions.*

- *Your responses will be strictly kept confidential.*

<u>Question 1</u>
Theme: structure

(i) Did you like the structure of the HLS?

If yes, can you please explain why?

If no, can you please explain why?

<u>Question 2</u>
Theme: navigation

(i) Did you experience any difficulties navigating through the HLS to perform your learning?

If yes, can you please explain why?

If no, can you please explain why?

(ii) Did you enjoy with the levels of freedom of navigation that were given in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

(iii) Were you comfortable by the fact that you were not given options other than to use the audio to navigate through the HLS to perform your learning?

If yes, can you please explain why?

If no, can you please explain why?

Question 3
Theme: disorientation

(i) Did you experience any higher levels of disorientation in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

Question 4
Theme: dependency upon the audio instructional aids

(i) Were you depended upon the audio instructional aids to perform your learning in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

Question 5
Theme: distraction

(ii) Were you distracted by the audio instructional aids while performing your learning in the HLS?

If yes, can you please explain why?

If no, can you please explain why?

Question 6
Theme: overall satisfaction

(i) Overall, are you satisfied with the HLS?

If yes, can you please explain why?

If no, can you please explain why?

(ii) Would you continue to learn in this type of HLS?

(iii) Have you got any suggestions and recommendations to improve this type of learning system?

If yes, can you please talk about them?

A.14 Observation Form in Relation to the HLS that provided No Instructional Aids

Two observation forms – one for the tutorial and one for the practical task – were used to observe participants' navigation efficacy, levels of disorientation, learning performance and unexpected findings/observations.

Participant number: ________

Observation form in relation the tutorial

1. Navigation efficacy

2. Levels of disorientation

3. Learning performance

    3.1. Time taken to complete the tutorial

    3.2. Time taken to complete the practical task

    3.3. Number of exercises completed in the practical task

4. Unexpected observations/findings

<u>Observation form in relation the practical task</u>

1. Navigation efficacy

2. Levels of disorientation

3. Learning performance

    3.1. Time taken to complete the practical task

    3.2. Number of exercises completed in the practical task

4. Unexpected observations/findings

A.15 Observation Form in Relation to the HLS that provided Instructional aids (Visual and Audio)

Two observation forms – one for the tutorial and one for the practical task – were used to observe participants' navigation efficacy, levels of disorientation, learning performance, use of the instructional aids (visual and audio) and unexpected findings/observations.

Participant number: ________

---

1. Navigation efficacy

2. Levels of disorientation

3. Learning performance

   3.1. Time taken to complete the tutorial

   3.2. Time taken to complete the practical task

   3.3. Number of exercises completed in the practical task

4. Levels of dependency on the instructional aids (audio – optional audio elements; visual elements) to complete the exercises

5. Unexpected observations/findings

Observation form in relation the practical task

1. Navigation efficacy

2. Levels of disorientation

3. Learning performance

   3.1. Time taken to complete the practical task

   3.2. Number of exercises completed in the practical task

4. Levels of dependency on the instructional aids (audio – optional audio elements; visual elements) to complete the exercises

5. Unexpected observations/findings

APPENDIX B: SIGNIFICANT RESULTS FROM EXPERIMENT 2 IN RELATION TO THE HLS THAT PROVIDED NO INSTRUCTIONAL AIDS

B.1 (a) Analysis of variance of disorientation results

Question 1: "I know my current location in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.833		2.750		1.417		4.667		2.500		5.333		5.250		5.083	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	4	33	2	16	2	16	0	0	1	8	0	0	0	0	0	0
Disagree	2	17	1	8	7	58	0	0	2	17	0	0	0	0	0	0
Slightly disagree	2	17	3	25	1	8.3	2	16	5	42	0	0	1	8	1	8
Neither	0	0	0	0	2	16	0	0	0	0	0	0	0	0	0	0
Slightly agree	4	33	4	33	0	0	1	8	2	17	1	8	1	8	1	8
Agree	0	0	2	16	0	0	6	50	2	17	6	50	3	25	5	42
Strongly agree	0	0	0	0	0	0	3	25	0	0	5	42	7	58	5	42
Significance	F(1,88)= 21.537, p= 0.000															
Question 2: "Being on the current page I know what I was reading previously in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	0.833		3.917		0.417		5.083		2.000		5.167		5.500		5.417	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	4	33	0	0	7	58.3	0	0	2	17	0	0	0	0	0	0
Disagree	6	50	2	17	5	41.7	0	0	3	25	0	0	0	0	0	0
Slightly disagree	2	17	1	8	0	0	1	8	4	33	1	8	0	0	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	0	0	4	33	0	0	2	17	2	17	1	8	0	0	1	8
Agree	0	0	3	25	0	0	3	25	1	8	4	33	6	50	5	42
Strongly agree	0	0	2	17	0	0	6	50	0	0	6	50	6	50	6	50
Significance	F(1,88)= 28.033, p= 0.000															

B.1 (b) Analysis of variance of disorientation results

Question 3: "Being on the current page, I know where to go next in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	0.583		4.333		1.167		4.833		2.083		4.417		5.667		5.833	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	9	75	0	0	4	33	0	0	1	8	1	8	0	0	0	0
Disagree	1	8	0	0	4	33	0	0	3	25	0	0	0	0	0	0
Slightly disagree	1	8	2	17	3	25	1	8	5	42	1	8	0	0	0	0
Neither	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	1	8	3	25	1	8	2	17	3	25	2	17	0	0	0	0
Agree	0	0	6	50	0	0	6	50	0	0	5	42	4	33	2	17
Strongly agree	0	0	1	8	0	0	3	25	0	0	3	25	8	67	10	83
Significance	F(1,88)= 4.732, p= 0.032															

Question 4: "I know how to reach my desired location in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	0.917		4.500		1.667		4.000		1.500		5.250		5.667		5.750	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	6	50	0	0	1	8	0	0	3	25	0	0	0	0	0	0
Disagree	3	25	1	8	6	50	0	0	4	33	0	0	0	0	0	0
Slightly disagree	2	17	1	8	3	25	3	25	3	25	0	0	0	0	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	1	8	2	17	2	17	3	25	2	17	2	17	0	0	0	0
Agree	0	0	5	42	0	0	6	50	0	0	5	42	4	33	3	25
Strongly agree	0	0	3	25	0	0	0	0	0	0	5	42	8	67	9	75
Significance	F(1,88)= 6.961, p= 0.010															

B.2 (a) Learning performance results

Post-test score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	9.167	16.833	7.833	18.677	17.583	18.083	19.250	19.000
Significance: F(1,88)= 19.517, p= 0.000								
Practical task score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	24.667	41.833	27.917	42.167	47.750	46.500	47.750	48.667
Significance: F(1,88)= 4.226, p= 0.043								
Test-gain score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	8.583	16.167	7.417	18.167	2.667	2.917	1.167	2.000
Significance: F(1,88)= 4.268, p= 0.042								

B.2 (b) Learning performance results

Time efficacy – length of time taken to complete the XHTML tutorial								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	60.833	35.417	51.083	31.667	35.417	12.917	12.917	13.000
Significance: F(1,88)= 4.199, p= 0.043								
Time efficacy – length of time taken to complete the practical task								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	58.333	34.833	55.000	35.000	12.417	12.417	13.750	12.083
Significance: F(1,88)= 4.740, p= 0.032								

B.3 (a) Attitude results

Question 1: "Overall, I like the structure that is offered in the HLS

Experience Profiles	Low DK and low CE				Low DK and high CE				High DK and low CE				High DK and high CE			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.417		4.083		1.083		4.167		2.250		4.500		5.583		5.583	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	2	17	0	0	6	50	0	0	1	8	0	0	0	0	0	0
Disagree	6	50	0	0	3	25	1	8	3	25	0	0	0	0	0	0
Slightly disagree	2	17	3	25	1	8	2	17	4	33	2	17	0	0	0	0
Neither	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	1	8	3	25	2	17	2	17	4	33	3	25	0	0	0	0
Agree	0	0	5	42	0	0	5	42	0	0	4	33	5	42	5	42
Strongly agree	0	0	1	8	0	0	2	17	0	0	3	25	7	58	7	58
Significance	$F(1,88) = 6.729$, $p=0.011$															

Question 2: " I experience difficulties navigating through the HLS to perform my learning"

Experience Profiles	Low DK and low CE				Low DK and high CE				High DK and low CE				High DK and high CE			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.333		4.750		1.500		4.333		1.667		4.667		5.750		5.583	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	4	33	0	0	2	17	0	0	0	0	0	0	0	0	0	0
Disagree	4	33	0	0	4	33	0	0	0	0	0	0	0	0	0	0
Slightly disagree	2	17	1	8	5	42	3	25	1	8	1	8	0	0	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	2	17	3	25	1	8	2	17	4	33	4	33	0	0	0	0
Agree	0	0	5	42	0	0	4	33	4	33	4	33	3	25	5	42
Strongly agree	0	0	3	25	0	0	3	25	3	25	3	25	9	75	7	58
Significance	$F(1,88)= 7.655$, $p=0.007$															

B.3 (b) Attitude results

Question 3: " I enjoy the levels of freedom of navigation that are offered in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	1.083		4.167		1.333		5.000		2.000		5.250		5.583		5.500	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	5	42	0	0	5	42	0	0	2	17	0	0	0	0	0	0
Disagree	2	17	1	8	1	8	0	0	2	17	0	0	0	0	0	0
Slightly disagree	4	33	2	17	4	33	1	8	5	42	0	0	0	0	0	0
Neither	1	8	0	0	1	8	0	0	1	8	0	0	0	0	0	0
Slightly agree	0	0	3	25	1	8	3	25	1	8	3	25	1	8	0	0
Agree	0	0	3	25	0	0	2	17	1	8	6	50	3	25	6	50
Strongly agree	0	0	3	25	0	0	6	50	0	0	3	25	8	67	6	50
Significance	$F(1,88)= 16.407, p= 0.000$															

Question 4: "Overall, I experience high levels of disorientation in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	4.750		1.500		5.000		2.000		3.167		0.667		0.417		0.417	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	0	0	4	33	1	8	1	8	1	8	8	67	8	67	7	58
Disagree	0	0	2	17	0	0	4	33	2	16	2	17	3	25	5	42
Slightly disagree	1	8	4	33	0	0	4	33	1	8	1	8	1	8	0	0
Neither	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	2	17	2	17	0	0	3	25	6	50	1	8	0	0	0	0
Agree	7	58	0	0	6	50	0	0	2	17	0	0	0	0	0	0
Strongly agree	2	17	0	0	5	42	0	0	0	0	0	0	0	0	0	0
Significance	$F (1,88) = 4.725, p = 0.032$															

B.3 (c) Attitude results

Question 7: "Overall, I am satisfied learning in the HLS"																
Experience Profiles	**Low DK and low CE**				**Low DK and high CE**				**High DK and low CE**				**High DK and high CE**			
	FD		**FI**		**FD**		**FI**		**FD**		**FI**		**FD**		**FI**	
Mean	0.417		3.917		1.333		4.833		2.167		4.833		5.250		5.500	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Strongly disagree	8	67	1	8	2	17	0	0	1	8.3	0	0	0	0	0	0
Disagree	3	25	0	0	6	50	1	8	6	50	2	17	0	0	0	0
Slightly disagree	1	8	0	0	3	25	0	0	2	17	0	0	0	0	0	0
Neither	0	0	1	8	0	0	0	0	0	0	0	0	0	0	0	0
Slightly agree	0	0	6	50	1	8	1	8	0	0	1	8	2	17	1	8
Agree	0	0	4	33	0	0	7	58	2	17	2	17	5	42	4	33
Strongly agree	0	0	0	0	0	0	3	25	1	8	7	58	5	42	7	58
Significance	$F(1,88) = 5.047$, $p = 0.027$															

B.4 Open-ended questionnaires results

Experience profiles: low DK and low CE; low DK and high CE; high DK and low CE			Experience profile: High DK and high CE	
FD	1.	"I am unsatisfied learning in the HLS because I cannot impose a structure on the learning content, experiencing higher levels of disorientation." *(Low DK and high CE)*	7.	"Overall, I am happy learning in the HLS as I have more control over the tutorial."
	2.	"I cannot learn in the HLS at all. The high levels of flexibility offered in the HLS structure makes it difficult for me set my own learning paths to achieve my learning goals. " *(Low DK and low CE)*	8.	"I am satisfied with the HLS as I can reach the information I need easily and quickly."
	3.	"I do not like the HLS because I find it difficult to navigate through the HLS to reach the information that I need." *(High DK and low CE)*	9.	"I can access content in accordance with their information needs and navigation preferences in the non-linear environment."
FI	4.	"The HLS is structured in such a way that it allows me to set my own learning paths in relation to the information I need in the tutorial." *(Low DK and low CE)*	10.	"The high levels of flexibility that are offered in the HLS permit me high levels of freedom of navigation and to have more control over the tutorial."
	5.	"I am happy learning in the HLS because I can make use of the flexibility that is offered in the tutorial." *(High DK and low CE)*	11.	"The HLS provides non-linearity features which I always prefer to perform my learning with."
	6.	"Overall, I am satisfied learning in the HLS as I can enjoy some levels of freedom of navigation." *(Low DK and high CE)*	12.	"I enjoy learning in the HLS because the learning content of the XHTML is presented in non-linear structure."

B.5 (a) Interview results in relation to FD/FI with low DK and CE, low DK and high CE, or high DK and low CE

	Structure		Navigation		Disorientation		Satisfaction	
FD	1.	"I cannot learn in a HLS which presents its learning content in non-linear structure. I prefer linear structure. " *(low DK and low CE)*	7.	"I know what I need to refer to in relation to the learning content, but I have difficulties navigating through the HLS to reach this information." *(High DK and low CE)*	13.	"I experience high levels of disorientation in the HLS. I do not know my current location, where to go and how to reach a desired destination" *(Low DK and low CE)*	19.	"This HLS is not suitable for me. I cannot learn effectively in this HLS." *(Low DK and high CE)*
	2.	"The Non-linear structure makes it difficult for me to map a mental representation of the physical arrangement of HLS document." *(High DK and low CE)*	8.	"The flexibility offered in the HLS makes it very difficult for me to choose my own learning paths to achieve my learning goals." *(Low DK and high CE)*	14.	"Knowing where to go, I find it hard to reach my destination in the HLS. Overall, I experience high levels of disorientation in such HLS." *(High DK and low CE)*	20.	"I am unsatisfied with the HLS as I experience high levels of disorientation, and in turn, hinder my learning performance." *(Low DK and low CE)*
	3.	"The non-linear structure makes it difficult for me to impose a structure on the learning content that is presented in the HLS." *(Low DK and high CE)*	9.	"I have difficulties navigating through the HLS to perform my learning." *(Low DK and low CE)*	15.	"I cannot impose a structure on the learning content, and in turn I experience high levels of disorientation." *(Low DK and high CE)*	21.	"I do not like the HLS because of the non-linearity features and the absence of instructional aids." *(High DK and low CE)*
FI	4.	"The structure in the HLS permits me to set my own learning paths in the tutorial." *(low DK and low CE)*	10.	"I can navigate effectively through the HLS to achieve my learning goals." *(Low DK and high CE)*	16.	"I know where to go, how to reach my desired location, and what I read previously in the HLS. I experience little disorientation in the HLS" *(High DK and low CE)*	22.	"I like the HLS because I do not experience high disorientation, and I can set my own learning too." *(Low DK and low CE)*
	5.	"I have shown a positive attitude towards the structure as it provides flexibility in terms of navigation." *(Low DK and high CE)*	11.	"I am happy with the levels of freedom of navigation which is offered in the HLS." *(High DK and low CE)*	17.	"I experience little disorientation in the HLS and I know how to handle to such issue." *(Low DK and low CE)*	23.	"I am satisfied with the HLS as it offers levels of flexibility which I normally prefer when learning." *(High DK and low CE)*
	6.	"The structure as it enables me to decide what and which way I am going to view each lesson in the tutorial." *(High DK and low CE)*	12.	"I am able to set my own navigation paths while performing my learning in the HLS." *(Low DK and low CE)*	18.	"I feel low levels disorientation in the HLS." *(Low DK and high CE)*	24.	"I am satisfied learning in the HLS." *(low DK and high CE)*

B.5 (b) Interview results in relation to FD/FI with high DK and high CE

	Structure		Navigation		Disorientation		Satisfaction	
FD/FI	1.	"The non-linear structure permits me to have more control of the tutorial."	4.	"I enjoy high levels of freedom of navigation in the HLS which I normally prefer when learning."	7.	"I do not experience any level of disorientation in the HLS."	10.	"I am satisfied with the HLS as, firstly, I can learn at my own pace, and secondly, I do not experience disorientation."
	2.	"The structure offered in the HLS allows me to enjoy high levels of freedom of navigation and to reach specific information easily and quickly."	5.	"I have no difficulty navigating through the HLS to perform my learning."	8.	"I can impose a structure on the learning content and have knowledge about the physical arrangement of the document that is specified by the hypermedia nodes, preventing me from disorientation"	11.	"I am happy learning in the HLS because of its non-linearity features."
	3.	"The non-linear structure allows me to access and sequence the information in accordance with the information that I need in the tutorial."	6.	The HLS permits me to set my own navigation paths when using the tutorial.	9.	"I can navigate and orientate effectively through the HLS while completing the tutorial. Overall, I do no encounter disorientation in the HLS."	12.	"Overall, I am happy with the HLS because I have more control over the tutorial and enjoy high levels of freedom of navigation."

B.6 (a) Observation results related to navigation

<table>
<tr><th rowspan="3">Experience Profiles</th><th colspan="4">Navigation</th></tr>
<tr><th colspan="2">In the Tutorial</th><th colspan="2">In the Practical Task</th></tr>
<tr><th>Navigate effectively</th><th>Navigate less effectively</th><th>Navigate effectively</th><th>Navigate less effectively</th></tr>
<tr><td>(i) Low DK and low CE</td><td>FI</td><td>FD</td><td>FI</td><td>FD</td></tr>
<tr><td>(ii) Low DK and high CE</td><td>FI</td><td>FD</td><td>FI</td><td>FD</td></tr>
<tr><td>(iii) High DK and low CE</td><td>FD and FI</td><td></td><td colspan="2">Both FD and FI users interacted very less with the HLS, and therefore, the observation data related to navigation were not gathered.</td></tr>
<tr><td>(iv) High DK and high CE</td><td>FD and FI</td><td></td><td colspan="2">Both FD and FI users interacted very less with the HLS, and therefore, the observation data related to navigation were not gathered.</td></tr>
</table>

B.6 (b) Observation results related to disorientation

Experience Profiles	Levels of Disorientation					
	In the Tutorial			In the Practical Task		
	Low-level	High-level	None	Low- level	High-level	None
(i) Low DK and low CE	FI	FD		FI	FD	
(ii) Low DK and high CE	FI	FD		FI	FD	
(iii) High DK and low CE	FI	FD		Observation data on disorientation was not gathered since both FD and FI interacted very less with the HLS.		
(iv) High DK and high CE			FD and FI	Observation data on disorientation was not gathered since both FD and FI interacted very less with the HLS.		

B.6 (c) Observation results related to time-efficacy

Experience Profiles	**Time efficacy**	
	In the Tutorial	**In the Practical Task**
(i) Low DK and low CE	FD spent more time than FI	FD spent more time than FI
(ii) Low DK and high CE	FD spent more time than FI	FD spent more time than FI
(iii) High DK and low CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI
(iv) High DK and high CE	FD spent the same amount of time as FI	FD spent the same amount of time as FI

B.6 (d) Observation results related to completion of exercises

Experience Profiles	Number of exercises completed in the practical task	
	some of the exercises	all of the exercises
(i) Low DK and low CE	FD	FI
(ii) Low DK and high CE	FD	FI
(iii) High DK and low CE		FD and FI
(iv) High DK and high CE		FD and FI

B.7 High level findings

Learning performance		Low DK & low CE	Low DK & high CE	High DK & low CE	High DK & high CE
Post-test/practical task scores		FD performed worse than FI.	FD performed worse than FI.	FD performed as well as FI.	FD performed as well as FI.
Test-gain		FD achieved lower gain scores than FI.	FD achieved lower gain scores than FI.	FD and FI users achieved low gain scores.	FD and FI achieved lower gain scores.
Time-efficacy	Tutorial	FD spent more time than FI.	FD spent more time than FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
	Practical Task	FD spent more time than FI.	FD spent more time than FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
Observation					
Navigation	Tutorial	FD had more difficulties navigating through the tutorial than FI.	FD had more difficulties navigating through the tutorial than FI.	FD had more difficulties navigating through the tutorial than FI.	FD and FI navigated effectively through the HLS
	Practical task	Similar findings (to those gathered in the tutorial) were identified.	Similar findings (to those gathered in the tutorial) were identified.	FD and FI interacted less with the HLS, so no observation data on navigation was gathered.	FD and FI interacted less with the HLS, so no observation data on navigation was gathered.
Disorientation	tutorial	FD suffered more disorientation than FI.	FD suffered more disorientation than FI.	FD suffered more disorientation than FI.	FD and FI did not experience disorientation
	Practical task	FD suffered more disorientation than FI.	FD suffered more disorientation than FI.	FD and FI interacted very little with the HLS, so no observation data on disorientation was gathered.	FD and FI interacted very little with the HLS, so no observation data on disorientation was gathered.
Time efficacy	tutorial	FD spent more time than FI.	FD spent more time than FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
	Practical task	FD spent more time than FI.	FD spent more time than FI.	FD spent same amount of time as FI.	FD spent same amount of time as FI.
No. of exercises completed		FI completed all exercises than FD.	FI completed all exercises than FD.	FD and FI completed all exercises.	FD and FI completed all exercises.
Attitudes/opinions of the HLS gathered from questionnaires and semi-structured interviews		FD showed negative attitudes towards the HLS: said they experienced high levels of disorientation in the HLS, and in turn, failed to learn effectively. In contrast, FI favoured the HLS: said they were enabled to make use of the flexibility in the tutorial; were allowed to set their own navigation paths in the tutorial; and experienced little disorientation.	Similar findings to those gathered from the low DK and low CE experience profile groups were identified.	FD showed a negative attitude towards the HLS: their low levels of CE made it difficult for them to use the HLS, leading to greater disorientation. Conversely, FI showed a positive attitude towards the HLS: they gave the same reasons for favouring the HLS as to those given by FI participants with low DK and low CE, and low DK and high CE.	FD and FI showed a positive attitude towards the HLS because of three main reasons. Firstly, they were enabled to navigate effectively through the HLS and did not experience disorientation. Secondly, they had more control over the tutorial and thirdly they enjoyed high levels of freedom of navigation in the HLS.

APPENDIX C: OTHER ANOVA RESULTS

C.1 Disorientation results in relation to the HLS that provided visual instructional aids

Question 1: "I know my current location in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.083	5.083	5.667	5.333	4.917	5.083	5.583	5.417
Significance	F(1,88)= 0.000, p= 1.000							

Question 2: "Being on the current page I know what I was reading previously in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	4.667	4.833	5.000	4.833	5.500	5.083	5.417	5.417
Significance	F(1,88)= 0.980, p= 0.325							

Question 3: "Being on the current page, I know where to go next in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.083	5.250	5.667	5.500	5.333	5.000	5.417	5.333
Significance	F(1,88)= 1.445, p= 0.233							

Question 4: "I know how to reach my desired location in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.333	5.083	5.000	5.333	5.250	5.083	5.667	5.417
Significance	F(1,88)= 1.304, p= 0.257							

C.2 Learning performance results in relation to the HLS that provided visual instructional aids

Post-test score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	14.083	13.083	13.333	13.417	17.750	18.500	18.250	18.583
Significance: F(1,88)= 4.521, p= 0.390								

Practical task score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	40.917	41.917	43.250	42.417	47.667	48.333	48.250	48.417
Significance: F(1,88)= 0.364, p= 0.548								

Test-gain score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	13.417	12.750	11.583	11.917	3.250	3.750	2.750	3.333
Significance: F(1,88)= 0.111, p= 0.740								

Time efficacy – length of time taken to complete the XHTML tutorial								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	36.917	34.083	35.417	33.083	11.667	11.500	10.917	10.833
Significance: F(1,88)= 0.038, p= 0.846								

C.3 Attitude results in relation to the HLS that provided visual instructional aids

Question 1: "Overall, I like the structure that is offered in the HLS								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.333	5.167	4.917	5.083	4.750	4.833	5.250	5.333
Significance	F(1,88)= 0.148, p=0.701							

Question 2: " I experience difficulties navigating through the HLS to perform my learning"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	0.750	0.750	0.750	0.833	1.000	1.250	0.750	0.667
Significance	F(1,88)= 0.240, p=0.626							

Question 4: "Overall, I experience high levels of disorientation in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	0.500	0.583	0.750	0.833	0.917	1.000	0.583	0.500
Significance	F(1,88) = 0.070, p=0.793							

Question 6: "I am distracted by the visual instructional aids in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	0.750	0.833	1.000	0.917	0.750	0.750	0.833	0.833
Significance	F(1,88) = 0.032, p=0.858							

Question 7: "Overall, I am satisfied learning in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.083	5.000	5.583	5.000	4.583	4.917	5.500	5.417
Significance	F(1,88) = 0.012, p=0.913							

C.4 Disorientation results in relation to the HLS that provided audio instructional aids

Question 1: "I know my current location in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.333	5.667	5.583	5.333	5.417	5.583	5.750	5.417
Significance	F(1,88)= 0.042, p= 0.838							
Question 2: "Being on the current page I know what I was reading previously in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.333	5.083	5.250	5.583	5.500	5.667	5.583	5.417
Significance	F(1,88)= 3.060, p= 0.084							
Question 3: "Being on the current page, I know where to go next in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.333	5.083	4.833	5.250	4.417	4.833	5.417	5.583
Significance	F(1,88)= 2.057, p= 0.155							
Question 4: "I know how to reach my desired location in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.250	5.167	5.333	5.250	5.083	5.500	5.750	5.417
Significance	F(1,88)= 2.482, p= 0.119							

C.5 (a) Learning performance results in relation to the HLS that provided audio instructional aids

Post-test score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	15.570	15.583	15.333	15.000	18.583	19.000	18.750	19.750
Significance: F(1,88)= 0.497, p= 0.482								

Practical task score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	41.667	42.500	44.250	43.00	47.833	47.833	49.167	48.667
Significance: F(1,88)= 0.446, p= 0.506								

Test-gain score								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	15.167	15.000	14.250	13.500	2.667	3.333	2.750	3.167
Significance: F(1,88)= 0.050, p= 0.824								

C.5 (b) Learning performance results in relation to the HLS that provided audio instructional aids

Time efficacy – length of time taken to complete the XHTML tutorial								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	42.917	41.667	37.333	37.917	13.167	12.083	12.167	11.500
Significance: F(1,88)= 0.329, p= 0.568								
Time efficacy – length of time taken to complete the practical task								
	Low DK and low CE		Low DK and high CE		High DK and low CE		High DK and high CE	
	FD	FI	FD	FI	FD	FI	FD	FI
Mean	43.750	40.833	41.667	39.167	14.250	13.833	13.333	12.333
Significance: F(1,88)= 0.171, p= 0.681								

C.6 Attitude results in relation to the HLS that provided audio instructional aids

Question 2: " I experience difficulties navigating through the HLS to perform my learning"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	5.333	5.583	5.583	5.583	5.583	5.500	5.417	5.667
Significance	F(1,88)= 1.803, p=0.183							
Question 4: "Overall, I experience high levels of disorientation in the HLS"								
Experience Profiles	**Low DK and low CE**		**Low DK and high CE**		**High DK and low CE**		**High DK and high CE**	
	FD	**FI**	**FD**	**FI**	**FD**	**FI**	**FD**	**FI**
	N=12	N=12	N=12	N=12	N=12	N=12	N=12	N=12
Mean	0.417	0.417	0.500	0.667	1.000	1.167	0.417	0.500
Significance	F(1,88) = 0.168, p=0.683							